Document 354-92

MG

RCC

RANGE ATMOSPHERIC AND OCEANIC ENVIRONMENTAL SUPPORT CAPABILITIES, REQUIREMENTS, AND PROCUREMENT

METEOROLOGY GROUP

RANGE COMMANDERS COUNCIL

WHITE SANDS MISSILE RANGE
KWAJALEIN MISSILE RANGE
YUMA PROVING GROUND
ELECTRONIC PROVING GROUND
DUGWAY PROVING GROUND

NAVAL AIR WARFARE CENTER-WEAPONS DIVISION
ATLANTIC FLEET WEAPONS TRAINING FACILITY
NAVAL AIR WARFARE CENTER-AIRCRAFT DIVISION
NAVAL UNDERSEA WARFARE CENTER, DIVISION NEWPORT

45TH SPACE WING
AIR FORCE DEVELOPMENT TEST CENTER
30TH SPACE WING
CONSOLIDATED SPACE TEST CENTER
AIR FORCE FLIGHT TEST CENTER
AIR FORCE TACTICAL FIGHTER WEAPONS CENTER

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Prepared by

METEOROLOGY GROUP
RANGE COMMANDERS COUNCIL

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PREFACE

The objective of the Range Commanders Council (RCC) is to enhance the national capability for research, development, test, and evaluation at member ranges. To implement this objective, the RCC and its technical and operational groups seek to improve the overall responsiveness, efficiency, effectiveness, and economical operation of the member ranges, individually and collectively. The RCC Meteorology Group (MG) is concerned with bettering the capabilities of range geophysical agencies to define the effects of atmospheric and oceanic parameters on aeronautical, marine, missile, and space systems. The MG focuses its efforts on the instrumentation and techniques used to measure, predict, and evaluate these effects and on improving overall environmental support to range activities and users.

An important aspect of the MG's work is identifying support capabilities and requirements for natural atmospheric and oceanic environments. These capabilities and requirements must satisfy present and projected needs. Planned procurement by individual ranges showing equipment upgrades and possible equipment excess will foster exchanges, transfers, joint procurement, and cost savings to all member ranges. Equipment in excess of individual range requirements is announced in the activity report. Specialized data sets and data bases are identified in this publication for the same reasons as planned procurement. This document represents a current identification of individual range capabilities, requirements, procurement, and specialized data sets and data bases. This new document supersedes document 354-80 which is obsolete and should be destroyed.

The ranges have limited resources to meet the objective of enhancing national capabilities for development and test support. In updating range facilities in support of this objective, the RCC is concerned with where to place these limited resources for R&D and with procurement of instrumentation. This document was prepared by the MG to assist in the determination of atmospheric and oceanic priorities and to consolidate and publicize participating ranges and geophysical capabilities.

The statement of true requirements for data and services is a prerequisite for determining the solutions to the above concerns. Therefore, the RCC has a continuing and pressing need to maintain current validated statements of range and user requirements for natural atmospheric and oceanic environmental services. Satisfaction of that need is complicated by the wide variation of services required, the diverse programs supported, and the governmental agencies and contractors involved in those programs.

Secondary in importance, but vital, is the identification of the instrumentation and techniques that will be required to measure the physical environments in which future systems will operate.

In 1969, to meet the need for requirements statements, the RCC directed the MG to update IRIG Document 108-64, ***Range Users Meteorological Requirements***. The MG formed a committee to revise that document under the expanded concept of range and user needs for natural environmental support. The revision was to include not only requirements for meteorology, but also the needs in such related fields as aeronomy, climatology, geophysics, oceanography, and atmospheric physics. This committee developed document 125-72 to support this task assignment. In 1978, the MG determined that document 125-72 needed to be updated and expanded to include capabilities of the member ranges and requirements for range management and to have a management indicator program for determining their shortfalls and overkills. The committee added planned procurement and equipment excess to requirements for promulgation, joint procurement, and cost savings. In 1980, this publication was reissued as document 125-80, then renumbered to 354-80. Page changes were provided by individual ranges in 1983. This update drops the equipment excess section because it is now identified in individual range activity reports and added data sets and data bases.

This document is in loose-leaf format to accommodate the ever-changing capabilities, requirements, and statements related to atmospheric and oceanic environmental measurements. The document will provide the RCC with a satisfactory basis to plan for the modernization, exchange, joint development and procurement of the instruments, techniques, and services required to meet new demands. It will allow the RCC to maintain a balanced and standardized interrange capability to respond to new needs of the testing community.

Today's atmospheric and oceanic environmental sciences are unable to completely match the ranges' needs for definitive information and predictive capability. Because existing data and current theoretical models are inadequate, areas of development and test application exist in which range users can be offered no more than qualitative interpretations. Within the framework of these limitations, requirements frequently are stated by users in terms of available equipment. At times, the true but unstated requirements are more stringent and cannot be met by present equipment. It is important to distinguish between the requirements that can and cannot be met. This document attempts to identify those requirements exceeding current range capabilities. Thus, this document should furnish a basis for initiating exploratory and advanced development of needed range instrumentation, thereby contributing to the process of range modernization. Two important areas strongly related to range requirements were not investigated nor included in this document. No attempt was made to assess dollar values to different testing processes or to determine which combinations might be optimum for evaluation purposes. These areas are elaborated on in the following paragraphs:

a. In cases of stated user requirements that are in excess of present capabilities, cost-benefit ratios for atmospheric and oceanic environmental data need to be developed. Such ratios would serve to quantify the percentage increase in effectiveness of an operation, or the percentage decrease in operational costs. The ratios would be acquired through a process of development and acquisition of new instrumentation and techniques to meet expanded requirements. This development and procurement process may, in some instances, be hampered by competition with other needs of the development and testing function, by the difficulty in assessing intangible benefits of improved reliability, and by the degree to which overall austerity prevails in a given funding cycle. These factors may delay the improvement of environmental measurement systems; however, the capability for adequately measuring the natural environment in which tests and operations are conducted cannot be indefinitely delayed. The consequence of delay would be high risks in weapon systems decisions, where mistakes can be far more costly than a new data system or improved range facility. When cost-benefit ratios are developed for atmospheric and oceanic environmental data, they will aid the major ranges and test facilities in making decisions for needed modernization.

b. The optimum interface of various combinations of instrumentation must be determined, and advantageous tradeoffs delineated. Typical of these combinations are atmospheric and oceanic data-gathering satellites with surface, rocketsonde, rawinsonde, wind profiler, and buoy-observational stations. Investigations into tradeoffs can answer such questions as whether or not satellites or ground-based indirect sensing will provide enough cloud information to supplant surface observations of cloud type and amount, or if they will provide enough information about vertical profiles of wind and thermodynamic variables to take the place of direct probing by Doppler radar or balloon and rocket soundings. Answers to these types of questions are important, for they may determine if test-site stations can be completely automated to provide a more effective and less costly service to range users.

The MG committee believes that this document will also be extremely valuable to the T&E community when selecting appropriate sites for required system tests. Range users and program planners will be in a better position to plan their tests at minimum cost if they have knowledge of all the major ranges' present and planned atmospheric and oceanic environmental capabilities and climatology. Standard error (accuracy) estimates for meteorological data currently furnished to users at the major ranges are contained in RCC-MG document 353-87, ***Meteorological Data Error Estimates.***

The MG committee will appreciate constructive criticism to assist in improving the document content. Correspondence may be addressed to the Chairman of the Meteorology Group in care of the

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ABBREVIATIONS

AGL	above ground level
C	degrees Celsius
cm	centimeter
E-O	electro-optics
F	degrees Fahrenheit
f/s	feet per second
fcst	weather forecast
g	gram
keV	thousand electron volts
Kft	thousand foot
km	kilometer
kts	knots
m	meter
m/s	meter per second
mbar	millibar
mesomet	mesometeorological
met	meteorological
meV	million electron volts
MHz	megahertz
micro	prefix signifying 1×10^{-6}
min	minute
MSL	mean sea level
NMI	nautical mile
obs	observation
RH	relative humidity
sec	second
sfc	surface
T	temperature
V_E	vector error
V_{EE}	vector error estimate

ACRONYMS

ACU	Acquisition Control Unit
ADAS	Automatic Data Acquisition System
ADP	Automatic Data Processing
AFDTC	Air Force Development Test Center
AFETR	Air Force Eastern Test Range
AFFTC	Air Force Flight Test Center
AFGL	Air Force Geophysics Laboratory
AFGWC	Air Force Global Weather Central
AFMTC	Air Force Missile Test Center
AFSPACECOM	Air Force Space Command
AFSC	Air Force Systems Command
AFTAC	Air Force Technical Applications Center
AFWL	Air Force Weapons Laboratory
AIR	Atmospheric Instrumentation Research Inc.
AL	Astronautics Laboratory
ALTS	Automatic Laser Tracking System
ASL	Army System Laboratory
ASL	Atmospheric Sciences Laboratory
ATCT	Air Traffic Control Tower
AWS	Air Weather Service
BLM	Bureau of Land Management
BMIC	Battle Management Interoperability Center
BWS	Base Weather Station
C3I	Command, Control, Communications, and Intelligence
CCAFS	Cape Canaveral Air Force Station
CCFF	Cape Canaveral Forecast Facility
CCTV	Closed-Circuit Television
CDAPS	Central Data Acquisition Processing System
COMNAVOCEANCOM	Commander Naval Oceanography Command
CSTC/SO	Consolidated Space Test Center/STR Office
CTS	Center Technical Services
DASS	Data Acoustic Sounding System
DBASI	Digital Barometer Altimeter Setting Indicator
DCP	Data Collection Packages
DCP	Data Collection Platform
DF	Direction Finder
DOD	Department of Defense
DOE	Department Of Energy
DPG	Dugway Proving Ground
EATS	Extended Area Test System
EOSAF	Electro-Optical Sensor Evaluation and Analysis Facility
EPG	Electronic Proving Ground
ER	Eastern Range
ESC	Environmental Support Center
ESD	Electronics System Division
ESMC	Eastern Space and Missile Center
ETAC	Environmental Technology Applications Center

ACRONYMS (continued)

45 SPW	45th Space Wing
FAA	Federal Aviation Administration
FBM	Fleet Ballistic Missile
FLC	Flight Line Collimator
FLIR	Forward Looking Infrared
FTSS	Flight Test Support System
GASS	Gas-Aerosol Sensing System
GL	Geophysics Laboratory
GOES	Geo-Stationary Orbital Environmental Satellite
HEL	High Energy Laser
HELMET	High Energy Laser Meteorological (System)
HELSTF	High Energy Laser Systems Test Facility
HQAWS	Headquarters Air Weather Service
IFR	Instrument Flight Rules
IGOR	Intercept Ground Optical Recorder
ILS	Instrument Landing System
IOT&E	Initial Operational Test and Evaluation
IREPS	Intergrated Refractive Effects Prediction System
ITR	Instrumented Test Range
IUAS	Integrated Upper Air System
JCS	Joint Chiefs of Staff
JDMTA	Jonathan Dickinson Missile Tracking Annex
JLRPG	Joint Long Range Proving Ground
JSC	Johnson Space Center
KMR	Kwajalein Missile Range
KSC	John F. Kennedy Space Center
LLP	Lightning Location and Protection
LLS	Lightning Location System
LPATS	Lightning Position Tracking System
LPV	Long Path Visibility
MARSS	Meteorlogical and Range Safety Support System
METR	Marine Environment Test Range
MG	Meteorology Group
MIDDS	Meteorological Interactive Data Display System
MILS	Missile Impact Locating System
MMACPAC	Meteorological Monitoring and Control Package
MMIRL	Mini-Mobile Infrared Laboratory
MSFC	Marshall Space Flight Center
MSS	Meteorological Sounding System

ACRONYMS (continued)

NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASA/MARSHALL	Marshall Space Flight Center
NASA/WALLOPS	Wallops Flight Facility
NAWC-AC, Pax River	Naval Air Warfare Center-Aircraft Division, Patuxent River
NAWC-WEPS, China Lake	Naval Air Warfare Center-Weapons Division, China Lake
NAWC-WEPS, Pt. Mugu	Naval Air Warfare Center-Weapons Division, Point Mugu
NATC	Naval Air Test Center
NCDC	National Climatic Data Center
NFOV	Narrow Field of View
NOAA	National Oceanic and Atmospheric Administration
NOSC	Naval Ocean Systems Center
NTS/DOE	Nevada Test Site
NWC	Naval Weapons Center
NWS	National Weather Service
OD	Operations Directive
OR	Operations Requirements
ORCS	Optical Range Communications System
PAFB	Patrick Air Force Base
PI	Program Introduction
PMTC	Pacific Missile Test Center
POR	Period of Record
PRD	Program Requirements Document
PSP	Program Support Plan
PUP	Principle User Processor
RAWS	Range Automated Weather System
RBC	Rotation Beam Ceilometer
RCC	Range Commanders Council
RCC	Range Control Center
RDT&E	Research, Development, Test, and Evaluation
RIS	Range Instrumentation Ships
RMO	Range Meteorology Office
ROCC	Range Operations Control Center
ROS	Representative Observation Site
RSL	Range Systems Laboratory
RTWAPS	Real-Time Winds Aloft Processing System
SAC	Strategic Air Command
SAMS	Surface Atmospheric Measurements System
SAMS	Surface Automated Measuring System
SAMTC	Space and Missile Test Center
SAMTO	Space and Missile Test Organization
SC	Statement of Capability
SD	Space Division (Los Angeles, CA)
SESC	Space Environmental Services Center

ACRONYMS (continued)

SFC	Space Forecast Center
SLF	Shuttle Landing Facility
SMG	Space Flight Meteorology Group
SMOS	Summary of Meteorological Observations, Surface
6585th TG	6585 Test Group (Holloman AFB)
SNL	Sandia National Laboratories
SPAWARSYSCOM	Space and Naval Warfare Systems Command
STAFFMETS	Staff Meteorologists
STR	Space Test Range
30 SPW	30th Space Wing
TDA	Tactical Decision Aid
TECOM	U.S. Army Test and Evaluation Command
TESS	Tactical Environmental Support System
TFWC	Tactical Fighter Weapons Center
TRACON	Terminal Radar Control
TTR	Tonopah Test Range
UDS	Universal Documentation System
USAEPG	U.S. Army Electronic Proving Ground
USAFETAC	U.S. Air Force Environmental Applications Center
USAKA	U.S. Army Kwajalein Atoll
USASDC	U. S. Army Strategic Defense Command
UTTR	Utah Test and Training Range
VAFB	Vandenberg Air Force Base
VFR	Visual Flight Rules
WINDS	Weather Information Network and Display System
WL	Wright Laboratory
WR	Western Range
WRDC	Wright Research and Development Center
WSMC	Western Space and Missile Center
WSMR	White Sands Missile Range
YPG	Yuma Proving Grounds

NATURAL ENVIRONMENTAL SUPPORT AVAILABLE TO RANGE USERS

From the moment an environmental-sensitive item is envisioned until it is finally delivered to the using agency, the effects of the natural atmospheric and oceanic environment must be considered. These effects fall into four general classes. First, the environment in which the item is expected to operate will influence both its design and its development. Second, the condition of the natural environment at the test site will directly affect the way an item test is conducted as well as the performance of the item during the test. These effects require prior establishment of environmental criteria for the test and of environmental test objectives. Third, the temporal and spatial changes of the environment during the test must be measured at the test site. Finally, the measured effect of the environment on the test item's performance must be evaluated.

For these reasons, individual test range geophysical agencies have responsibilities to their respective agencies and customers to ensure that the atmospheric and oceanic environments are fully considered in the design and development of a test. They also strive to guarantee that appropriate environmental criteria are set for tests, that these criteria are met with adequate environmental test data collected, and that all aspects of the environments are taken into account during the evaluation of these tests.

In the course of fulfilling these four primary responsibilities, test range meteorologists can provide a multitude of services to governmental agencies and authorized contractors. The major ranges' geophysical agencies may

a. **Provide Development Planning Consultant Services**. When given a requirement for a system to eliminate a particular threat, the agencies summarize the environmental envelopes within the possible theaters of operation for decisions involving general classes of guidance and delivery systems. They provide detailed inputs of average and extreme ranges of environmental parameters affecting system components. The agencies furnish values of persistence, predictability, and climatological frequency of operationally critical atmospheric and oceanic parameters to determine operability or optimum mix systems or both. They also specify the extent of natural atmospheric and oceanic environmental limitations to systems.

b. **Furnish Test Planning Consultant Services**. The geophysical agencies identify the environmental sensitivities of components, systems, and techniques proposed for acquisition and testing. The agencies specify the conditions under which environment-sensitive items must be tested, and the environmental elements that must be collected during testing. For laboratories, geophysical agencies identify the areas where environmental data deficiencies will degrade the quality and effectiveness of development programs. They provide government agencies and contractors with climatological planning studies of the various range environments for use in selecting candidate ranges for systems tests. For test and evaluation organizations, the geophysical agencies identify the areas where the lack of an adequate environmental data base will reduce reliability of test programs. The agencies aid in the preparation of environmental impact-of-testing statements in test documentation. They provide needed consultation for selection and documentation of the best approach to collecting environmental data for individual tests and give advice on possible tradeoffs to overcome any environmental degradation of test-item performance. The agencies specify to the individual ranges the geophysical equipment and facilities that require updating to provide and to maintain a viable range capability for testing in the atmospheric and oceanic environment.

c. **Provide Data Acquisition and Forecast Services**. The geophysical agencies gather atmospheric and oceanic environmental data during tests, providing measurements of normal and specialized environmental parameters at ground level, on towers, by indirect sensing (including the use of satellites), and by physical probing of the atmosphere to heights of 100 km. Using current test site data, the resources of the National Weather Service and DOD weather services, and the facilities of a fully-equipped weather station, the geophysical agencies provide close forecasting support to individual range projects.

d. **Perform Evaluation Services**. The agencies evaluate and analyze atmospheric and oceanic environmental effects on performance of items during testing. They assess relative merits of competing systems from the environmental standpoint and assist in defining engineering design action and alterations needed to optimize system effectiveness with respect to the natural environment. After tests are completed, the agencies also aid in the preparation of environmental data for reports. For a summary of the environmental equipment and capabilities for the Range Commanders Council ranges, see the following chart.

X = Have Capability
P = Planned

SUMMARY OF THE ENVIRONMENTAL EQUIPMENT/CAPABILITIES FOR THE RANGE COMMANDERS COUNCIL - METEOROLOGY GROUP

EQPMTS/SVCS	45SPW	NAWC-WEPS PT. MUGU	WSMR	30SPW	AFDTC	AFFTC	KMR	NAWC-WEPS CHINA LAKE	YPG	DPG	6585TG	EPG	TTR	NAWC-AC PAX RVR	STR	WL	UTTR
Fcst Svcs	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Consult Svcs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ADP Met Data	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
SFC Obs																	
24 Hour	X	X	X		X		X				X			X		X	
Restricted Hrs				X		X		X	X	X		X	X				X
Fixed Sta	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Mobile Sta	X	X	X	X	X		X	X	X	X	X	X	X	X			X
Towers	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
Upper Air Obs																	
Rawinsonde																	
Fixed	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X
Mobile	X	X	X	X	X	X		X	X	X		X	X	X			X
Rocketsonde																	
Fixed	X	X	X				X						X				
Mobile	X																
Profiler																	
Fixed	X		P	X						X			P				X
Mobile								P		P							
PIBAL																	
Single	X	X	X	X	X	X	X	X	X	X		X		X			X
Dual	X	X	X	X	X	X	X	X	X	X		X					
Oceanic Obs																	
SST		X		X			X							X			
Tide		X		X			X										
Wave/Swell		X		X			X										
Current		X															
Salinity		X															
Special Instru																	
Wx Radar	X	P	X	X	X	P	X	P		P	X			X		X	P
Satellite Rcvr	X	X	X	X	X	X	X	X		X		P	X	X	X	X	X
Ltg Det/Track	X	P	P	X	X	X		P		X			X	P			X
Field Mills	X	X						X		P			X				

45th Space Wing
(45 SPW)

INTRODUCTION

The Eastern Space and Missile Center (ESMC) has evolved over the past 40 years through a series of organizational establishments and consolidations. In 1949, a Joint Long Range Proving Ground (JLRPG) was established in Florida by Public Law 60 (81st Congress). The JLRPG was organized into the Air Force Missile Test Center (AFMTC) in 1951. The range was redesignated the Air Force Eastern Test Range (AFETR) in May 1964. In February 1977, Patrick Air Force Base (PAFB) was separated from the Eastern Test Range (ETR) and the resources of the ETR were consolidated as Detachment 1, Space and Missile Test Center (SAMTC). Effective October 1979, ESMC was formed under the Space and Missile Test Organization (SAMTO) by rejoining the ETR with PAFB and integrating the 6555th Aerospace Test Group (6555 ASTG) into the center. In October 1991, ESMC was transferred from the Air Force Systems Command to the Air Force Space Command (AFSPACECOM) and is now known as the 45th Space Wing (45 SPW).

Today, 45 SPW responsibilities are to

a. Participate in system planning and acquisition, perform factory and on-site testing, manage military construction programs associated with range and launch facilities, process launch vehicles and payloads, conduct pre-launch system checkout, manage and control countdown and launch operations, conduct post-launch flight evaluation, and formulate recommendations to support major program milestone decisions.

b. Provide range services including operations and maintenance of range instrumentation systems, operations and test planning, program support management, area surveillance, range safety, frequency management and interference control, meteorological support, data collection and reduction, communications, and photographic support.

c. Maintain cooperative support agreements with the National Aeronautics and Space Administration (NASA) concerning all space operations at the John F. Kennedy Space Center (KSC) and the Cape Canaveral Air Force Station (CCAFS).

d. Maintain and operate a port facility in support of Fleet Ballistic Missile (FBM) programs.

e. Maintain a communications network into the east and south Atlantic areas, consisting of both terrestrial radio and satellite facilities to support authorized communications users.

f. Operate and maintain instrumentation ships and sites in support of Joint Chiefs of Staff (JCS) and other Department of Defense (DOD) and NASA requirements.

g. Provide a test capability for space boosters, space shuttle, and on-orbit satellite tracking and other test activities.

h. Provide contract administration services per DODD 4105.59H.

i. Provide host base services and responsibilities per AFR 11-4 or DODD 4000.19M. Operate and maintain PAFB and the Base Hospital.

The 45 SPW management structure is designed to serve a twofold purpose. First, it ensures effective support of general purpose facilities and services to range users and other authorized agencies. And second, it coordinates numerous activities of assigned and attached units engaged in use, operation, or support of the center.

Each military or other government agency using the center provides a staff office that serves as the focal point for its respective organization and liases with assigned center elements concerning specific test needs. Assigned and attached organizations, constituting elements and the work force of 45 SPW, report in terms of operational relationship or need through established channels to the commander. The Air Force also procures the services of range contractors to provide administrative, operations, maintenance, and logistics capabilities for 45 SPW.

The center interfaces directly with resident range user representatives of the Army, Navy, Air Force, and NASA on technical planning and programming matters pertaining to all support requirements. Agencies desiring 45 SPW support normally initiate requests by methods outlined in the Universal Documentation System established by Document 501-90 of the RCC Documentation Group and detailed in 45 SPW Regulations 80-2 and 11-8.

The status of 45 SPW as a designated DOD National Test Facility makes it directly subject to those DOD policies pertaining to the development, operation, and use of such facilities by DOD, government, and commercial organizations. The 45 SPW, in turn, formulates specific local operational policies and procedures to ensure effective response to all organizations to the extent of available resources and as directed by the Secretary of Defense.

DESCRIPTION OF MAJOR FACILITIES

The 45 SPW consists of a complex of instrumented facilities for launching and evaluating the performance of missile and space systems. The major land-based facilities that comprise 45 SPW include Patrick Air Force Base (PAFB), Cape Canaveral Air Force Station (CCAFS), Jonathan Dickinson Missile Tracking Annex (JDMTA), Antigua Air Station, and Ascension Auxiliary Air Field. These facilities are augmented when necessary with instrumented aircraft and ships and, in addition, 45 SPW uses instrumentation operated by NASA in Bermuda and at Wallops Island, Virginia.

A brief description of each major land-based facilities follows:

a. **Patrick Air Force Base**. Patrick Air Force Base serves as the administrative, technical, and logistics headquarters for 45 SPW. The PAFB is located approximately 60 miles east of Orlando, Florida, and is situated between the Atlantic Ocean to the east and the Banana River to the west.

The PAFB encompasses 1,822 acres of land and is approximately 4.1 miles from north to south and 1.25 miles from east to west. The average elevation of the base is 9 feet above sea level. The base is equipped with a 9,000-foot runway with instrument approach facilities, air traffic control tower (ATCT), and terminal radar control (TRACON) facilities. The air field is primarily used by military aircraft for administrative and logistics traffic required to support 45 SPW operations. Instrumentation resources located at PAFB include one FPQ-14 class metric tracking radar with on-axis capability and a fixed Intercept Ground Optical Recorder (IGOR) class optics facility.

b. **Cape Canaveral Air Force Station**. Cape Canaveral Air Force Station (CCAFS) is the primary technical operations facility of 45 SPW. All 45 SPW launch vehicle and payload preparation facilities and launch complexes are located at CCAFS. The CCAFS is located approximately 22 miles north of PAFB and is situated between the Atlantic Ocean to the east and the Banana River and NASA Kennedy Space Center (KSC) to the west.

The CCAFS occupies 15,804 acres of land. The facility has 73 miles of paved roads that interconnect the technical operating areas on CCAFS with KSC and surrounding non-government property. A total of 36 launch complexes have been constructed at CCAFS. Only seven are still active, two are being prepared for reactivation, and thirteen are inactive.

The CCAFS maintains a 10,000-foot runway (the "Skid Strip"). The CCAFS Skid Strip is primarily used to receive large military transport aircraft ferrying launch vehicle components and payloads to CCAFS and KSC. An ATCT is located at the runway and activated when aircraft movement is scheduled. The TRACON services for the CCAFS area are provided by PAFB.

Range contractor personnel operate the 45 SPW instrumentation resources that are located at CCAFS. These resources include a permanent FPS-16 class metric tracking radar, a relocatable FPS-16 class metric tracking radar, the primary command transmitter, a large number of optics sites, the Range Control Center (RCC), its replacement, the Range Operations Control Center (ROCC), the central communications facility, the central data processing center, and the primary weather facility for upper air observations. The 45 SPW integrated telemetry facility (TEL IV) and one FPQ-14 class metric tracking radar with on-axis capability and one FPQ-16 relocatable radar are located near the CCAFS on NASA KSC property.

c. **Jonathan Dickinson Missile Tracking Annex**. Jonathan Dickinson Missile Tracking Annex (JDMTA) is the latest of the 45 SPW instrumentation annexes. The facility was activated in 1988 to serve as a replacement for instrumentation facilities at Grand Bahama Island, which were deactivated as a cost-saving measure.

The JDMTA occupies approximately 12 acres inside the Jonathan Dickinson State Park, which is located just north of Jupiter, Florida, or approximately 95 miles south of PAFB. The land was acquired by the Air Force through a 50-year lease with the Florida Department of Natural Resources.

Instrumentation at JDMTA consists of one FPQ-14 class metric tracking radar, one TAA-8 and four TAA-50 telemetry systems, two Daytron Command/Control Antennas, and Trident Flight Test Support System (FTSS). Communications with the CCAFS and other 45 SPW facilities are provided by both telephone and dedicated microwave relay.

Operations at JDMTA are consolidated within a single 18,443-square-foot instrumentation building. The operations, maintenance, and support functions for the instrumentation systems are accomplished by range contractor personnel. There is no housing or subsistence facilities at this annex; all personnel must live off base.

d. **Antigua Air Station**. Antigua Air Station is located in the northeastern part of the island of Antigua in the Leeward Islands approximately 1,250 miles southeast of CCAFS. The Air Force installation is located on 535 acres of land. The island is a volcanic formation and is hilly with a maximum elevation of 1,330 feet above sea level.

Instrumentation at Antigua AS includes an FPQ-14 class metric tracking radar, TAA-8 and TAA-3A telemetry systems, a command/control facility, an upper air weather facility, and a Missile Impact Locating System (MILS) located in the Atlantic Ocean adjacent to the Island. Communications services with CCAFS and other 45 SPW facilities are provided by commercial satellite and high frequency (HF) radio.

Antigua AS includes nine separate operating areas: a main base and eight outlying instrumentation and communications sites. The Antiguan Government operates an airfield near the station. This airfield is used by Air Force aircraft that make regular visits to the island to transport range personnel and for logistics support.

Range contractor personnel operate and maintain the instrumentation and provide normal base support services at Antigua AS. These services include utilities, quarters, messing, medical, BX, theater, transportation, laundry, and recreational activities. There is no off-base housing available from or sponsored by official sources. Limited rental housing is available in the nearby community.

e. <u>**Ascension Auxiliary Air Field**</u>. Ascension Auxiliary Air Field is located on Ascension Island, a British possession in the South Atlantic Ocean approximately 4,400 miles southeast of CCAFS. The Air Force installation is located on 3,856 acres occupied under the terms of an agreement with the government of the United Kingdom. The island is of volcanic origin, is approximately 7 miles in diameter, and has a maximum elevation of 2,800 feet above sea level.

Instrumentation at Ascension AAF includes an FPQ-15 and TPQ-18 class radar; TAA-3A, TAA-3C, and S-Band telemetry systems; an upper-air weather facility; and a MILS installed adjacent to the island in the South Atlantic Ocean. Communications with CCAFS and other 45 SPW facilities or support aircraft and ships is provided by satellite link and HF radio.

Ascension AAF includes 13 separate operating areas: a main base site, an airfield with a 10,000-foot runway, and 11 nearby instrumentation and communications sites. Range contractor personnel operate and maintain the instrumentation and provide normal base support services at Ascension AAF. These services include utilities, quarters, messing, medical, BX, theater, transportation, laundry, and recreational activities. Permanent and TDY visitors are furnished quarters on base. There is no off-base housing.

The Commander, Detachment 11, 4th Weather Wing, serves as the 45 SPW Staff Meteorologist. Detachment 11 provides meteorological, environmental, and aerospace support services to 45 SPW and range users. Meteorological support for range operations originates from the Cape Canaveral Forecast Facility (CCFF) located within the Range Operations Control Center (ROCC) at CCAFS. The CCFF is manned by Detachment 11 personnel on a continuous basis. The CCFF receives, analyzes, and interprets meteorological data required to support range operations and prepares and disseminates both routine and specialized weather forecasts and warnings for all ground processing, launch, and recovery activities as well as all range facilities, aircraft, and ships.

Detachment 11 personnel also operate a Base Weather Station (BWS) at PAFB that provides weather briefings for PAFB flight operations and forecast services during normal airfield operating hours. The CCFF provides backup support to the BWS. Detachment 11 personnel also staff the Representative Observation Site (ROS) adjacent to the PAFB runway during normal airfield operating hours and collect and disseminate airfield weather observations.

Detachment 11 personnel operate the 45 SPW Staff Meteorology Section at the 45 SPW Headquarters Building at PAFB. The Staff Meteorology section provides environmental and climatological consulting services to the 45 SPW Commander, 45 SPW organizations, and other range users. The Staff Meteorology section also provides a focal point for meteorological issues for the ETR and the 45 SPW Deputy Commander for Systems Development who manage the acquisition, operation, and maintenance of range technical systems. Another Detachment 11 section provides 24-hour support to the specialized mission of the Air Force Technical Applications Center (AFTAC) located at PAFB.

Detachment 11 is supported directly and indirectly by several Air Force organizations including the Environmental Technical Applications Center (USAFETAC), the Global Weather Central (AFGWC), and the Geophysics Laboratory (GL). These organizations provide the 45 SPW Staff Meteorologist with technical advice, research, and developmental information plus access to worldwide meteorological and climatological data. The National Weather Service Office in Melbourne, Florida, participates in the daily Detachment 11 weather discussions and Detachment 11 personnel consult with forecasters at the National Hurricane Center in Miami during tropical storm and hurricane threat situations.

The 45 SPW Staff Meteorologist is supported by the 45 SPW Center Technical Services (CTS) Contractor. The CTS contractor is responsible for the collection and dissemination of surface-weather observations from a site near the Shuttle Landing Facility (SLF) at KSC and upper air observations from CCAFS, Antigua AS, and Ascension AAF. Contractor personnel also collect surface and upper air observations on Range Instrumention Ships (RIS). The CTS contractor is also responsible for the operation and maintenance of 45 SPW meteorological instrumentation, providing acquisition, and sustaining engineering support including both hardware and software and associated test, evaluation, and analytic services. An overview of 45 SPW meteorological services and support is shown on the following charts.

Site	Service	System	Support Normal Ops	Capability Test Support	Altitude Capability	Method of Reduction	Remarks
Cape Canaveral AFS (KXMR)	Consulting		M-F 07-16L	As required			
	Forecasting		Daily 24 hrs	As required			
	Surface Obs		None	As required			
	Rawinsonde	MSS (2)	Daily, 12Z, 00Z	As required	0-30 km	Real-time/ batch	
	Jimsphere		None	As required	0-16 km	Real-time/ batch	
	Rocketsonde	PWN-11D 12A	W 10L	As required	4-95 km	Batch	
Kennedy Space Center (KX68)	Consulting	Supported by Cape Canaveral Forecast Facility					
	Forecasting						
	Surface Obs		Daily 24 hrs	As required			
	Rawinsonde		None	None			
	Jimsphere		None	None			
	Rocketsonde		None	None			
Patrick Air Force Base (KCOF)	Consulting		M-F 07-16L	None			
	Forecasting		Daily 07-23L	None			Base Weather Station
	Surface Obs		Daily 05-23L	None			
	Rawinsonde		None	None			
	Jimsphere		None	None			
	Rocketsonde		None	None			
Antigua Air Station (TAPA)	Consulting	Supported by Cape Canaveral Forecast Facility					
	Forecasting						
	Surface Obs		None	As required			
	Rawinsonde	GMD-4(1)	M-Th 12Z	As required	0-30 km	Batch	
	Jimsphere		None	None			
	Rocketsonde	PWN-11D	None	As required	14-70 km	Batch	
Ascension Island AAF (FHAW)	Consulting	Supported by Cape Canaveral Forecast Facility					
	Forecasting						
	Surface Obs		None	As required			
	Rawinsonde	MSS (1)	M-F 12Z	As required	0-30 km	Batch	
	Jimsphere		None	None			
	Rocketsonde	PWN-11D, 12A	None	As required	4-95 km	Batch	

TYPICAL RANGE REQUIREMENTS SUPPORTED

The 45 SPW supports five major classes of ballistic missiles or space launch vehicles. These include

a. Trident Series Ballistic Missile
b. Delta Series Expendable Launch Vehicle (DOD and commercial)
c. Atlas Series Expendable Launch Vehicle (DOD and commercial)
d. Titan Series Expendable Launch Vehicle (DOD and commercial)
e. Space Shuttle.

Typical meteorological support requirements for each of these five classes of vehicle are diverse; however, the common elements of the support are summarized below.

SUPPORT	AREA(S)	TIME(S)	VERTICAL RESOLUTION/ ALTITUDE CAPABILITY	PARAMETERS	REMARKS
Observations:					
Surface	Launch area Impact area	As required		Ltg Tstm., precip., cloud cover, visibility, surface winds, temperature, pressure, RH, sea conditions, other	Limited observations available from some instrumentation sites
Rawinsonde	Launch area Impact area	As required	100 ft/100 Kft	Upper winds, temperature, pressure, RH, sea conditions, other	No dual track capability
Windsonde					Windsondes replaced by high resolution rawinsondes processed by RTWAPS

SUPPORT	AREA(S)	TIME(S)	VERTICAL RESOLUTION/ ALTITUDE CAPABILITY	PARAMETERS	REMARKS
Observations:					
Jimsphere	Launch area	As required	100 ft/ 55 Kft	Upper winds	
Rocketsonde	Launch area Impact area	As required	1000 ft 100-300 Kft	Upper winds, temperature, other	
Forecast	Launch area Impact area	As required		Ltg. tstm., precip., cloud cover, visibility, surface winds, upper winds, temperature, pressure, RH, sea conditions, other	
Evaluate launch minima	Launch area	Countdown period		Ltg. tstm., precip.,cloud cover, visibility, surface winds	

PLANNED UPGRADES TO METEOROLOGICAL SYSTEMS

The 45 SPW is pursuing selective modernization of meteorological systems in spite of an extremely limited funding environment. Most modernization efforts have been funded by specific range users. A summary of major upgrades and replacement activities is provided next.

PROGRAM	SITE	MANAGING AGENCY	PROJECTED IOC
Improved weather dissemination system	CCAFS/KSC	45 SPW	CY 92
Ground-based field mill system replacement	CCAFS/KSC	45 SPW/ NASA	CY 92
Surface winds system replacement	CCAFS/KSC	45 SPW	CY 92
Automated weather dissemination system (AWDS)	CCAFS	Downward directed	CY 92
Lightning detection and ranging system (LDAR)	CCAFS/KSC	NASA/KSC	CY 92
WSR-88D NEXRAD Radar	Melbourne	NOAA	CY 92

SPECIALIZED METEOROLOGICAL SYSTEMS

The 45 SPW operates and maintains a number of specialized meteorological systems to support range and range user requirements. These specialized systems are summarized in the subsequent paragraphs below. The 45 SPW staff meteorologist should be consulted for more detailed information on the capabilities and limitations of specific systems.

a. **Surface Observation Systems**. The 45 SPW operates a network of meteorological towers covering most of CCAFS, KSC, and the surrounding area. These instrumented towers were originally deployed to support the prediction of toxic hazard corridors resulting from the release of launch vehicle propellants. Although toxic hazard corridor support remains an important application today, these sensors are also used to monitor surface wind convergence (a precursor to air-mass thunderstorm formation), to monitor sea breeze and thunderstorm outflow development, and to assess surface wind conditions at or near launch complexes to ensure that launch minima are satisfied.

At the present time the array of 39 towers provides 5-minute average values. Most towers are equipped with wind speed and direction sensors at both 12- and 54-foot levels and air temperature at 6-, and 54-foot levels. Tower 110 is an instrumented 200-foot tower and Tower 313 is an instrumented 500-foot tower.

A second 200-foot tower (Tower 006) is being activated. The 200- and 500-foot towers are also instrumented at several levels for relative humidity measurements. Wind and temperature sensors located along the Shuttle Landing Facility (SLF) and at the Shuttle Launch Complexes (SLC 39A and 39B) are also integrated into the surface observation system.

The NOAA National Data Buoy Center provides a permanently moored environmental buoy in the Atlantic Ocean 35 km east of CCAFS. The buoy provides surface wind, pressure, pressure change, air and sea temperature and sea state data once every 30 minutes.

b. **Upper Air Observation**. The 45 SPW operates a number of upper air observing systems to satisfy range and range user requirements for measurement from the surface to near 70 km.

Dual Meteorological Sounding Systems (MSS) are operated at CCAFS and provide the primary rawinsonde data using specialized MSS sondes from the surface to 30 km. The MSS is also used to receive meteorological telemetry from selected rocketsonde payloads.

Rocketsondes are launched from an oceanside facility approximately 5 miles north of the CCAFS Weather Station. Super Loki boosters are used with both telemetric (PWN-10D and PWN-11D) and passive (PWN-12A) payloads. Wind and temperature data are measured between 20 and 70 km, and the capability exists to merge time coincident rawinsonde and rocketsonde data. Range radars provide metric tracking data for rocketsonde data reduction.

The MSS output is processed at the CCAFS Weather Station by dual Data General MV15000 computer systems that comprise the Real-Time Winds Aloft Processing System (RTWAPS). The RTWAPS enables 45 SPW to collect, quality control, and disseminate rawinsonde, and Jimisphere data in near real-time using either dedicated or dial-up telephone circuits.

A dedicated interface to the CCFF provides the forecasters with near real-time display of the upper air measurements as well. Upper-air data are also transmitted to the 45 SPW Central Computer Complex where the observations serve as input to range safety impact prediction programs, blast damage over pressure prediction programs, and launch vehicle effluent deposition programs.

A jimisphere balloon capability is also supported at CCAFS using any of three FPS-16 class or two FPQ-14 class metric tracking radars, which interface directly to the RTWAPS.

A third MSS is operated at Ascension AAF and a GMD-4 is used at Antigua AS. Both range instrumentation ships, the USNS Redstone and USNS Observation Island, are equipped with Beukers WO-8000 Omega rawinsonde systems.

Three Doppler Acoustic Sounding Systems (DASS) have recently been acquired and are now being installed. The DASS will provide nearly continuous monitoring of boundary layer winds and mixed layer depth from the surface to about 1 km.

Finally, NASA has recently installed a 50 MHz wind profiling radar system at KSC. This system is now undergoing initial testing and evaluation by the NASA Marshall Space Flight Center (MSFC). The radar is designed to provide direct measurement of winds at 150 m intervals between 2 and 20 km as often as once every 6 minutes.

c. **Weather Surveillance Radar Systems**. The 45 SPW operates a dedicated, Enterprise WSR-74C, 5 cm weather surveillance radar. The radar is located at PAFB with the control console located at the CCFF. The radar has been upgraded with a volume scanning processor developed by McGill University. The volume scanning processor drives the antenna through a series of 24 elevation steps once every 5 minutes, digitizes the radar reflectivity, and generates a series of graphic displays of the radar reflectivity within 200 miles of CCAFS. Typical products include Constant Altitude PPI (CAPPI) displays at user selectable altitudes, maximum echo top maps, and vertical cross sections along user selectable axes.

The National Weather Service is presently installing a Unisys WSR-88D NEXRAD doppler weather surveillance radar at the Melbourne Weather Service Office. Principle User Processors (PUPs) have been programmed for installation in both the CCFF and PAFB Base Weather Station.

d. **Lightning Detection and Warning Systems**. The 45 SPW operates a network of 31 ground-based electric field mills throughout CCAFS and KSC. The field mills are integrated into the real-time Cyber computers at the Central Computer Facility. The Cyber computer system acquires the field mill data and generates real-time plots of the ground-level electric field as well as identifies lightning events and corresponding charge center locations. Field mill data are also directed to a series of digital strip chart recorders in the CCFF that provide the forecasters with direct, real-time display of the time series of the electric field at each site. The ground-based field mill network is used to help monitor the electrical development of clouds over CCAFS and KSC and to identify clouds that could pose a triggered lightning threat.

The 45 SPW also operates a network of five-gated, wide-band magnetic direction finders that are used to locate the strike points of cloud-to-ground lightning flashes within about 100 km of CCAFS. The direction finder data are processed by a dedicated position analyzing computer within the CCFF and then displayed graphically on a dedicated display. The records from the lightning surveillance system are also supplied to range users to evaluate the need to retest launch vehicle, payload, and ground systems after nearby lightning events.

e. **Data Management and Display Systems**. The 45 SPW operates a Meteorological Interactive Data Display System (MIDDS). The MIDDS, a derivative of the University of Wisconsin McIDAS, serves as the primary meteorological data management and display system at the 45 SPW.

The MIDDS is configured with dual IBM 4381 processors with 25 Gigabits of disk storage. The MIDDS presently supports three forecaster terminals in the CCFF and other maintenance and developmental terminals, is equipped with two independent GOES antenna systems, and is capable of receiving GOES satellite imagery from two spacecraft. The MIDDS also receives alphanumeric data containing conventional meteorological observations and forecasts as well as gridded NMC analyses and forecasts that are stored for subsequent retrieval and display by the CCFF forecasters. A direct line from the AWN provides global observation and forecast data.

The MIDDS receives real-time data from many of the local sensor systems for storage and display. These inputs include

1. WSR 74C Volume Scanning Radar Data
2. Wind Tower and Field Mill Data from the Cyber Computer System
3. LLP Lightning Surveillance System Data
4. MSS and Jimsphere Data from the CCAFS Weather Station
5. NWS WSR-57 Radar Data from selected sites via dial-up
6. KSC Doppler Radar Wind Profiler Data.

All MIDDS graphic information can be switched into the 45 SPW closed circuit television network for briefing purposes. Also, the MIDDS collects, stores, and forwards local meteorological data to NASA MIDDS systems at the Johnson Space Center (JSC) and Marshall Space Flight Center (MSFC) during Space Shuttle launch, on-orbit, and landing support.

The 45 SPW also operates a Meteorological and Range Safety Support System (MARSS). The MARSS receives data from the 45 SPW wind tower network and generates real-time displays of the surface meteorological data which can be triggered to generate predictions of toxic hazard plume corridors in the event that launch vehicle propellants are released.

The system is routinely used to assess the potential toxic hazard plume corridors to support routine propellant operations at both CCAFS and KSC. Range users generally suspend propellant operations when predicted corridor lengths exceed preset safety limits.

One MARSS terminal is located in the CCFF, a second is located at a Range Safety position within the RCC, and a third is located at PAFB. Five MARSS terminals are supported at KSC.

SPECIALIZED METEOROLOGICAL DATA SETS

Many of the specialized instrumentation systems summarized in the foregoing section provide unique data sets. These data sets are retained where possible to support range user requirements or other requests from qualified external agencies.

DATA SET	SITE	PERIOD RECORD	MEDIA/FORMAT	VOLUME	REMARKS
Rawinsonde	CCAFS	Oct 80-Present	9 track tape/ASCII	9610 OBS	Launch support and daily OBS
	Antigua AS	Oct 80-Present	9 track tape/ASCII	1682 OBS	
	Ascension AF	Oct 80-Present	9 track tape/ASCII	2133 OBS	
Windsonde	CCAFS	Oct 80-1988	9 track tape/ASCII	855 OBS	No longer used
Jimsphere	CCAFS	Oct 80-Present	9 track tape/ASCII	1975 OBS	Dayton tab. some dual track
ETR Wind Tower	CCAFS/KSC	Dec 77-Present	9 track tape/ASCII	300 tapes	5 min. interval data
KSC Wind Tower	KSC area	Jul 87-Present	9 track tape/ASCII	9 tapes	5 min. interval data
Ground-Based Field Mill	CCAFS/KSC	Jul 79-Present	9 track tape/ASCII	700 tapes	Adverse weather periods only

DATA SET	SITE	PERIOD RECORD	MEDIA/FORMAT	VOLUME	REMARKS
WSR 74C Radar	PAFB	1986-Present	9 track tape	700 tapes	Available from NOAA/ ERL,GSFC
Cloud-to-Ground Lightning	CCAFS Area	1985-Present	9 track tape	100 tapes	Available from NOAA/ERL

CLIMATOLOGY

Monthly climatological summaries for the major 45 SPW land-based facilities at PAFB, CCAFS, Antigua AS, and Ascension AAF are summarized in the following tables. Additional climatological data are available through the 45 SPW Staff Meteorologist.

CLIMATOLOGY

ASCENSION AUXILIARY AIR FIELD
ASCENSION ISLAND, SOUTH ATLANTIC OCEAN

	WINDS (knots)			TEMP (°F)								PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	REL	CLD		MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	HUM %	CVR TENS		AVG	MAX
JAN	ESE	15	30	89	83	78	73	66	74	-		0.3	0.9
FEB	ESE	15	33	89	85	80	75	68	74	-		0.4	1.3
MAR	ESE	15	30	89	86	81	76	70	74	-		1.5	6.7
APR	ESE	17	32	90	86	81	76	69	72	-		1.2	2.0
MAY	ESE	17	36	89	84	80	75	67	70	-		0.4	0.3
JUN	ESE	17	33	87	82	78	73	67	69	-		0.6	1.0
JUL	ESE	17	33	87	81	76	72	67	69	-		0.5	0.8
AUG	ESE	16	31	84	79	75	70	65	70	-		0.4	0.5
SEP	ESE	15	35	84	79	74	70	63	73	-		0.4	0.2
OCT	ESE	15	30	84	79	75	70	65	74	-		0.5	0.3
NOV	ESE	15	30	86	80	76	70	64	72	-		0.3	0.2
DEC	ESE	15	30	87	81	77	72	64	73	-		0.3	0.2
YRLY	ESE	16	36	90	82.0	77.0	72.0	63	72	-		6.8	6.7

NOTE: - = no data

CLIMATOLOGY

PATRICK AIR FORCE BASE, (PAFB)
ORLANDO, FLORIDA

	WINDS (knots) PREVAILING			TEMP (°F)					REL	CLD	PCPN (inches)	
MONTH	DIR	SPD	PEAK	ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	HUM %	CVR TENS	MON AVG	24 HR MAX
JAN	N	9	45	86	69	63	56	25	77	-	2.3	3.8
FEB	N	10	50	88	70	63	56	32	77	-	2.8	4.7
MAR	SE	10	42	90	74	68	61	27	75	-	2.9	3.6
APR	E	10	45	96	78	73	67	42	73	-	1.9	2.8
MAY	E	9	54	94	82	77	72	57	75	-	3.6	3.2
JUN	E	8	89	98	85	80	75	57	78	-	5.6	6.9
JUL	SE	7	60	99	87	82	76	67	78	-	4.4	5.6
AUG	E	7	60	97	87	82	77	68	79	-	4.4	3.4
SEP	E	9	64	95	86	82	77	64	77	-	7.4	7.4
OCT	NE	10	38	91	81	77	72	50	75	-	5.2	7.6
NOV	N	10	59	87	75	70	64	33	75	-	2.3	4.9
DEC	NNW	9	43	86	71	64	58	27	76	-	1.9	2.0
YRLY	E	9	89	99	79.0	73.0	68.0	25	76	-	44.7	7.6

NOTE: - = no data

CLIMATOLOGY

CAPTE CANAVERAL AIR FORCE STATION (CCAFS)
AND
KENNEDY SPACE CENTER (KSC), FLORIDA

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	NW	8	46	84	69	60	52	19	80	-	2.6	4.6
FEB	N	8	60	87	69	60	51	25	79	-	2.9	3.2
MAR	N	9	48	88	74	65	57	29	77	-	2.9	5.6
APR	ESE	8	53	94	78	70	62	34	75	-	1.4	5.1
MAY	E	8	46	95	82	75	67	44	77	-	2.9	3.0
JUN	E	7	50	98	86	79	72	53	81	-	5.5	4.3
JUL	S	6	50	96	88	81	73	55	83	-	5.1	3.6
AUG	E	6	60	97	87	81	73	64	84	-	5.1	5.8
SEP	E	7	68	94	86	80	73	59	82	-	6.9	6.9
OCT	E	8	40	92	81	75	68	40	78	-	4.7	6.4
NOV	NW	8	46	89	75	68	60	31	78	-	3.2	5.9
DEC	NW	7	40	85	70	62	53	25	79	-	2.0	2.8
YRLY	E	7	68	98	79.0	71.0	63.0	19	80	-	45.2	6.9

NOTE: - = no data

CLIMATOLOGY

ANTIGUA AIR STATION
ANTIGUA, LEEWARD ISLANDS

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	ENE	11	-	-	80	76	72	-	75	-	2.5	-
FEB	ENE	11	-	-	80	76	72	-	73	-	1.3	-
MAR	E	11	-	-	81	77	73	-	72	-	1.4	-
APR	E	12	-	-	82	78	73	-	73	-	1.9	-
MAY	E	11	-	-	84	80	76	-	75	-	3.8	-
JUN	E	12	-	-	86	83	79	-	76	-	2.9	-
JUL	E	12	-	-	87	83	79	-	77	-	3.7	-
AUG	E	11	-	-	88	84	80	-	77	-	3.6	-
SEP	E	9	-	-	87	83	79	-	77	-	4.5	-
OCT	E	8	-	-	86	82	78	-	79	-	4.2	-
NOV	E	9	-	-	84	79	73	-	78	-	4.5	-
DEC	ENE	10	-	-	82	79	75	-	77	-	3.6	-
YRLY	E	11	-	-	84.0	80.0	76.0	-	76	-	38.0	-

NOTE: - = no data

NAVAL AIR WARFARE CENTER-WEAPONS DIVISION, POINT MUGU (NAWC-WEPS, PT. MUGU)

INTRODUCTION

The Naval Air Warfare Center-Weapons Division, Point Mugu (NAWC-WEPS, Pt. Mugu), formerly the Pacific Missile Test Center (PMTC), is the Navy's largest test and evaluation center for airborne weapon systems. Many of the high-technology weapons successfully employed in the Gulf War in 1991 such as the Tomahawk Land Attack Cruise Missile, the Stand-off Land Attack Missile (SLAM) were proven or developed here as well as much of the tactical software used for electronic warfare. In all of these systems, the Navy's natural operating environment plays a key role in defining the performance envelopes, GO/NO-GO decisions, and tactical use of these systems. The NAWC-WEPS, Pt. Mugu, Geophysics Division is the center's source for the full spectrum of environmental services needed to support real-time range testing, aviation and mission planning forecasts, post-operation performance evaluation, and fleet battlegroup applications that evolve from the T&E experience.

GENERAL INFORMATION

The NAWC-WEPS, Pt. Mugu, is an Echelon 3 activity under the Naval Air Systems Command, headquartered at Point Mugu, California. The center supports aircraft/ship systems, weapons systems, missiles, and space vehicle test and evaluation operations on its Sea Test Range off the coast of Southern California and also on its down-range site in Hawaii. Additionally, NAWC-WEPS supports military training exercises and various other programs sponsored by U.S., foreign government, and non-government agencies.

Facilities include extensive test laboratories and heavily instrumented ranges. Capabilities exist for testing air, surface, and undersea weapon systems; controlled systems and targets; and totally integrated weapon systems (weapon, vehicle, man, and target). In addition, types of tests include conventional gunnery, mine, or bombing practice exercises. Weapon systems can be operationally tested in realistic, controlled environments. Their characteristics and effectiveness can be analyzed, defined, evaluated, and documented.

The center offers the advantage of laboratories collocated with operational air and sea test range capabilities. The option is available to mix laboratory-simulated testing with operational flight testing. This feature can help speed project efforts toward completion while economizing on money and material resources. A large complement of technical personnel with proven professional competence including Fleet-experienced test personnel and combat-experienced pilots are available to assist. Fleet exercises and mock engagements, during which simulators provide realistic threats, can be readily supported.

The center is in close proximity to NAWC-WEPS, China Lake; Naval Ocean Systems Center, San Diego; Naval Civil Engineering Laboratory, Port Hueneme; Naval Ship Weapon Systems Engineering Station, Port Hueneme; 30th Space Wing, Vandenberg Air Force Base; and Air Force Flight Test Center, Edwards Air Force Base.

The major tenant organizations located at Point Mugu are the Air Test and Evaluation Squadron FOUR, Navy Satellite Operations Center, Attack Squadron THREE ZERO FIVE, Patrol Squadron SIXTY-FIVE, Antarctic Development Squadron SIX, Naval Air Reserve, and the Naval Telecommunications Center. All of these related activities, working together in one proven location, provide efficiency, capability, and convenience to the customers of the NAWC-WEPS, Pt. Mugu.

LOCATION

The Point Mugu complex has one of the best locations in the world for a facility of its kind. The center is in Ventura County at the southeastern corner of the Oxnard Plain. The site is on the coast in a relatively isolated region with the Sea Test Range immediately adjacent. The nearest cities are Oxnard and Ventura, which lie 8 and 12 miles to the northwest, and the city of Camarillo, which is 9 miles to the north. Downtown Los Angeles is 53 miles to the southeast, while Santa Barbara is 45 miles to the northwest. Several uninhabited islands of the Channel Islands chain are located at various distances offshore, accommodating the instrumentation of the center's overwater ranges.

A deep-water harbor (35-foot draft) is nearby at Port Hueneme. Both mainland and island-based test sites with elevations from sea level to nearly 1,500 feet are available. San Nicolas Island provides a platform ideally suited for testing in the marine environment. It approximates a shipboard platform but with all the advantages of a mainland test site. Santa Cruz Island serves as a microwave relay station for radar, telemetry, and communications to and from Vandenberg Air Force Base (VAFB) and San Nicolas Island.

DESCRIPTION OF MAJOR FACILITIES

The center consists of the main base, which includes the Naval Air Station (NAS), located at Point Mugu; Laguna Peak, a 1,500-foot-high mountain peak located one-half mile east of the main base; and the facilities of San Nicolas and Santa Cruz Islands located offshore. A sea-surface area of approximately 32,000 square nautical miles makes up the Sea Test Range.

Air space is coordinated with the Federal Aviation Administration (FAA) and other Federal agencies. The NAS Point Mugu maintains three runways. The primary runway is 11,000 by 200 feet; the secondary runway is 5,500 by 200 feet; and a third runway, at San Nicolas Island, is 10,000 by 200 feet. All runways are lighted and equipped with arresting gear and have ground control approach capabilities. Aircraft parking with tiedown capability is also available. The load-carrying capacities of runways and taxiways at NAS Point Mugu and San Nicolas Island airports are subject to dimension limitations. The runways and taxiways will safely handle most operational models of military aircraft. For final determination, landing gear configuration and tire pressure should be checked with the particular facility permissible gross weight tables.

SEA TEST RANGE

The Sea Test Range is a highly instrumented area offshore from Point Mugu. This deep ocean area and controlled air space parallels the California coast to the southwest for approximately 200 miles and extends seaward more than 180 miles. Air, surface, and submarine-launched missile test operations, aircraft tests, and Fleet exercises involving aircraft, ships, submarines, and targets are routinely conducted in this area.

Weapon systems under test can be evaluated and observed by radar, Extended Area Test System (EATS), photography, and telemetry instrumentation concurrently from multiple sites. Instrumentation sites are located at Point Mugu, Laguna Peak, San Nicolas Island, and Santa Cruz Island. The Air Force's 30th Space Wing instrumentation sites located at Vandenberg AFB and Pillar Point are also available and integrated into the operational network.

GEOPHYSICS DIVISION CAPABILITY

a. **Functions**. The air-ocean environment, which makes up NAWC-WEPS's outdoor range or "Shooting Gallery," must be fully measured, described, predicted, and evaluated, because it has a significant impact on whether or not a given test operation can be conducted and also on the performance of the weapon system, sensors, and supporting resources engaged in the test.

The Geophysics Division's capability located in the Range Operations Department provides a broad spectrum of support for range programs. Climatic planning is provided to assist in determining favorable times of year or day to meet test objectives. Weather observations and forecasts are provided to ensure that GO/NO-GO and other test weather criteria can be met and to ensure that all aviation support can be safely conducted for Sea Test Range and cross-country flights.

State-of-the-art instrumentation, maintenance, and measurement capabilities sample the atmospheric and oceanic environments from below the surface of the sea to as high as 350,000 feet, so radar tracking and systems performance test and evaluation can be conducted and corrected for environmental effects. On the ground and on target ships, geodetic surveys are conducted to locate precise positions in all coordinates. From space, satellites depict the broad, detailed picture of cloud cover and storms necessary for planning operations.

b. **Meeting User Needs**. With the increasing use of automation, operational products from the Geophysics Division are more easily and quickly tailored to meet the needs of range users. Examples include the wide variety of processed upper-air sounding data and graphics displays, so all metric radar tracking operations can be corrected and compensated for the effects of atmospheric refraction. Speed of sound, Mach number, density, and total moisture content are but a few of the other variables derived from sounding data to support the analysis of aircraft, missile, and sensor (both RF and IR/E-O) tests. Processed wave data from ocean buoys provide detailed spectra of the entire distribution of waves for use in launching and recovery considerations.

A variety of electromagnetic propagation displays of the Navy's Integrated Refractive Effects Prediction System (IREPS) now run on PCs, HP9845, or HP9020 desktop computers. These products assess atmospheric effects on radar, jammer, tracking, and communication systems and are a valuable tool in post-operation evaluations. The IREPS was developed by the Naval Ocean Systems Center (NOSC) and is the Navy's standard system for assessing the influence of atmospheric conditions on RF electro-magnetic energy.

Other examples of products available from the Geophysics Division include specialized forecasts for aviation airfield support and major projects (for example, Tomahawk, Harpoon, SLAM, Trident, Aegis, F-14 Phoenix, and CIWS). Color and animated displays of high resolution weather satellite data are available in tracking and control spaces (T&C Alpha), so critical GO/NO-GO weather conditions can be monitored along with operational test geometry before, during, and after operations.

In addition, a workstation of the Tactical Environmental Support System (TESS), installed in the Range Operation's Battle Management Interoperability Center (BMIC), is available to produce a variety of state-of-the-art and standard Navy environmental displays to assess or optimize sensor performance. These displays include products developed by the Navy's laboratories as well as new decision-aid concepts under development by the Geophysics Division to support all variants of cruise missiles. They are used in the BMIC during battlegroup-type, multi-participant, secure, over-the-horizon operations, so the impact of weather on mission planning, active flight, and terminal guidance can be factored in. Under an MOA with CNOC, the Geophysics Division will help to determine environmental support needs and to determine where environmental products and models are beneficial to the support of Navy weapon systems.

c. <u>Geophysics Division Support Services</u>. The more specific Geophysics Division support services available to provide pre-operation, concurrent, and post-operation data, products, and documentation are described next.

1. Marine, aviation, and general weather forecasts, warnings, and flight briefings/clearances from the NAWC-WEPS Weather Center.

2. Hourly airfield surface weather observations (Point Mugu and San Nicolas Island).

3. Upper-air rawinsonde observations (Point Mugu and San Nicolas Island). Rawinsonde observations provide data on temperature, pressure, wind speed and direction, moisture (relative and absolute humidity, precipitable water), density, refractive index (radio-radar propagation), speed of sound, and

wind drift forecasts (bearing, range, and impact time for chaff operations from drop point to sea-level impact) from the surface to 30 km (100,000 feet). Additionally, a data base is maintained on the CYBER 175 of upper-air measurements (rawinsonde data) from Point Mugu, San Nicolas Island, and Barking Sands, Hawaii. These data are routinely used for refractive corrections during data reduction and are available to all range users.

4. Meteorological rocketsonde observations plus weather satellite overpasses provide data on temperature, pressure, density, wind speed and direction, and speed of sound from 30 to 90 km (100,000 to 300,000 feet).

5. Oceanographic services from available installations (Begg Rock and the Inner Sea Test Range) include sea-state measurements (wave height, period, and direction) wave-energy spectra, ocean-water temperature profiles, sea-state buoy moorings, ocean-current measurements, and specialized climatologies for underwater testing and ASW applications.

6. Meteorological Interactive Data Display System (MIDDS) and D/WIPS satellite display systems featuring animation, color enhancements, other data retrieval capabilities for analysis and presentation of cloud, storm, and other features derived from geostationary and polar-orbiting imagery. These satellite displays are also available via fiber optics in T&C Alpha as well as the BMIC. Both displays and color-hard copies of weather features are available for real-time assessment of environmental conditions significant to operations and for post-operational reconstruction and documentation of weapon system performance. High resolution data and tailored displays permit assessment for particular operational areas and actual flight paths.

7. Analysis and Evaluation Services. Special project marine and aviation forecasts; analyses, geographical displays, and predictions of radio-radar propagation and optical-tracking conditions; specialized climatic summaries; assessments (pre- and post-operation) of effects of the natural environment on operations and test performance; determination and interpretation of critical weather/ocean elements, which affect conventional, tactical, and strategic weapons systems. Quantitative assessments are available using the Navy Tactical Environmental Support System (TESS) workstation installed in the Range Operations BMIC. Tactical Decision Aid (TDA) concepts under development are available for validation and application to range GO/NO-GO decision making.

8. Flood warning system for timely measurement of rainfall and streamflow in the Calleguas Creek and Revolon Slough watersheds.

9. Geodetic Services. Geographic positions in the World Geodetic System of 1984 (WGS-84), which is the geodetic reference framework for NAWC-WEPS, Pt. Mugu; elevations in ellipsoidal heights or mean sea level heights; transformation of geodetic data to other datum such as the North American Datum of 1927 (NAD-27) and the Old Hawaiian Datum (OHD); State Plane Geodetic Plane field survey services include triangulation, traverses, precise levels, and coordinate system for data reduction purposes.

10. Field measurement support at Point Mugu, San Nicolas Island, remote stations, and aboard ship. The Marine Environment Test Range (METR) is located on the northwest end of San Nicolas Island and at other facilities to monitor the marine environment and evaluate its effects on systems during actual operations with emphasis on electro-optical and RF sensors. A helo-borne measurement capability also exists to measure critical environmental parameters along specific operational geometries.

11. Complete instrumentation support including equipment maintenance, repair, modification, installation, and logistics for airfield flight safety equipment as well as ocean buoys and complex sensor systems installed at remote locations for routine or special scientific applications.

12. A comprehensive summary with samples of the Geophysics Division's operational products and services is available in the ***Geophysics Products and Services for Range Users Manual***, a locally produced publication.

d. **Laser/EO Facilities**. The lagoon and Beach Laser Ranges at Point Mugu provide the facilities for a variety of laser-oriented development, test and evaluation, and measurement programs. Air-to-ground, ground-to-ground, and ground-to-air tests can be performed. The ranges provide access to a coastal marine environment with widely varying weather conditions. The range complex consists of three landmarks in a triangular formation: Laguna Peak (450-meter elevation), a beachline targeting area, and a lagoon laser site make up the vertices. Lasers can be operated from the peak or the lagoon site, where targets can be in the air or on the beach. The San Nicolas Island Overland Laser Range Facility is designed specifically for the measurement of laser beam propagation phenomena. The range, 4,000 meters long and 50 meters wide, is over undulating island terrain.

San Nicolas Island provides a real-world marine environment in which a comprehensive measurement program of this environment and its effects on radiation from electro-optical or high-energy laser systems can be conducted. The Marine Environmental Test Range (METR) facilities on San Nicolas consist of four sites located on the northwestern tip of the island. The sites provide overwater ranges of 4,000 and 2,500 meters and an overland calibration range of 300 meters. The METR facility is the Navy's prime test range for testing electro-optical systems in a marine environment.

SUPPORT FACILITIES/RESOURCES-POINT MUGU

	POINT MUGU	OFF-STATION	SHIPBOARD
METEOROLOGY:			
Forecast capability	X	X	X
Consultation, analysis, evaluation services	X	X	X
Automatic data processing: currently HP-1000 computer phased over to new computer terminal and input/output peripherals with direct access to Cyber 175 Desk Top Graphics and decision-aid displays	X		
Instrumentation-Surface: Weathervision system distribution to control rooms/flight ready rooms	10		
AN/UMQ-5 wind systems	3	X	
AN/GMQ-32 transmissometer with runway visual range at Pt. Mugu	2		
AN/GMQ-13 cloud height set	2		
AN/GMQ-29 automatic weather station offshore island automatic meteorological data collection system	1	1	

SUPPORT FACILITIES/RESOURCES-POINT MUGU (continued)

	POINT MUGU	OFF-STATION	SHIPBOARD
METEOROLOGY:			
HANDAR with data rreadout at master console in PMTC Weather Center	1	5	2
Pyranometer (180) with recorder	1	X	
Geostationary Operational Environmental Satellite (GOES) system, landline from NWS, SFSS, Redwood City (DWIPS)	1		
Meteorological Interactive Data Display System (MIDDS) with data readouts in T&C rooms	1		
Electric field mill (for lightning warning)	1	X	
Instrumentation-upper atmosphere:			
balloon-borne (surface to 30 km)	X	X	X
rocket-borne (20 km to 90 km)	X	X	
Meteorological Sounding System (MSS)	2		
AN/UMQ-12 Rawinsonde System	5	X	X
OCEANOGRAPHY:			
Forecast capability for wave height/period, temperature, currents/drift, and acoustic products	X	X	X
Consultation, analysis, and evaluation	X	X	X
Instrumentation-Oceanographic Datawell Waverider System (Directions/wave height/period/ water temperature)	1	1	

SUPPORT FACILITIES/RESOURCES-POINT MUGU (continued)

	POINT MUGU	OFF-STATION	SHIPBOARD
GEODESY:			
Geodetic capability includes accomplishment of first order horizontal and vertical control, astronomic latitude and longitude to determine deflection of the vertical, gravity valves, precise levels, astronomic azimuths, geodetic consulting services, and aircraft and ship camera target surveys	X	X	X
Instrumentation-Geodetic:			
Wild T-2 Theodolite	1	X	
Wild T-3 Theodolite	1	X	
Wild T-4 Theodolite	1	X	
Wild N-3 Level	2	X	
Nikon Total Station	1	X	
Gravity meter	1	X	
Geodimeter - Infrared	1	X	
Jana N1001 Precise Level	1	X	
Wild Surveying Camera	1	X	

X - indicates a capability

SUPPORT FACILITIES/RESOURCES-SAN NICOLAS ISLAND

	POINT MUGU	OFF-STATION	SHIPBOARD
METEOROLOGY:			
AN/GMD-29 automatic weather station	1		
AN/GMQ-13 cloud height set	2		
AN/GMQ-32 transmissometer	2		

SUPPORT FACILITIES/RESOURCES-SAN NICOLAS ISLAND (continued)

	POINT MUGU	OFF-STATION	SHIPBOARD
AN/UMQ-5 wind system automatic weather stations HANDAR	3		
Meteorological Sounding System (MSS)	1		
AN/UMQ-12 rawinsonde system	1		
Analysis and evaluation services are available at Point Mugu	X	X	X
AN/FPS-81 weather radar	1		
AN/GMD-1B rawinsonde system	1		
88 foot launch/ballistic wind tower	1		
AN/GMQ-29B semi-automatic meteorological station	1		
OCEANOGRAPHY:			
Wave/height/period recording system (moored northwest of island)	1		
Expendable Bathythermograph (XBT) probes	X	X	X
Air Launched BT Probes	X	X	X

X - indicates a capability

PLANNED ACQUISITION OF GEOPHYSICAL EQUIPMENT AT NAWC-WEPS, PT. MUGU

EQUIPMENT	PLANNED ACQUISITION DATE
1. TESS (3)	CY 92
2. AN/SMQ-11	CY 92
3. MIDDS Wide Word Workstation	Committed (in procurement)
4. JOTS DTC2	CY 92
5. DIFAX Upgrade	CY 92
6. COMEDS - CMW	CY 92
7. NEXRAD PUPS	CY 94
8. ASOS	CY 94
9. Geodetic GPS	CY 92
10. MIDDS Upgrades	CY 92
11. Scientific Sounding System	CY 93
12. Portable Met Tracking System	CY 93
13. New Desktop Computers	Continuing
14. Helo Met System (APL)	CY 92
15. Navy Lightning Warning System	CY 92

NOTE: Under an existing MOA with CNOC, NAWC-WEPS, Pt. Mugu will provide feedback on potential operational applications of the above equipment to the support of Navy weapon systems and battle-group interests.

CLIMATOLOGY

The climate at the center and associated ranges includes mild temperatures, low annual rainfall, partially overcast summers, and mostly sunny winters. Surface winds at Point Mugu are usually from the west at a mean speed of 9 knots. At San Nicolas Island, the wind is primarily from the northwest at a mean speed of 11 knots. The mean annual temperature at both stations is near 58.5 °F and the relative humidity averages 75 percent. Point Mugu averages about 11.5 inches of rainfall per year, while San Nicolas Island averages about 7.6 inches per year. The variations in the weather permit test conductors to select weather conditions desired. To meet test objectives, it is often possible to operate in a foggy, cloudy atmosphere and a dry, clear atmosphere on the same day through proper choice of elevation, location, and time of day.

CLIMATOLOGY

NAVAL AIR WARFARE CENTER-WEAPONS DIVISION, POINT MUGU
POINT MUGU, CALIFORNIA

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	NE	11	51	90	64	54	45	29	64	5	2.7	11.6
FEB	W	9	49	89	64	55	45	27	69	5	2.3	13.9
MAR	W	10	43	99	63	55	46	33	72	5	1.7	6.7
APR	W	10	50	100	65	56	48	34	75	5	0.8	4.2
MAY	W	9	39	96	66	59	51	35	77	5	0.1	1.0
JUN	W	8	35	100	68	61	54	41	80	5	0.1	0.3
JUL	W	8	27	93	71	64	57	41	82	5	0.1	0.2
AUG	W	8	25	97	73	66	58	46	81	5	0.1	1.2
SEP	W	8	43	100	73	65	58	39	78	5	0.3	5.0
OCT	W	8	45	105	71	62	53	33	73	5	0.2	2.1
NOV	NE	9	48	98	69	59	48	31	65	4	1.6	6.4
DEC	NE	11	50	89	65	55	45	28	62	4	1.6	5.3
YRLY	W	9	51	105	67.6	59.2	50.7	27	73	5	11.5	13.9

CLIMATOLOGY

NAVAL AIR WARFARE CENTER-WEAPONS DIVISION, POINT MUGU
SAN NICOLAS ISLAND, CALIFORNIA

	WINDS (knots)			TEMP (°F)							PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	REL HUM	CLD CVR	MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	%	TENS	AVG	MAX
JAN	NW	11	52	84	61	55	48	33	70	5	1.7	7.4
FEB	NW	11	48	83	61	55	49	33	75	5	1.5	6.2
MAR	NW	10	52	89	61	55	49	34	74	5	1.2	4.6
APR	NW	12	46	98	63	57	50	38	72	5	0.6	2.3
MAY	NW	12	44	100	64	58	51	38	74	5	0.1	1.6
JUN	NW	12	45	100	67	61	54	41	73	5	0.1	0.2
JUL	NW	10	45	98	70	63	56	44	78	5	0.1	0.1
AUG	NW	10	41	95	71	64	57	47	79	5	0.1	1.0
SEP	NW	10	39	105	72	65	58	46	75	5	0.1	2.2
OCT	NW	10	41	100	70	63	56	40	71	4	0.3	2.9
NOV	NW	10	44	89	66	59	52	37	67	4	1.0	5.6
DEC	NW	10	45	87	62	56	49	35	67	5	1.2	6.0
YRLY	NW	11	52	105	65.6	59.0	52.3	27	73	5	7.6	7.4

WHITE SANDS MISSILE RANGE (WSMR)

INTRODUCTION

White Sands Missile Range (WSMR) is located in south-central New Mexico. The WSMR Post Headquarters is about 50 miles north of El Paso, Texas and 25 miles east of Las Cruces, New Mexico. The main range occupies a land area approximately 40 miles (east-west) by 100 miles (north-south). In addition, a leased range extension, 40 miles square, lies adjacent to the northern boundary. The range can be extended westward by activating several other smaller extensions on the western boundary of the range.

The climatic and geographical environments of WSMR are particularly suitable for missile and rocket testing operations. Meteorological conditions typical of the desert provide excellent year-round visibility with good coverage by optical instrumentation obtainable about 95 percent of the time, both day and night.

The Tularosa Basin terrain of WSMR is generally a flat, sandy desert with an elevation about 4,000 feet above mean sea level (MSL). Mountain ranges parallel the east and west range boundaries and cross the main range about 75 miles north of the post area. The nature of the terrain and sparse ground cover provide a high probability of prompt recovery of flight test hardware for post-test analysis. The entire range area is relatively remote and sparsely populated, yet is sufficiently near well-developed areas to be readily accessible.

The WSMR, a national missile range operated by the U.S. Army, is engaged in RDT&E activities involving a variety of ballistic and guided missile systems, research sounding rockets, high energy laser, and other research efforts.

Almost all activities on WSMR require some meteorological support. The atmosphere is constantly changing. These changes affect missile performance, radar and optical systems, and telemetry systems used and being tested on the range. Meteorological measurements made during the tests are essential to the evaluation of various test programs. Some of the major functions of furnishing meteorological support for the range operations and for the test programs of the range users are

a. meteorological data collection,

b. general and specialized weather forecasts,

c. severe weather warnings,

d. unguided rocket impact prediction,

e. High Energy Laser Meteorological (HELMET) Support,

f. meteorological consultation services,

g. meteorological workstation, and

h. climatological data.

METEOROLOGICAL DATA COLLECTION

The WSMR is a highly instrumented missile range. Over the vast expanse of land, the meteorological team collects meteorological data at permanent and mobile sites. These data consist of both surface and upper air observations of existing atmospheric conditions as required by the users. High-altitude meteorological data (90,000 to 250,000 feet) are gathered by meteorological rocket soundings. The meteorological team provides the following support:

a. **Surface Observations**. Surface observations are taken on a 24-hour-per-day, 7-day-per week basis and recorded at the Headquarters Weather Station (Bldg. 21925). Special observations from anywhere on the range are taken in support of range operations.

b. **Upper Air Measuring Systems**. The primary upper air measuring system at WSMR is the Integrated Upper Air System (IUAS). This system is an integration of two off-the-shelf, upper-air measuring systems. The Vaisala Rawinsonde System measures the normal atmospheric parameters of pressure, temperature, and humidity. It also provides low-resolution winds using navigational aids to position the sonde. At the same time, an Enterprise WF-100 radar tracks the flight package to provide higher resolution winds. Both sets of data are fed into an IBM-compatible computer. The data are then integrated and formatted to user-specified formats. The most common formats are coded-meteorological messages, artillery aiming-messages, space-shuttle formats, post-analysis formats, and PIBAL messages. The real-time radar data can also be transmitted directly to the Range Control Center for further processing.

The beauty of the IUAS is its versatility. It can be operated as a stand-alone Vaisala Rawinsonde, a radar stand-alone, or in the integrated mode.

1. **Vaisala Stand-alone Mode**. If high resolution winds are not required, the system can be operated in a Vaisala stand-alone mode, which simplifies the operation because no tracking is required. Also, by stripping off the radar portion of this software, the IUAS software can be sized to fit a laptop computer. In this configuration, the system is completely portable, operating off a 24-volt battery.

2. **Radar Stand-alone Mode**. Some users require observations of upper air winds much more frequently than the more conservative parameters (such as, during the later stages of unguided-probe launches, or for PIBALs as often as every five minutes). To put that many sondes in the air would be very complicated, would saturate the radio frequency band, and could get rather expensive. Consequently when wind measurements only are required, the system is operated in a radar stand-alone mode.

3. **Integrated Mode**. Whenever high resolution measurements of all parameters are required, the system is operated in the integrated mode, which is true for all post-mission flights and for all flights for the space shuttle. The IUAS provides normal rawinsonde flights and the special low-level flights that are provided by two different types of ground equipment at other STS potential landing sites.

c. Data Acquisition Systems. In addition to the IUAS, WSMR has four stand-alone Vaisala Rawinsonde Systems and two A.I.R. Automatic Data Acquisition Systems (ADAS). One ADAS is equipped with an optical tracker and one with a radio theodolite. The ADASs are used where mobility is required.

d. Meteorological Rocket Observation. These rockets provide a means for obtaining high-altitude meteorological data from 90,000 to above 200,000 feet MSL. Meteorological rockets are launched from the Small Missile Range Complex. Inflatable Robin spheres are tracked for high-altitude density and wind measurements.

e. Meteorological Towers. Two 500-foot, fully instrumented meteorological towers and one 200-foot meteorological tower are currently used on WSMR in support of missions. The 500-foot towers are located at LC-35 and LC-36, and the 200-foot tower is located at LC-33.

f. **Fixed Pole Anemometers**. There are numerous fixed pole anemometers located as high as 125 feet above the surface at various launch complexes and at special-use areas.

WEATHER FORECASTS

The Weather Forecast Unit provides general and special weather forecasts for all meteorological parameters required by programs operating at WSMR. Parameters forecast routinely at 0800 and 1400 daily include

a. cloud types, level amounts, and heights above ground in feet;

b. visibility and restrictions to visibility in miles;

c. public-worded weather forecast for 48 hours at WSMR and recorded on telephone;

d. turbulence (type, location, duration, and altitude);

e. freezing level height;

f. surface winds (direction, mean velocity, and peak gusts);

g. maximum and minimum temperatures; and

h. 72-hour general outlook.

In addition, winds aloft are forecast along with ambient air temperatures every 5,000 feet from the surface through 100,000 feet MSL.

Specialized weather forecasts are specifically tailored to the individual user's needs and involve the following parameters:

a. winds aloft to 200,000 feet MSL for high altitude constant level balloons,

b. D-values and altimeter for helicopter operations,

c. icing areas in clouds for drone operations and likelihood of contrail formation,

d. index of refractions for radar operations,

e. parachute and balloon drifts for safety, evaluation, and recovery purposes,

f. artillery meteorological messages for aiming correction purposes, and

g. nuclear fallout predictions.

SEVERE WEATHER WARNINGS

Severe weather warnings are issued when weather conditions are expected that may endanger life or property or might jeopardize successful completion of range missions. Weather warnings are issued for thunderstorms with hail, lightning, or strong wind gusts; icing roads; heavy snow; wind gusts over 30 knots; tornadoes; and dust storms with low visibilities. Weather warnings have nearly a 90 percent verification rate for the missile range.

UNGUIDED ROCKET IMPACT PREDICTION

The ballistics meteorological services consist of the analysis of theoretical unguided rocket performance, atmospheric effects upon rocket performance, and determination of launcher settings which will satisfy project requirements of trajectories and impact points for the various stages. "Impact prediction" is the term applied to the service provided just before rocket launch. A major feature is that the ballistics meteorologist who performs this function provides the test conductor with launcher settings. These settings compensate for the wind effect and allow the launch of an unguided rocket into the desired trajectory and impact area. The launcher settings provided are based upon application of timely wind measurements in the operational area and on forecasting expertise.

Low-level wind field measurements for real-time application are obtained from 500-foot towers instrumented at eight levels, with local analog plots and digital sampling at five per second, and from the WF-100 PIBAL Tracking System with local analog plots and digital sampling at 20 per second. Higher level winds are provided with rawinsonde measurements. All data are formatted and transmitted to a high-speed computer for processing.

Before each launch, the ballistics meteorologist runs a mathematical trajectory simulation for each rocket. Input includes weight, thrust, center of gravity, inertia, nozzle-exit area versus time, drag coefficients, normal-force coefficients, centers of pressure, pitching moment of inertia and coefficient, reference area, and reference length versus Mach number for each phase of the rocket flight, along with initial launch conditions and atmospheric parameters.

HIGH ENERGY LASER METEOROLOGICAL (HELMET) SUPPORT

Meteorological support services are provided in support of testing conducted at the High Energy Laser Systems Test Facility (HELSTF), WSMR. High Energy Laser (HEL) tests in the atmosphere may be adversely affected by the atmospheric path or little affected, depending on local conditions. Atmospheric effects include absorption, scattering, extinction, optical turbulence, and nonlinear effects. The WSMR has developed and fielded a modern HEL Meteorological System (HELMET), with operations and maintenance by the HEL Support Branch of the U.S. Army Atmospheric Sciences Laboratory (ASL), to predict, advise, measure, report, and analyze the effects of the atmosphere on the propagated beam.

The HELMET Support Branch provides the following tailored support products:

a. **HELSTF Forecast**. A single-page forecast of weather conditions expected to affect the test area.

b. **Toxic Corridor Advisory**. Written description of the downwind, pie-shaped area at risk to toxic chemical gases which may be released at the site in hazardous concentrations. The description is provided in near real time.

c. **Propagation Advisory**. GO/NO-GO advisory on expected propagation conditions provided at T-90, T-60, and T-30 minutes to the Test Director and the Site Manager.

d. **Real-Time Displays**. The closed-circuit TV (CCTV) displays show real-time wind and crosswind analog displays and a computer-generated CCTV GO/NO-GO display of computed propagation elements including winds, crosswind, optical turbulence, total absorption/extinction, temperature, and dew point.

e. **Test Reports**. One-page descriptions of the atmospheric conditions along the beam path during downrange HEL tests at HELSTF.

f. **Consultations**. Professional advice given to project scientists, test directors, and site managers concerning atmospheric conditions and effects on directed energy propagation. Advice is also given for special studies, analyses, probabilities of favorable conditions, and special test reports.

The HELMET system consists of meteorological sensors, towers, computers, microprocessors, data recorders, equipment, and instrumentation for acquiring and displaying meteorological data on site. The HELMET system acquires, processes, collects, analyzes, displays, and archives relevant meteorological and micrometeorological data used to support HELSTF operations. The HELMET system consists of the following subsystems:

a. four meteorological towers up to 32 m (100 feet) high with instrumentation;

b. gas-aerosol sensing system (GASS) van;

c. four-horn acoustic sounder for wind and optical turbulence profiles;

d. tethered balloon sounding system, surface to 1,000 feet AGL;

e. computers for real-time analysis, display, recording, archiving;

f. whole-sky imager with real-time cloud analysis (512 x 512 array); and

g. forecaster workstation, lightning, and satellite displays.

CONSULTATION SERVICES

Professional meteorological consultation services are provided to test officers requiring meteorological support services at WSMR or to those planning to use WSMR facilities for future RDT&E programs. These consultant services generally cover the entire scope of meteorologic and atmospheric effects, techniques of applying meteorological data, instrumentation available for data collection, and recommendations for the data and techniques useful to any particular project.

METEOROLOGICAL WORKSTATION

a. **Surface Atmospheric Measurements System (SAMS)**. The SAMS is a collection of hardware and software working together to collect, acquire, reduce, and record a diverse set of atmospheric parameters from a group of remote sensing stations. These stations, called Data Collection Packages (DCPs), interrogate a variety of atmospheric sensors for data, scale the data, perform certain processing functions, and store the data in a form to be transmitted to a central site. The central site, called the Acquisition Control Unit (ACU), directs the DCPs to transmit collected data, acquires these data, calculates a variety of derived parameters, maintains a history of the acquired data, and provides standard and special-purpose reports and plots.

Twenty or more DCPs are deployed throughout the range. The following standard parameters are measured at each location: air temperature, relative humidity, wind direction, wind speed, barometric pressure, precipitation, soil temperature, delta temperature between .5M-4M, and solar radiation. Other parameters are measured at selected sites. Data are reported every 15 minutes to the ACU at the WSMR Weather Operations Center. The parameters for each location are displayed as they are reported on CRT displays at the ACU and in the Forecast Section of the Weather Operations Center.

At the same time, the data is stored on a hard disk. At the end of each month, the entire data base for that month is transferred to 9-track magnetic tapes. These tapes are available from March 1987 to the present. The SAMS data can be summarized in several different formats. The most common are every 15 minutes by site, every hour by site, monthly averages by site, and for a given date/time at all sites. The data can also be displayed graphically. The entire data base or selected summaries can be made available for authorized users.

b. **The Meteorological Interactive Data Display System (MIDDS)**. The MIDDS is a sophisticated interactive video tool to process meteorological data. The workstation is linked to NASA's Johnson Space Flight Center's mainframe computer by a dedicated data line.

The MIDDS allows access to satellite imagery for GOES, POLAR and METEOSAT and in the near-future GOES I-M series. The imagery is completely navigated and can be viewed simultaneously with conventional weather data. The use of graphics and picture frames allows generation of two-and three-dimensional, multi-colored, composite weather images with time-lapse sequencing. The MIDDS is used to support the space shuttle operations and many range users. It can be activated to serve as an emergency mission control center for Johnson Space Flight Meteorology Group (SMG) if an emergency occurs at Houston, Texas.

c. **Forecast Workstation Upgrades**. The Forecast Section has upgraded its workstation capability to include the following:

1. alphanumeric data feeds including DIFAX from a Zephyr feed;

2. Alden Display workstation for graphics overlays such as cross-sectional analysis;

3. GOES real-time imagery every 30 minutes, plus radio capability;

4. all sky camera imaging plus digital recording for HEL; projects;

5. lightning location and protection (LLP) system which includes a three-antenna array on WSMR with a color graphical display (real time) and color printer;

6. NOAA 404 MHz profiler data and real-time display; and

7. Doppler WX radar and real-time display.

CLIMATOLOGY

Many thousands of meteorological observations, both surface and aloft, are made within the confines of WSMR and at off-range locations. Because of the high density of observations, particularly rawinsonde, many research opportunities are offered which could not be accomplished at other locations without special expenditures of time, money, and manpower.

Analysis of these data has provided unusually complete studies of WSMR atmospheric conditions. These studies are available for each rawinsonde in published form. Monthly tabulations of means and extremes from the surface to 100,000 feet MSL of wind direction, wind velocity, temperature, pressure, dew point, relative humidity, freezing level height, density, and index of refraction are recorded for a 13-year period.

Climatology records for the A-Station Headquarters area are available in published form for a 26-year period. The following parameters are available by hour and by month (means and extremes are included): wind direction and wind velocity including peak gusts, sky cover, amounts and heights, temperature, relative humidity, dew point, pressure, visibility, and weather occurrences.

CLIMATOLOGY

WHITE SANDS MISSILE RANGE
WHITE SANDS, NEW MEXICO

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	W	5	71	76	56	44	32	-6	48	4	.56	96
FEB	W	6	102	84	61	48	36	8	40	4	.57	1.62
MAR	W	8	74	89	68	55	42	16	32	4	.45	1.26
APR	W	8	78	96	76	63	50	20	27	3	.92	.99
MAY	W	7	74	103	85	71	58	34	26	3	.35	.82
JUN	W	6	60	110	94	80	66	41	27	3	.87	2.40
JUL	SE	5	57	112	94	81	69	49	43	5	2.01	2.62
AUG	SSW	4	52	106	92	79	67	51	46	5	2.14	4.25
SEP	W	4	48	102	86	74	61	40	43	4	1.55	2.96
OCT	W	5	60	94	77	64	51	22	42	3	1.23	2.11
NOV	W	5	77	87	64	52	39	5	43	3	.51	1.83
DEC	W	5	82	77	57	44	32	-10	49	4	.87	2.18
YRLY	W	6	102	112	76	63	50	-10	39	4	11.45	4.25

30TH SPACE WING
(30 SPW)

INTRODUCTION

The Western Space and Missile Center was renamed the 30th Space Wing (30 SPW) in October 1991. The 30th Space Wing is located at Vandenberg AFB in a coastal valley of central California, 15 miles southwest of Santa Maria and 10 miles northwest of Lompoc. Detachment 30, Second Weather Squadron is responsible for base weather station operation as well as providing staff and operational weather service to Air Force Systems Command (AFSC), research and development laboratories, and other programs as directed by HQ Air Weather Service (HQAWS). Range tests are performed throughout the 100,000 acres of the base, in the 200-mile off-shore corridor extending from northern California to Mexico, and out to 90° east longitude in the Indian Ocean.

CAPABILITIES

The detachment commander is the Staff Meteorologist to the 1st Strategic Aerospace Division and is the Director of the Office of Staff Meteorology. Weather officers and civilians function as technical advisors and consultants to 30 SPW on all programs and tailor their services to support the Western Range (WR). Staff Meteorologists (STAFFMETs) provide forecasts, observations, climatology studies, and consultation on engineering problems unique to testing and evaluation of space and missile systems and those unique to WR operations.

The Vandenberg Environmental Support Center (ESC) serves as the hub for weather data acquisition and processing systems supporting base operations. The ESC operates 24 hours everyday to meet the collective needs for monitoring meteorological conditions that may impact the Vandenberg AFB mission.

The 30 SPW provides the following forecasting services:

a. <u>Operations Forecasts</u>. Three types of forecasts are provided for the Western Range to support the Department of Defense (DOD), National Aeronautics Space Administration (NASA) space vehicle launches, and Strategic Air Command (SAC) ballistic missile launches and testing.

1. **Long-Range Forecasts**. Forecasts issued prior to T-48 hours are general statements for planning purposes.

2. **Planning Forecasts**. Forecasts issued from T-48 to T-24 hours contain more detailed information and can be used for operational planning purposes.

3. **Operational Forecasts**. Forecasts issued between T-24 and T-0 hours are used for operational GO/NO-GO decisions. These forecasts usually focus on specific mission constraints.

b. **Terminal Aerodrome Forecasts**. Twenty-four hour forecasts are issued at 0800L and 1400L weekdays and are valid for a 15-NMI radius around the Vandenberg AFB airfield.

METEOROLOGICAL INSTRUMENTATION SYSTEMS

Vandenberg AFB uses the standard Air Weather Service (AWS) meteorological equipment to support airfield operations. To meet the unique support requirements of the WR, 30 SPW is equipped with sophisticated and integrated meteorological systems.

Surface observation systems include

a. **Airfield Operations**. Surface observations are conducted at the Representative Observation Site (ROS), located in the control tower at the airfield, using standard USAF meteorological equipment. The observer maintains a continuous weather watch at the ROS weekdays 0700-1700L. Instrumentation at the ROS and airfield is standard to most Air Force bases and includes

1. **Digital Barometer Altimeter Setting Indicator (DBASI)**. The display indicates altimeter setting and station pressure to five significant digits and is updated approximately every 25 seconds. The system has an error detection capability to perform a self test every 25 seconds for computational errors.

2. **Cloud-Height Set (AN/GMQ-13)**. This equipment is often called the Rotation Beam Ceilometer (RBC) and provides measurements of clouds day or night. The cloud-height measurements range from 50 to 4,000 feet.

3. **Wind-Measuring Sets (AN/GMQ-20)**. The GMQ-20 is used to provide fixed station surface wind-speed and direction measuring. The sets are oriented to magnetic north and can measure wind-speeds up to 240 knots on the recorder. Magnetic direction is converted to true north before long-line transmission.

4. **Temperature and Humidity Sets (AN/TMQ-11)**. The temperature-sensing element of this set is a device that changes its electrical resistance with changes in temperature. The dew-point sensing element is a gold-alloy device coated with lithium chloride that changes its electrical resistance with changes in humidity. These changes in electrical resistance cause a change in the signal from the transmitter to the indicator.

5. **Visibility Measuring Sets (AN/GMQ-32)**. The trans-missometer of this device operates by projecting a beam of light directed at a light sensitive photocell. The photocell is sensitive to the amount of light received and registers any reduction in the amount of light. An obstruction such as fog, rain, or haze between the projector and the detector reduces the amount of light the photocell receives. The percentage of reduction is converted by tables into linear visibility values.

b. **AN/FPS 77 Weather Radar**. The AN/FPS 77 radar at the ESC is standard to most AWS units providing support to airfield operations. The fixed-storm detection radar is capable of detecting and displaying precipitation echoes within a maximum range of 200 NMI.

c. **Weather Information Network and Display System (WINDS)**. The WINDS instrumentation network includes several types of sensors mounted on 26 towers ranging from 12 to 300 feet tall. The towers are located near fuel storage, tracking, and launch facilities. The placement of the towers enables monitoring of weather conditions for operational constraints and safety criteria for the sites. Some towers also provide data to the site operations control facility. The WINDS tower sensors sample the atmosphere once per second. All tower data is digitized at the tower site by the Meteorological Data Acquisition Terminal (a microprocessor), averaged into 1-minute samples, and quality checked against climatology limits identified by the Office of Staff Meteorology. The actual data is compared to climatological maximums and minimums. Data which is out of limits is flagged as questionable, and the flags are retained throughout further processing. The data are then transmitted to the ESC and into the Central Data Acquisition Processing System (CDAPS) where all tower data are collected and then transferred to the MIDDS-V computer for further processing and display.

d. **Doppler Acoustic Sounding System (DASS)**. Vandenberg has four DASSs located on the base: two on South Vandenberg and two on North Vandenberg. The DASS is used to remotely measure winds from the earth's surface to heights up to 1,000 meters. Both the transmitter and receiver of the DASS are built into the bottom of a lead-lined container (monostatic configuration). The trans-mitter sends out a single frequency (2,400 Hz) "beep" into the atmosphere. The sound scatters in the atmosphere because of density fluctuations, and a percentage of the sound will scatter back to the DASS to be detected by the receiver. The return signal is analyzed for time delay, intensity level, and frequency (Doppler) shift. From this information, wind direction and speed are calculated.

e. **Lightning Location System (LLS)**. The LLS is designed to detect approximately 80 percent of all cloud-to-ground lightning discharges within a range of 350 km and to measure accurate directions to all the ground strike points. The LLS is ideally suited for real-time thunderstorm detection and warning applications. The system detects only cloud-to-ground lightning flashes and measures the bearing angle to the ground strike point.

Upper-air observation systems include

a. **Meteorological Sounding System (MSS)**. The MSS tracks and acquires data from meteorological radiosondes. It was developed to meet the needs of all DOD test ranges. Duplicate systems are located at several of these ranges. Three sounding systems were procured in 1982 for use at Vandenberg AFB and Pillar Point AFS to replace the older and less accurate AN/GMD-2 systems used for the previous 30 years to acquire upper air data. The MSS is a completely solid-state design that offers a significant improvement in accuracy, reliability, and maintainability. Designed to provide precise 0.1-second internal data smoothing with more accurate, faster communicating sondes to meet WTR needs, the MSS is also compatible with current standard sondes.

b. **MSS Radiosonde**. This instrument was developed specifically for use with the MSS. Carried aloft by a helium-filled balloon to acquire meteorological data, the instrument contains a radio transceiver and solid-state transmitter with receiving frequencies from 400 to 406 MHz and transmitter frequencies from 1660 to 1700 MHz. The 400 to 406 MHz uplink carrier contains AM range modulation. Commutation rate in the telemetry section is one frame per 2 seconds, and the meteorological data modulation rate is approximately 500 to 5,000 pulses per second. The temperature sensor is a 10-millimeter diameter bead thermistor, and the relative-humidity sensor is a precision-calibrated carbon hygristor. Time, azimuth, elevation, and telemetry data are received during rawinsonde runs and recorded by the tracking equipment. The processed data includes

1. vertical profiles of the layered-averaged wind direction,
2. speed and sheer,
3. temperature,
4. dew-point temperature,
5. pressure, and
6. relative indices of refraction.

The tabulated profiles provide information at fixed altitude increments with supplemental listings for altitudes where significant changes occur. Data transmission is usually after the balloon reaches burst altitude. Partial soundings through lower altitudes can be produced during rawinsonde runs before processing the entire sounding.

c. **MSS Windsonde**. This lightweight transponder windsonde is designed especially for use with the high-accuracy MSS tracker. It produces high-resolution and high-accuracy windspeed measurements from the surface to approximately 30 km altitude. The instrument contains a 400-406 MHz receiver and a solid-state transmitter operating in the 1600-1700 MHz band, both powered by a 120-minute-life wet battery.

d. **Jimsphere**. Jimsphere balloons are made of metal-coated mylar that enables precise tracking by range radars. Jimspheres are constant volume balloons with bumpy surfaces. These features minimize the deformation of the balloon surface and improve vortex shedding, which improves balloon responsiveness to changes in winds along its ascent trajectory. The Jimsphere's fixed size and weight enables it to rise to a maximum altitude of 55,000 to 60,000 feet in approximately 1 hour. The tracking radar provides time, azimuth, range, and elevation data that are processed in 5-minute increments. A STAFFMET quality checks each block of data transmission. The data products include wind direction, speed, and shear values normally at altitude intervals of 100 feet. In addition to real-time data transmissions, data products are recorded on magnetic tapes for climatological applications. For resolution and accuracy estimates of the meteorological measuring equipment, please see RCC Document 353-87, ***Meteorological Data Error Estimates.***

SUMMARY OF RANGE SERVICES AND CAPABILITIES

SERVICES/MGMT	HOURS	ALT RANGE	REMARKS
Forecasting Service	24 hrs		Located at Bldg 21150 Vandenberg
Consulting Service	M-F	As Required	
Obs (Aerodrome) Surface	M-F 07-1700	As Required	
Obs UA Vandenberg,	00Z	Surface to 100K ft	MSS from either North or South Vandenberg or Pillar 12ZPt. AFS as required for operations support.
Obs (WINDS)	24 hrs	Surface	26 towers from 12 to 300 feet, 1-minute data output.
Obs (RADAR)	24 hrs	As required	
Lightning	24 hrs	Continuous	Real-time monitoring
Satellite Imagery	24 hrs	Metsat	New image every 30 minutes 1-km resolution
Ionospheric	24 hrs	50-800 km	Automatic monitoring
Doppler Acoustic Sounding Systems	24 hrs	Sfc to 1 km	10-minute average winds

CLIMATOLOGY

30TH SPACE WING
VANDENBERG AFB, CALIFORNIA

	WINDS (knots) PREVAILING			TEMP (°F)					REL	CLD	PCPN (inches)	
MONTH	DIR	SPD	PEAK	ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	HUM %	CVR TENS	MON AVG	24 HR MAX
JAN	W	6	33	83	61	53	44	25	-	6	2.5	-
FEB	NW	8	27	83	61	54	46	31	-	6	2.8	-
MAR	NW	9	27	87	60	54	47	31	-	6	2.5	-
APR	NW	9	33	90	61	55	48	36	-	6	1.2	-
MAY	NW	9	27	93	61	56	50	37	-	6	.2	-
JUN	NW	8	27	98	63	58	52	41	-	5	.1	-
JUN	NW	7	27	85	65	60	54	45	-	5	T	-
AUG	NW	7	27	96	66	61	55	45	-	5	.1	-
SEP	NW	6	27	100	69	62	55	41	-	6	.3	-
OCT	NW	6	27	99	68	60	52	35	-	7	.6	-
NOV	NW	7	33	87	65	57	49	32	-	7	1.7	-
DEC	NW	7	33	87	62	54	45	26	-	7	1.9	-
YRLY	NW	7	33	100	63	57	50	25	-	6	13.9	-

Notes: - = no data; T = trace

AIR FORCE DEVELOPMENT TEST CENTER (AFDTC)

INTRODUCTION

The Air Force Development Test Center (AFDTC) is located on the Eglin Air Force Base complex in north west Florida, between Pensacola and Panama City. The complex consists of a land area covering more than 724 square miles and an associated joint-use air space and water area covering 86,500 square miles in the Gulf of Mexico. The terrain of the reservation is smooth except for numerous steep-banked creeks. About four-fifths of the land is covered by scrub pine and underbrush. Elevations vary from sea level to 280 feet in the extreme northeast portion of the reservation. A unique attribute of the test complex is the concentration of many individual test areas encompassing a variety of environments: jungle conditions, rolling hills, heavily forested areas, cleared flat areas, and water areas. This variety contributes to the flexibility of integrating test areas for multi-site instrumentation.

The AFDTC performs development test and evaluation of all Air Force non-nuclear air armaments and supports testing by the Air Force Operational Test and Evaluation Center and operational commands. The AFDTC serves as lead test center in the areas of munitions ballistics, terminal effects, munitions compatibility, electro-magnetic warfare testing, intrusion/interdiction testing, climatic simulation, ground simulation of flight trajectories, radar and laser cross-section measurement, and inertial and terminal guidance systems testing.

RANGE USERS GUIDE

All requests for test support should be sent to the Deputy Commander for Test Engineering (3246 Test W/TZ), Eglin AFB, Florida, 32542. The directorate of Computer Sciences has the responsibility for accepting work loads requiring only computer sciences support. Requests for support should be submitted as early as possible. Normally 120 calendar days are needed to complete programming actions. The letter from the requesting agency should outline objectives, requirements, and appropriate technical data for the desired support. Detailed instructions for preparing the test request are in Test Wing Pamphlet 80-2, which is available upon request.

SPECIALIZED RANGE EQUIPMENT

a. **Meteorological Data Acquisition System (METVAN)**. The METVAN supports precision-guided munitions/electro-optics tests by providing specialized measurements of meteorological parameters critical to atmospheric transmission and target/background scene characteristics. This system is housed in a truck van and, by using generators, can operate independently in the field. The METVAN has a data collection and processing system which analyzes and records data radio-telemetered from three remote stations. A station can consist of any or all of the following sensors: temperature, dew-point, wind, pressure, forward-scatter visibility, pyranometer, pyrheliometer, pyroradiometer, aerosol-size analyzer, raindrop-size analyzer, and rain-rate probe. The METVAN also carries equipment to take manual soil and snow measurements. The Test Wing operates two complete field-capable systems.

b. **Portable Sounding System**. This system is used to measure, from the surface to 50,000 feet, profiles of temperature, humidity, pressure, wind direction, and wind speed. It can operate independently or in conjunction with the METVAN. The Portable Sounding System uses a digital radiosonde to acquire the thermodynamic data and an on-board LORAN-C receiver for position data that is used in wind finding. The sondes are time switched, providing vertical resolution of less than 300 feet.

The system is contained in a small truck and consists of a telemetry antenna and receiver, a LORAN microprocessor, a microcomputer with disk drive, and a printer. Because it is completely portable, measurements can be made at any test site. Two systems are available for deployment.

c. **Range Automated Weather System (RAWS)**. The RAWS consists of fixed automatic weather stations at B-71, B-75, C-52N, C-72, the Destin Coast Guard Station, on two levels at Coupland Tower (B-70), and on three levels of the C-52A tower. Two portable weather stations and keyboard terminals are available for field work by weather observers. The stations measure temperature, relative humidity, pressure, wind velocity, sky irradiance, rainfall/rain rate, and ceiling (at three sites). The stations operate 24 hours a day and are linked via VHF radio telemetry to the Eglin Weather Station. There a microcomputer polls the stations and then formats, displays, and stores the data. The stations process the data on-site and temporarily store data for about one week. Alarm transmissions can be triggered when parameter thresholds are met. New data collection requirements for the station can be programmed and relayed from the base station microcomputer.

d. **Lightning Position and Tracking System (LPATS)**. The LPATS is used to locate, track, and display cloud-to-ground lightning occurrences in the southeastern United States. The LPATS remote video display terminals are located at Test Areas C-3, C-7, and the Base Weather Station. Each is connected to the central analyzer microcomputer located at the Pensacola Naval Air Station. The U.S. Navy operates the basic system which consists of four remote antenna receivers that detect and monitor lightning stroke characteristics and a central analyzer that computes the stroke location. Every stroke location is time-tagged, stored, and made available to the display monitors. Strokes are depicted within milliseconds of their discharge time and are color coded by 10-minute periods to allow visual observation of storm movement. A supplementary electric field antenna system at C-3 senses and records the electric field strength from the stroke.

RANGE SERVICES/CAPABILITIES

SERVS/ MGMT	OP'L HOURS	ALT RANGE	MAX CPBLTY	NOMEN-CLATURE	TIME REQ. FOR MSMT	DATA HNDLNG	REMARKS
Fcst Service	Daily 24 Hours		Daily 24 Hours				Located in Flight Ops Bldg, Eglin Main
STAFF MET	M-F		Daily 24 Hours				Environ-mental consulting service
Sfc Obs (Aero-drome):							
Eglin AFB	Daily 24 Hours	Sfc	Daily			Manual	Fully-equipped obs site

RANGE SERVICES/CAPABILITIES (continued)

SERVS/ MGMT	OP'L HOURS	ALT RANGE	MAX CPBLTY	NOMEN-CLATURE	TIME REQ. FOR MSMT	DATA HNDLNG	REMARKS
Duke Field	Daily 0900-2400L	Sfc	Daily 24 Hours			Manual	Located in base ops facility
Surface Obs (Test Range):							
A-15	As required	Sfc	Daily 24 Hours			Manual	Support test range ops
B-75	As required	Sfc	Daily 24 Hours			Manual	
B-70	As required	Sfc	Daily 24 Hours			Manual	
C-52	As required	Sfc	Daily 24 Hours			Manual	
C-72	As required	Sfc	Daily 24 Hours			Manual	
Surface Obs (Mobile)	As required	Sfc	Daily 24 Hours			Manual	Tactical obs equip-ment
Upper-Air Obs (Theodo-lite)	As required	Sfc to 20K ft	Once per hour	ML-474	45 Minutes	Manual	Sites as required
Upper Air Obs (Rawin-sonde):							

RANGE SERVICES/CAPABILITIES (continued)

SERVS/ MGMT	OP'L HOURS	ALT RANGE	MAX CPBLTY	NOMEN-CLATURE	TIME REQ. FOR MSMT	DATA HNDLNG	REMARKS
Eglin Main	Daily 0900-1500L	Sfc to 100K ft	Once every 3 hours	GMD-5	2 Hours, 30 Minutes	ADP	Schedule nominal
Test Ranges	As required	Sfc to 50K ft	Once every 1.5 hours	Portable Sounding System	1 Hour	ADP	LORAN-C wind finding
Radar Obs	Daily 24 Hours	Sfc to 80K ft	Contin-uous	FPS-77		Manual	Weather echoes to 200 NMI
Electro-Optical Meteoro-logical msmnts.	As required	Sfc	Contin-uous	METVAN	As programmed	ADP	Special parameters
Test Range Weather Data	Daily 24 Hours	Sfc +300 ft/150 ft towers	As required Weather	Range Automated System	As programmed office micro-computer	ADP	Data output to weather

TYPICAL RANGE REQUIREMENTS SUPPORTED

TEST PROGRAM CATEGORY	SERVICE REQUIRED	VERTICAL SPATIAL RESOLUTION	HORIZONTAL SPATIAL RESOLUTION	TEMPORAL RESOLUTION	ACCURACY/ REMARKS
Precision Guided Munitions	Sfc Obs		At test site	Each mission T-2 hrs T-0 353-87	As specified in RCC Document
	Upper-Air (Theodolite)	500 ft to 3,000 ft; 1,000 ft; 3,000 ft to 20,000 ft	At test site	T- 1 hr	

TYPICAL RANGE REQUIREMENTS SUPPORTED (continued)

TEST PROGRAM CATEGORY	SERVICE REQUIRED	VERTICAL SPATIAL RESOLUTION	HORIZONTAL SPATIAL RESOLUTION	TEMPORAL RESOLUTION	ACCURACY/ REMARKS
	Upper-Air (Rawinsonde)	1,000 ft to 50,000 ft	At Eglin Main	T-3 hrs	Thermodynamic quantities and upper-level winds required
	Upper-Air (Portable sounding system)	250 ft to 3,000 ft; 1,000 ft to 50,000 ft	At test site	T-l hr	
	Electro-Optical		Deployed as required measurements	Mission duration	Two complete METVANS available
Unguided	Sfc Obs	At test site	Each mission T-2 hrs/T-0		
	Upper-Air (Theodolite)	500 ft to 3,000 ft; 1,000 ft; 3,000 ft to 20,000 ft	At test site	T- 1 hr	
Ground Equipment	Sfc Obs	At test site	Mission duration		
Airborne Instrumentation (Elect Warfare, Avionics, Command and Control)	Upper-Air (Rawinsonde)	1,000 ft to 50,000 ft	At Eglin Main	T + 3 hrs	
Training Operations	Sfc Obs	At range site	Mission duration		
	Upper-Air (Theodolite)	500 ft to 3,000 ft; 1,000 ft; 3,000 ft to 20,000 ft	At range site	T- 1 hr	

PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

EQUIPMENT NOMEN-CLATURE	CAPABILITY EQUIPMENT	FIXED/ MOBILE	EXPECTED DELIVERY	QUANTITY	PRICE	MANUFAC-TURER
Intellisonde Meteorological RAWIN System	Automated Sounding System	Mobile	CY 90	One	$79K	Atmospheric Instrumentation Research, Inc.

DATA SETS/DATA BASES

a. **Rawinsonde**. Two years of data in hard copy form are available for all upper-air soundings on the Eglin complex.

b. **Range Automated Weather System**. One month of data in hard copy form is available for the seven sites on the Eglin complex.

CLIMATOLOGY

The climate of Eglin may be considered to be semi-tropical, being dominated by maritime tropical air in summer and continental polar air in winter.

There are two principal seasons: summer, which occurs from June through September, and winter, from November through March. The summer is characterized by high humidity and frequent air-mass type thunderstorms. Although low ceilings and visibilities are infrequent, flying conditions up to 50,000 feet are sometimes hazardous, especially during afternoon and early evening hours. This hazardous condition is due to thunderstorms and associated phenomena such as turbulence and gusty winds. In winter, the weather is dominated by prevailing westerly winds with fairly frequent frontal passages or periods under the influence of semi-stationary frontal zones. These frontal zones can result in extended periods of marginal to poor flying weather because of low stratiform clouds with occasional multi-layered cloud systems extending as high as 50,000 feet. April-May and October-November are the best periods for operational flying weather.

Total rainfall for the year averages 62 inches, falling on 106 days. Most of the rain results from heavy showers and thunderstorms; almost half of the total falls during the four summer months. The monthly mean relative humidity ranges between 59 and 74 percent. Frost appears infrequently, and the occurrence of snow or sleet is a rare event.

The summer months are the most likely for tropical storms to move through the area with September being the month of highest frequency. Although the chance of any particular hurricane hitting the area is small, the erratic paths of hurricanes in general make any one of them a potential threat.

CLIMATOLOGY

AIR FORCE DEVELOPMENT TEST CENTER
EGLIN AIR FORCE BASE, FLORIDA

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	N	5	50	78	60	51	42	6	59	6	4.2	5.5
FEB	N	6	53	80	63	54	44	12	64	6	4.5	5.9
MAR	N	6	57	85	68	60	50	19	67	6	6.0	9.3
APR	S	6	51	94	76	67	58	29	65	6	4.5	6.1
MAY	S	5	57	102	83	74	65	40	71	6	3.6	5.2
JUN	S	4	62	103	88	80	72	52	72	6	5.4	6.3
JUL	S	4	50	106	89	82	74	60	74	7	8.0	5.9
AUG	S	4	94	104	89	82	74	62	74	6	6.9	5.6
SEP	N	5	100	97	86	78	70	43	71	6	6.9	8.6
OCT	N	5	44	95	79	70	59	33	66	5	3.4	6.7
NOV	N	5	54	89	70	60	49	17	72	6	3.6	3.2
DEC	N	5	56	80	63	54	44	9	66	6	4.8	7.7
YRLY	N	5	100	106	76	68	58	6	68	6	61.8	9.3

AIR FORCE FLIGHT TEST CENTER (AFFTC)

INTRODUCTION

The Air Force Flight Test Center (AFFTC), Edwards Air Force Base, California, conducts Development Test and Evaluation (DT&E) of manned and unmanned aircraft systems and related subsystems, and of equipment for the Air Force and other government agencies. The AFFTC supports Initial Operational Test and Evaluation (IOT&E) for these programs as required. The AFFTC is tasked with the responsibility for DT&E of all-weather testing and for operation of the United States Air Force Test Pilot School. Major center activities involve flight testing of virtually all new Air Force and Army aircraft including weapon separation, delivery characteristics, and external stores certification. The AFFTC is also the lead center for aerospace deceleration, drone, and remotely piloted vehicle testing.

The AFFTC is directly responsible to Air Force Systems Command (AFSC). Most support activities at AFFTC are provided by tenant organizations with maintenance of range telemetry and tracking equipment provided by contractors. The center users include all DOD agencies and other governmental organizations as well as most civilian manufacturers. Users and their typical programs include Air Force (B-1, B-2, ATF, C-17, F-15, F-16 and ALCM), NASA (F-18, STS and assorted DARPA projects), and the U.S. Army (helicopters and parachutes).

The Astronautics Laboratory (AL) is a tenant organization at AFFTC and has the mission of providing rocket technology to be used in future Air Force armament, missiles, launch vehicles and spacecraft. The laboratory also provides technological support to other services and non-DOD agencies. This support includes engineering, scientific consultation, technical programs direction, contract management, and in-house projects execution (analytical, experimental, test and evaluation).

GEOGRAPHY

The AFFTC is located on the western edge of California's Mojave Desert, approximately 90 statute miles north of Los Angeles by highway at latitude 34° 54' North and longitude 117° 54' West at an altitude of 2,302 feet above mean sea level (MSL). The Tehachapi Mountains are located west of Edwards Air Force Base and the San Gabriel Mountains are located to the south.

Edwards AFB is comprised of parts of Kern, San Bernardino, and Los Angeles Counties and includes more than 301,000 acres of land encompassing a land area of approximately 15 by 35 statute miles. The AL occupies 72,500 acres in the northeast corner of Edwards AFB. Within the reservation are 65 square miles of usable landing area on Rogers and Rosamond Dry Lakes with runway lengths of up to 7.5 statute miles.

RANGE SERVICES/CAPABILITIES

SERVICES/ MGMT	DAYS/ HOURS	ALT RANGE	MAX CPBLTY	EQUIP	TIME REQ. FOR MSMT	DATA HANDLING
Forecasting	M-F 06-18L		Daily 24 hrs			
Consulting (STAFFMET)	M-F 0730-1630L		Daily 24 hrs			
Surface Observations (Airfield)	Daily 06-22L	Sfc	Daily 24 hrs			Manual
Surface Micromet (Network)*	Daily 24 hrs	Sfc - Data	Continuous		5 - 30 Minutes	ADP
Rawinsonde (Fixed)	M-F 02-16L	Sfc to 30 km	6 Obs/ Day	MSS	3 hrs	ADP

*** A network of 19 towers measuring 73 variables: one 200-foot tower, six 54-foot towers, and twelve 30-foot towers.**

PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

EQUIPMENT	PURPOSE	LOCATION	QUANTITY	PURCHASE	REMARKS
Wind Tower	Sfc Data *	Fixed	6	FY 90	Climatronics
Wind Tower	Sfc Data *	Mobile	6	FY 90	Climatronics
Radio Theodolite	Upper Air	Mobile	1	FY 91	AIR INC

***Wind Velocity/Temperature/Relative Humidity**

CLIMATOLOGY

The AFFTC's dry desert climate results in excellent flying conditions year-round. At approximately 100 miles from the Pacific Ocean, it is generally free from coastal fog and humidity. The summer months are generally dry and cloudless with temperatures often reaching over 100 °F. Winters are characterized by moderately increased cloudiness, windstorms, occasional precipitation, and temperatures often below freezing.

Because of the good visibility and infrequent cloudiness, weather conditions at Edwards AFB are highly favorable for conducting tests requiring optical tracking or clear photographic conditions. Visibility is 10 miles or better 96 percent of the time with infrequent low visibilities caused by blowing dust, blowing sand, haze, precipitation, or fog.

CLIMATOLOGY

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA

	WINDS (knots)			TEMP (°F)					REL	CLD	PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	HUM	CVR	MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	%	TENS	AVG	MAX
JAN	WSW	6	53	82	57	44	31	3	55	5	.91	2.72
FEB	WSW	7	58	82	61	48	35	14	51	5	.89	2.46
MAR	WSW	9	64	87	64	52	39	17	48	4	.85	3.38
APR	WSW	10	52	97	72	58	44	27	42	3	.25	1.76
MAY	SW	11	54	105	81	66	51	32	36	3	.07	.60
JUN	SW	11	51	112	90	75	59	40	32	2	.04	.37
JUL	SW	13	51	113	98	82	66	47	27	2	.06	.37
AUG	SW	12	53	112	96	80	64	47	31	2	.18	.91
SEP	SW	14	42	109	91	74	57	34	35	2	.17	1.28
OCT	SW	10	45	102	79	63	46	19	37	2	.17	1.28
NOV	S	9	48	87	65	51	36	13	47	3	.58	1.49
DEC	SW	14	58	84	57	44	31	7	53	4	.74	1.50
YRLY	SW	11	64	113	76	61	47	3	41	5	4.91	3.38

KWAJALEIN MISSILE RANGE (KMR)

INTRODUCTION

The U.S. Army Kwajalein Missile Range is a Class II installation of the United States Army and is designated a subordinate activity of the U.S. Army Strategic Defense Command (USASDC), Washington, DC. Command of the installation with regard to its National Range mission is exercised under the guidance and control of the Chief of Research and Development, Department of the Army. Kwajalein Missile Range (KMR) became U.S. Army Kwajalein Atoll (USAKA) during 1986. In April 1991, the name was changed back to KMR. Originally, KMR was established by the Department of Defense as a National Range to provide support to DOD and other designated government agencies for launching, tracking, and collecting data in guided missile and space vehicle programs. To implement this mission, KMR maintains instrumentation sites on numerous islands in the Kwajalein Atoll.

The KMR is located in the Ralik Chain, the westernmost chain of islands of the Republic of the Marshall Islands. It is situated in the Westcentral Pacific Ocean, approximately 3,500 km southwest of Honolulu and about 7,800 km southwest of San Francisco. It lies less than 1,300 km north of the equator in the latitude of Panama and the Southern Philippines (8.7° north), and in the longitude of New Zealand (167.7° east). Its remoteness from centers of population and the proximity of the sea have a major bearing on the operation and maintenance of KMR.

The Kwajalein Atoll is a coral-reef formation in the shape of a crescent loop enclosing a lagoon. Situated on the reef are approximately 100 small islands with a total land area of only 14.5 square km. The three largest islands are Kwajalein (3.1 square km) at the southern tip of the atoll, Roi-Namur at the northern tip, and Ebadon, the westernmost island. They account for nearly half the total land area. While the typical size of the remaining islands is about 137 meters by 1,040 meters, the smallest islands are no more than sand cays that merely break the water's surface at high tide. By contrast, the lagoon enclosed by the reef is the world's largest, having a surface area of 2,850 square km. The lagoon's depth is generally between 30 and 55 meters; however, there are numerous coral heads approaching or breaking the lagoon surface. Around the atoll, the depth plunges to as much as 1,800 meters within 3 km of the atoll reef and 4,000 meters within 18 km.

The atoll's largest dimension is 120 km from Kwajalein to Ebadon, and its average width is about 24 km. Kwajalein and Roi-Namur Islands are 80 km apart and are the principal islands of KMR. The other islands used by KMR are situated between these two.

All islands of the atoll are quite flat, and few natural points exceed 4.5 meters above mean sea level; those that do are sand dunes. The average elevation of Kwajalein is 1.8 meters with its highest point being "Mt. Olympus," a man-made hill which is about 21 meters high. As a result of the coral base and the lack of elevation, there is a very shallow water table. This condition presents a major problem for underground construction.

ORGANIZATION

The KMR is managed by the Department of the Army through the USASDC in Washington, DC. Meteorological support services are provided by the met contractor. Most programs that come to KMR are associated with reentry of ballistic missile systems, the Strategic Defense Initiative, or probe launches from the islands of Roi-Namur, Meck, or Omelek.

RANGE USERS GUIDE

Prospective range users must initially contact the Plans and Programs Office of the lead range. For systems launched into KMR, the lead range is usually the 30th Space Wing or the Naval Air Warfare Center-Weapons Division, Point Mugu. For launches from Kwajalein, this is the Range Command Range Support Branch (CSSD-KA-RH), P.O. Box 1500, Huntsville, Alabama, 35807. All major programs are managed under the Universal Documentation System (UDS). When using this system, there are several levels of correspondence between the range user and the range specified by the user to satisfy requirements. These correspondence documents include a Program Introduction (PI), Statement of Capability (SC), Program Requirements Document (PRD), Program Support Plan (PSP), Operation Requirements (OR), and an Operations Directive (OD), which is the final document identifying all activities necessary to support the test.

RANGE SERVICES/CAPABILITIES

SERVICES/ MGMT	OP'L HRS	ALT RANGE	MAX CPBLTY	NMCLTR	TIME REQ FOR MSRMT	DATA PRSG	REMARKS
Forecasting Service	24 hrs daily		24 hrs daily				Forecasts for all ops and weather advisories
Consulting Service	M-F 0730-1630L		24 hrs daily				Consultant service on environmental matters for operations
Obs, Sfc (aerodrome)	24 hrs daily	Sfc	24 hrs daily				Manual
Obs, Sfc (remote sensors)	24 hrs daily	Sfc	24 hrs daily				Automatic stns Meck, Roi-Namur, and Illiginni, installed in 1990
Obs, UA Rawinsonde (Fixed) Kwajalein	0000L-1200L daily	Sfc-30km	16 per day	MSS(2)	2 hrs	ADP	May track two at once
Roi-Namur		Sfc-30 km	8 per day	MSS(1)	2 hrs	ADP	Manned only for test support
Obs, UA Rocket-sonde Omelek		20 to 65 km	6 per day	PWN-11D	50 min	ADP	Requires radar tracking
Kwajalein		20 to 65 km	6 per day	PWN-11D	50 min	ADP	Requires radar tracking
Obs, UA Robin Sphere Omelek		30 to 90 km	6 per day	PWN-12A	30 min	ADP	Requires radar tracking

RANGE SERVICES/CAPABILITIES (continued)

SERVICES/ MGMT	OP'L HRS	ALT RANGE	MAX CPBLTY	NMCLTR	TIME REQ FOR MSRMT	DATA PRSG	REMARKS
Obs, UA LLMR		1 to 40 km	6 per day	Modified PWN-11D	20 min	ADP	Requires radar tracking
Obs, UA Radar, PPI real time	24 hrs		contin-uous	WSR-74S		modem	Requires RDRS, modem/dial-in
Video tape	24 hrs		contin-uous	WSR-74S			Tape provided in VHS format
Mag tape	24 hrs		contin-uous	WSR-74S			9 track, 1600 BPI
WFR (Wind Finding Radar		Sfc to 5 km		WFR-100	20 min	ADP	Used for launcher setting winds. Radars track balloon-borne corner reflectors
Satellite Imagery	24 hrs daily		24 hrs daily	McIDAS, DMSP MarkIIA		ADP	Hourly images GMS IR, twice daily images each NOAA and DMSP orbiter

TYPICAL RANGE REQUIREMENTS SUPPORTED

The KMR tests are separated into ballistic missile launches, probe launches, and minor tests. Ballistic missile and probe launches require surface and upper air observations, plus forecasts as far as 14 days in advance. Normally, there is a telephone conference call with the lead range at approximately T-12 hours. A decision is generally made at that time to continue with the mission or to scrub it because of forecasted unfavorable weather conditions. Special weather-sensitive missions requiring low probability environmental conditions may be counted down to this point many times before there is a high probability of meeting reentry area weather requirements during the scheduled window. Minor tests include such diverse operations as radar calibration sphere deployments from free balloons or aircraft, optics star calibrations, and meteorological rocket launches. Minor tests require only routine weather forecasts and warnings.

TEST PROG SYSTEM	SVC RQRD	TIME OF EVENT	VERT SPTL RESLUTN	HORIZ SPTL RESLUTN	TEMPORAL RESLUTN	REMARKS
Probe launches	Launch winds	Each launch	Sfc to 30 km	Along trajec-tory	Each launch T-5 hrs to launch	Required launcher setting 60 m twr WFR, MSS, PWN-11D
Ballistic missile reentry (BSD)	Fcst ice cstl habitat, cloud LWC	Each launch	Sfc to 18 km	Along trajec-tory	T-12 hrs reentry	If conditions not favorable at T-12, reschedule mission
AST reentry optics	Fcst cld envmt	Each launch	Above 12 km	1,000 nm by 1,000 nm view area	T-3 hrs to reentry	Required to select optimal flight area

DATA SETS/DATA BASES

All surface and upper air observation data including aviation and synoptic observations, and rawinsonde observations from Kwajalein and Roi-Namur Islands are on archive at the National Climatic Data Center, Asheville, North Carolina. Meteorological rocket data is submitted to U.S. Air Force Environmental Technical Applications Center OLA branch in Asheville.

CLIMATOLOGY

KWAJALEIN MISSILE RANGE
REPUBLIC OF THE MARSHALL ISLANDS

MONTH	WIND (KTS) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM	CLD CVR	PCPN (In) AVG	24 HR MAX
JAN	ENE	15	57	91	86	81	77	68	76	.8	4.9	6.46
FEB	ENE	15	37	92	86	82	77	71	75	.8	3.0	4.60
MAR	ENE	14	38	91	87	82	77	70	76	.8	5.2	3.77
APR	ENE	13	39	92	87	82	77	71	79	.8	7.6	5.41
MAY	ENE	12	37	93	86	82	77	71	81	.9	11.2	8.35
JUN	ENE	11	44	92	86	82	77	71	81	.8	10.1	4.69
JUL	E	10	40	94	86	82	77	70	81	.9	10.3	5.68
AUG	ENE	9	37	95	87	82	77	71	80	.8	10.3	5.35
SEP	E	8	37	93	87	82	77	68	81	.9	10.9	4.69
OCT	E	9	46	97	87	82	77	71	80	.9	12.2	6.53
NOV	ENE	11	46	92	87	82	77	70	80	.8	11.0	7.24
DEC	ENE	14	42	90	86	82	77	69	78	.8	8.0	17.15
YRLY	ENE	12	57	97	87	82	77	68	79	.8	104.7	17.15

NAVAL AIR WARFARE CENTER-WEAPONS DIVISION, CHINA LAKE (NAWC-WEPS, CHINA LAKE)

INTRODUCTION

The Naval Air Warfare Center-Weapons Division, China Lake, California, (formerly the Naval Weapons Center (NWC)) is the principal Navy RDT&E Center for air warfare systems and missile weapon systems and the national range/facility for parachute test and evaluation.

The NAWC-WEPS, China Lake is geographically well located for its mission because good flying weather and abundant air and ground space are essential for weapon testing and evaluation. Clear skies prevail at throughout most of the year and the climate is semiarid with precipitation averaging about 4 1/4 inches a year. Measurable rainfall can be expected about 20 days a year and snowfall 2 days a year.

Surface winds affect tests and flight activities at NAWC-WEPS, China Lake. The climate report contains meteorological data recorded at the Center over a 44-year period. Because there is a seasonal pattern as well as a diurnal pattern, the meteorological data will help personnel in planning and scheduling tests and will aid in test evaluation.

The meteorological data was recorded at the Range Systems Laboratory (RSL). Attention must be paid, however, to topographic and orographic details at NAWC-WEPS, China Lake, because winds can be highly variable from place to place. The RSL is located in a position that makes it less subject to high winds, especially northerly winds, than the west side of the valley. On the other hand, westerly winds are more likely to be stronger at RSL than on the west side of the valley. Therefore, test site location should be taken into consideration when surface wind and other data are used for scheduling and test evaluation.

TOPOGRAPHY OF NAWC-WEPS RANGES

The NAWC-WEPS, China Lake lies in the interior of southcentral California, on the northern edge of the Mojave Desert at latitude 35° N and longitude 117° W, and is 2,215 feet above mean sea level (MSL). The RSL is located at latitude 35° 41' 39" N and longitude 117° 37' 14" W, at an altitude of 2,166 feet above MSL.

Mountains surround the test ranges. West and northwest of the center are the Sierra Nevada Mountains with peaks rising above 6,000 feet. Mount Whitney and other peaks rest 75 miles northwest exceeding 14,000 feet in altitude. The northern boundary of the center is the Coso Range, extending above 8,000 feet, and the northeastern to eastern boundary is the Argus Range with elevations above 6,000 feet. Farther to the east are the Slate and Panamint Ranges with peaks exceeding 11,000 feet. South is the El Paso Range with heights above 5,000 feet. The terrain on which the administration area and the ranges are located is nearly level throughout an area extending north-south for 30 miles and east-west for 15 miles. The floor of the valley is desert, consisting of sandy soil with a large dry lake bed.

EFFECT OF WIND PATTERN ON FLYING WEATHER

Air routinely flows into the Indian Wells Valley through low mountain passes. Air circulates in from the San Joaquin Valley via Tehachapi Pass and Red Rock Canyon as well as Walker Pass. To the northwest, air from Owens Valley flows through the gap at Little Lake. From the east, air often comes into the valley through Burro Canyon and, from the southeast, through the gap between the Argus and El Paso Mountains.

Clouds are generally of the high cirriform type with ceilings generally above 20,000 feet and the visibility is normally greater than 50 miles. Flying weather is excellent throughout the year except for gusty afternoon and evening surface winds causing turbulent conditions on landing and takeoff. Visual flying conditions with unlimited ceilings and unrestricted visibility normally occur 25 days per month. Cloud layers producing ceilings above 5,000 feet can be expected about 4 days per month. Marginal flying conditions with ceilings between

1,000 and 5,000 feet and prevailing visibility between 3 and 5 miles are experienced about 12 days per year. Instrument flying conditions with ceilings of less than 1,000 feet and prevailing visibility less than 3 miles occur an average of about 6 days per year.

SEASONAL WINDS

The strongest surface winds occur in the late winter and spring as cold fronts move rapidly through the area. These fronts occasionally cause severe dust and sand storms. Strong surface winds with a prevailing speed of 15 knots or greater can be expected 15 days a year, and strong gusts of 40 knots or greater can be expected 10 days a year. On about four of those windy days, the visibility will be reduced to less than 7 miles in blowing dust or alkali.

Summer is characterized by very warm, dry days with cool nights. Afternoon temperatures rise to 100 °F or higher about 66 days a year and drop into the 60s at night. The wind is generally light and variable, but with afternoon heating, a south-southwest wind begins to blow at 10 to 20 knots and lasts into the evening hours. With rapid heating of the ground, dust devils occasionally develop with winds up to 30 knots in the vicinity of the phenomena. Fair weather dominates the hot summer months with most precipitation from thunderstorms occurring during August and September in conjunction with the southeast monsoon.

Winters are cool with nighttime temperatures dropping to 32 °F or less about 77 days a year then warming into the 50s during the day. Precipitation is at its maximum from November through March with normal monthly rainfall averaging 1/2 inch or more. Normally, frontal systems move rapidly through the area on an average of three a month. Occasionally strong westerly winds of 20 to 30 knots can be sustained for periods up to 24 hours.

WINDS AND TEST AND EVALUATION

Meteorological data are necessary for tests and flight activities at NAWC-WEPS, China Lake. Winds and the dust they can carry affect not only visibility and personnel safety, but also influence the trajectory of missiles and parachutes, thereby distorting test results. In addition, blowing dust can cause electrical effects that make the handling of explosives hazardous.

DATA COLLECTION AND REDUCTION

The meteorological data were recorded over a 44-year period from 1945 through 1989 and extremes are based on this period of record. Normals are based on the period of 1960 through 1989. Surface winds were recorded hourly at RSL using Bendix wind equipment. Temperature and relative humidity were recorded using a hygrothermograph. Pressure was recorded using a microbarograph. After January 1989, all surface weather recordings were made using a HANDAR 540A Remote Automated Weather Station. Upper air information was obtained from balloons released at Tower 8 (G-1 Road). Until 1983 the balloon was tracked and data collected using a RAWIN SET AN/GMD- 1; after that time, the Meteorological Sounding System (MSS) was used.

RANGE SERVICES/CAPABILITIES

SERVICE	HOURS	EQUIPMENT	REMARKS
Surface Observations, Climatology, Warnings	Daily 05-23L		Navy Weather Detachment (NOCD)
Forecasts	M - F 05- 17L		NOCD
Capabilities, Range Climatology	M - F 07-16L		Range Meteorology Office (RMO)
Range Weather Support	M - F 05-16L		RMO
Upper Air Sounding	M - F 05L+09L	MSS & MRS (fixed)	Sfc to 50Kft for Range Forecast
Upper Air Sounding		AN/UMQ-12 (MRS) (mobile)	Soundings to meet test requirements
PIBAL		Theodolite (mobile)	Soundings to meet test requirements
Surface Observations		Automated Weather Stations (fixed and mobile)	Observations to meet test requirements

Operational hours indicated are normal work hours but may be modified to meet test requirements. Contractor overtime pay may be required.

MSS and MRS Upper Air Systems are located at T-8 (G-1 road), which is near the center of the administration area valley.

Automated Weather Stations (fixed) are interfaced into the Optical Range Communications System (ORCS) with data available to users at the Range Control Center (RCC) and T-8. Mobile stations provide data to users via VHF radio.

TYPICAL RANGE REQUIREMENTS

TEST PROGRAM	SERVICE PROVIDED	RESOLUTION	ACCURACY	REMARKS
Air	Rawinsonde Observations	Surface to 30K by 100 ft increments	Pressure ±0.3% Temperature ±1.5°C Humidity ±10% Wind ±0.2 mps V_{EE} ±1.5% of vector wind	Fixed and Mobile
	PIBAL Observations increments	Surface to 15K by 500 ft	Wind ±3.0 mps V_{EE} ±6% of vector wind	Mobile
Surface	Surface Observations	Sample rate 2-second intervals	Wind Speed ±2% Direction ±2° Temperature ±0.1°C Humidity ±5% Pressure ±3%	Fixed and Mobile

Major programs supported: HARM, ALARM, TACIT RAINBOW, TOMAHAWK, LASER GUIDED BOMB, SKIPPER FOG, SIDEWINDER, SIDEARM, SKYRAY FIBER, WALLEYE, ROCKEYE, REDEYE, SHRIKE, SNORT, SLAT, PSLE, HIGH SPEED AIR DROP, PARACHUTE QUALS, 120MM. A few programs required both surface and upper air support.

PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

EQUIPMENT	PURPOSE	LOCATION	QUANTITY	PURCHASE	REMARKS
RAWS	Surface Obs	Fixed Mobile	4 2	CY 91 CY 91	HANDAR Systems
MSS Upgrade	Upper Air Obs	Fixed T-8	2	CY 92 CY 94	Computer/ GPS Sonde Capability
Wind Profiler	Winds Aloft	Mobile/ Transportable	2	CY 93 CY 94	Winds to 10Kft
METVAN	Surface/ Upper Air Obs	Mobile	1	CY 92	Remote Support
NEXRAD PUP	Severe Weather	Fixed HGR #3	1	CY 93	NOCD
LDATS	Cloud to Strikes	Fixed HGR #3	1	CY 92	NOCD

SPECIALIZED DATA BASES

LOCATION	TYPE DATA	PERIOD	MEDIUM	FORMAT	REMARKS
NAWC-WEPS, China Lake	Surface Obs	1945-Current	Macintosh Computer	Excel Spread-sheet	Monthly Summary
NAWC-WEPS, China Lake	Surface Obs	1980 - Current	Macintosh Computer	Excel Spread-sheet	2 hourly Summary
NAWC-WEPS, China Lake	Surface Obs	1989-Current	IBM Floppy Disk	RAW Meso Net 11 Stations	HANDAR
NAWC-WEPS, China Lake	Rawin-sondes	1982 - Current	Macintosh Computer	Floppy Disk	1000 Foot/ Man & Sig Levels

NOTE: After January 1990, Upper air sounding data is available at 100-foot intervals from the surface to 10,000 feet, 200-foot intervals between 10,000 and 20,000 feet, and 500-foot intervals above 20,000 feet (MSL).

CLIMATOLOGY

NAVAL AIR WARFARE CENTER-WEAPONS DIVISION
CHINA LAKE, CALIFORNIA

	WINDS (knots)			TEMP (°F)					REL	CLDS	PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	HUM	CVR	MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	%	TENS	AVG	MAX
JAN	SSW	4	67	77	59	43	28	0	53	5	.71	1.26
FEB	SSW	5	60	88	65	49	34	9	52	6	.70	1.45
MAR	SSW	7	70	92	70	55	40	17	46	5	.59	2.18
APR	SSW	8	60	102	78	61	45	28	39	4	.15	.88
MAY	SSW	7	63	107	87	71	54	43	35	4	.12	.65
JUN	SSW	7	59	115	97	80	63	40	28	3	.05	.34
JUL	SSW	7	50	118	103	86	68	50	27	2	.23	1.35
AUG	SSW	6	60	113	101	84	67	50	28	3	.31	1.73
SEP	SSW	6	52	110	94	76	59	39	32	3	.25	1.54
OCT	SSW	5	57	103	82	65	47	21	36	3	.17	.78
NOV	SSW	4	56	89	68	52	36	15	44	4	.50	1.09
DEC	SSW	4	62	86	57	43	28	2	51	5	.50	1.14
YRLY	SSW	6	70	118	80	64	47	0	39	4	4.28	2.18

YUMA PROVING GROUND
(YPG)

INTRODUCTION

Yuma Proving Ground (YPG) contains approximately 1,400 square miles of land located in the southwestern section of Arizona. This area is part of the Sonora Desert, a low-latitude, hot-dry desert. In the United States, only this general area is considered to be environmentally compatible to the great deserts of the world. Comparison of the world's deserts indicates that the Yuma area is not closely analogous to other desert areas in certain respects, but it does offer the most comparable overall environment to be found in the United States.

The YPG Headquarters is located on the central-west edge of the Yuma Indian Reservation, 25 road miles northeast of the city of Yuma, Arizona, an agricultural and tourist center of approximately 50,000. The reservation is adjacent to the Colorado River and lies entirely within Yuma County, which occupies the southwestern part of the state of Arizona. The 870,166 acre area, circumscribed by the installation boundary, is of a general "U" configuration extending about 56 miles north-south and 48 miles east-west. Within the arms of the "U" lies the KOFA National Wildlife Refuge.

The general testing capabilities of YPG are

a. Air Delivery - both airdrop and air transportability.

b. Mobility Equipment - wheeled and track-laying equipment as well as tank fire-control systems.

c. Munitions and Weapons - weapons, explosive ordnance, and related items. Primary test site is the KOFA Range which contains a 64 km overland artillery range.

d. Aircraft Armament - includes facilities for both development and service tests of components and systems. Emphasis is on rotary-wing aircraft internal and external armament and fire control items.

e. Desert Environmental tests.

For additional information on YPG capabilities, procedures for scheduling programs, or use of resources, contact Chief, Test Resources Management Division, Materiel Test Directorate, YPG; phone (602) 328-6926 or DSN: 899-6926.

RANGE SERVICES/CAPABILITIES

SERVICES/ MGMT	OP'L HOURS	ALT RANGE	MAXIMUM CAPABILITY	TIME REQ FOR MEAS.	DATA HANDLING	REMARKS
Forecasting	Daily	24 hrs				
Consulting	M-F 0700 to 1500	24 hrs				
MESOMET Network	24 hrs	Sfc	16 sites	15 min	ADP	5 Visibility sensors
Instru-mented Ranges	As req.	Sfc	24 hrs		ADP	Scintilo-meter
Instru-mented Ranges	As req.	Sfc	24 hrs		ADP	2 Identical ranges
Instru- Ranges	As req.	Sfc	24 hrs		ADP	Instrumented identically
Tower System	M-F 0700 to 1500	50 to 300 ft	24 hrs	Real time	ADP	3 Towers
Rawinsonde	M-F 0500 to 1500	Sfc to 30 km	1 hour	1 hour for short flight	ADP	2 Sites
Rawinsonde (Mobile)	As req.	Sfc to 12 km	1 hour	1 hour	ADP	
Wind-finding radar	As req.	Sfc to 30 km	Flight time	Flight time	ADP	2 Sites

TYPICAL RANGE REQUIREMENTS SUPPORTED

TEST PROGRAM	SERVICE REQUIRED	TIME OF EVENT	VERTICAL RESOLTN	HORIZONTAL RESOLTN	TEMPORAL	REMARKS
Enhanced COBRA	Winds Temp Pressure	Hours	25 m each	4 levels	Real time	3 100m towers plus rawin flights
GPS	Rawinsonde	Hours	100 m	Point source	2 hours	Flights bracket test
Artillery	Rawinsonde	Hours	100 m	Point source	2 hours	Ballistic
M1 Tank	SFC Data	Hours		2 km	15 min	Meso Network
Desert Storage Exposure	SFC Data	Mo.		2 km	1 hour	Meso Network
20 mm Direct Fire	Winds on trajectory air density	Hours	500 m	10 sec		
Air delivery	Rawinsonde SFC Data	1 hour		Point source	2 hours 15 min	Observer at at drop site

RANGE PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

EQUIPMENT NOMENCLATURE	CAPABILITY OF EQUIPMENT	FIXED OR MOBILE	EXPECTED DELIVERY	QUANTITY	PRICE
IBM Computers	IBM Compatible	Fixed	Ongoing Updates	2	9K
Multiwave Transmissometer	Transmission Measurements	Mobile	CY 93	1	300K

RANGE PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT (continued)

EQUIPMENT NOMENCLATURE	CAPABILITY OF EQUIPMENT	FIXED OR MOBILE	EXPECTED DELIVERY	QUANTITY	PRICE
Portable Sodar	Wind at 20 m, Intervals to 1,000 m	Mobile	CY 93	1	90K
GPS Upgrade to Rawinsonde	Increased accuracy	Fixed	CY 94/95	1	250K
SAMS Upgrade	Improved MESOMET	Both	CY 95	1	525K

NOTE: All above equipment currently planned to be supplied by ASL.

CLIMATOLOGY

YUMA PROVING GROUND
YUMA, ARIZONA

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	N	3	33	89	64	52	43	23	40	.1	.47	.78
FEB	NW	3	38	94	72	59	46	26	37	.2	.25	.33
MAR	W	4	45	100	77	63	50	32	34	.1	.29	.46
APR	W	5	42	106	85	71	57	42	26	.1	.09	.53
MAY	W	5	34	117	94	79	64	46	24	.1	.04	.19
JUN	SW	4	29	121	102	88	72	54	21	0	.07	.09
JUL	SW	4	55	118	105	92	79	65	31	.1	.25	.90
AUG	SW	4	42	118	104	92	79	65	38	.1	.57	2.40
SEP	SW	3	34	115	98	85	72	56	34	.1	.43	.26
OCT	SW	3	35	112	88	74	61	36	34	.1	.39	.78
NOV	N	2	41	95	67	55	44	31	35	.1	.35	1.22
DEC	NW	3	45	84	67	54	43	26	47	.1	.33	.74
YRLY	W	4	55	121	82	73	59	23	33	.1	3.53	2.40

DUGWAY PROVING GROUND
(DPG)

INTRODUCTION

Dugway Proving Ground (DPG) is a multi-purpose test facility that includes a main base on the edge of the Great Salt Lake Desert of western Utah and an operating location in Panama. The DPG is the U.S. Army Test and Evaluation Command (TECOM) test center for assessment of smoke and obscurant systems and is the national center for chemical warfare and biological defense systems testing. The DPG also supports major artillery and mortar testing programs, and performs a variety of customer tests for all DOD components. Special capabilities include environmental chamber testing and long term exposure testing at the Panama operating location. Dugway's remote inland location provides an extra measure of security for the testing of sensitive material. DPG also hosts the 7th Ranger Training Battalion and reserve component training at the artillery ranges.

The DPG offers abundant air and ground space, data acquisition equipment, and facilities for test mission support. Ground space includes 600 square miles of test grids, maneuver areas, and artillery and mortar ranges. The DPG is also adjacent to the Utah Test and Training Range (UTTR). Air space utilization is coordinated between DPG and the UTTR by Clover Control. Data acquisition equipment at DPG includes radars, optical-tracking cameras, infrared imagers, and a wide range of meteorological instrumentation. Facilities include chemical and biological laboratories, test and conditioning chambers, on-site data processing facilities, and the 13,000-ft runway at Michaels Army Airfield.

Meteorological support at DPG is provided by the Dugway Atmospheric Sciences Laboratory (ASL) Meteorological (Met) Team and the DPG Meteorology Division. Meteorological support provided by the ASL Met Team consists of weather observation, analysis, and forecasting services.

The Dugway Meteorology Division assists in test planning and is responsible for micrometeorological data acquisition, quality control, remote sensing, dispersion modeling, and special studies. Specialized meteorological equipment include a radar wind profiler and Doppler acoustic sounders for wind profile measurements, scintillometers for area-averaged wind and optical turbulence measurements, and fast response sonic anemometer/thermometers and hygrometers for heat, moisture, and momentum flux and variance measurements.

RANGE TOPOGRAPHY

The DPG lies in the Great Basin of northwestern Utah at 40° N, 113° W at an elevation 1,315 m (4,313 ft) above mean sea level (MSL). The Dugway ranges lie on a flat dry lake bed with clay soils and small patches of vegetation-stabilized sand dunes. Vegetation and terrain features are generally 1 m or less in height, and surface roughness lengths are on the order of 3 to 4 cm.

Mountain ranges surrounding DPG include the Cedar Mountains to the northeast, the Dugway Mountains to the south, and Granite Mountain to the west. Each range has peaks rising 7,000 to 8,000 feet MSL. Terrain to the west of Granite Mountain consists of salt flats with little or no vegetation at 4,290 feet MSL, terminated at a distance of 50 km by the Deep Creek Mountains with peaks of 8,000 to 11,000 feet MSL. Terrain west of Granite Mountain and north of Wig Mountain is under the control of the UTTR. Terrain to the northwest and southeast of DPG is flat and open, providing unobstructed channeling of flow between mountain ranges. The terrain slope across the range area is 1.5 meters per kilometer with higher terrain to the southeast and lower terrain to the northwest.

EFFECT OF WIND PATTERNS ON FLYING WEATHER

Flying weather at DPG is generally good, characterized by patchy high clouds and visibilities exceeding 50 NMI. Turbulent flight conditions occasionally occur when a west-east jet stream crosses the mountains, causing lee-side waves. Intense surface heating during the summer months causes convective downbursts that are significant aircraft hazards. Thunderstorms also create turbulent flying conditions. The DPG has an average of 30 thunderstorm days per year, mainly during the late spring and late summer. Winter-time air stagnation conditions lead to reduced visibility in fog and low stratus. The DPG has an average of 38 fog days per year.

SEASONAL WINDS

Wind patterns during spring and fall are dominated by the movement of synoptic-scale features across Utah. The synoptic features include strong prefrontal winds from the southeast through the south, followed by a rapid shift to northeast with frontal passage and strong northerly through northwesterly winds after the front is well past the area. Strong winds with gusts in excess of 35 knots are expected 30 days per year, mostly associated with thunderstorms or strong prefrontal conditions during the spring or fall.

Summer wind patterns are dominated by local heating effects and mesoscale circulation patterns within the Great Basin. The dark basaltic rocks of mountain ranges surrounding DPG absorb and emit heat faster than the salty lake bottom with its high moisture content and albedo. Consequently, summertime diurnal heating during the day causes a northwesterly flow across test grids toward higher terrain south of DPG with a southeasterly downslope flow towards the salt flats at night. Summertime winds are typically 4 to 10 knots with occasional gusts exceeding 35 knots in convective downbursts or thunderstorms.

Winter wind patterns at DPG are dominated by high pressure and stagnation conditions, periodically punctuated by winter storms. Weak diurnal heating causes weak and disorganized wind patterns to predominate throughout the Great Basin. Surface wind speeds are typically 0.5 to 5 knots with occasional winds exceeding 35 knots in snowstorms.

DATA COLLECTION AND REDUCTION

The following climatological data bases are available for DPG:

a. Surface weather observations at the Ditto Weather Station,

b. 2-m temperature and 10-m winds from remote mesometeorological (mesomet) stations across DPG, and

c. Mandatory level radiosonde flight data from radiosonde sites at DPG.

The surface weather observation period of record (POR) is 38 years with thunderstorm and fog occurrences averaged only for 1980 through 1988. The mesomet POR is 5 years (1984 onwards), while the radiosonde POR is 12 years (1977 onwards). Additional data available include Doppler acoustic sounder and micrometeorological data from test sites, but these records are not continuous or formatted for climatological averaging. Radar wind profiler data archival began in May 1990.

RANGE SERVICES/CAPABILITIES

SERVICE	HOURS	EQUIPMENT	REMARKS
Surface Wx. Obs. and Fcst.	M-Th 0530-1730		ASL Met Team
Range Climatology	M-Th 0530-1730		Met Divisiom
Upper Air Sounding	M-Th	Beukers WL8000	ASL Met Team as required
PIBAL	M-Th	Theodolite	ASL Met Team
Wind Profiles	Continuous	Wind Profiler	Met Division
Wind Profiles	Continuous	Acoustic Sounder	Met Division
Mesomet Data	Continuous	Climatronics	Met Division
Sutron System	Continuous		Met Division
SAMS System	Continuous		ASL Met Team
Dispersion Modeling	M-Th		Met Division
Mesoscale Modeling	as required		Met Division
Special Studies	as required		Met Division

NOTES: Radiosonde flights, PIBALs, and field surface weather observations are taken as needed for test support activities. Additional measurements using micrometeorological instrumentation are also taken as needed to support field tests. Operational hours may be modified to meet test requirements. The DPG maintains two lightning detection direction finder (DF) units that are integrated into the Bureau of Land Management (BLM) lightning detection network.

PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

EQUIPMENT	PURPOSE	LOCATION	QUANTITY	REMARKS
Met Van	Remote Obs	mobile	1	CY 93
Boundary Layer Profiler	Wind Profiles	mobile	1	CY 92
Micromet Sensors		mobile	20	CY 92
Radiometric Profiler	Radiosonde Replacement	mobile	1	CY 95
Scintillo Meters	Wind and Turbulence	mobile	4	CY 93
Field Mill	Lightning Detection	fixed	1	CY 92

SPECIALIZED DATA BASES

TYPE DATA	PERIOD	MEDIUM	REMARKS
Surface Obs	1980-Present	Hard Copy	Earlier records at National Climate Data Center
Mesomet	1984-Present	VAX	Available for climatological summaries (8 stations)
Sutron Mesomet	1989-Present	VAX	Climatological formats under development (12 stations)
SAMS Mesomet	1987-Present	Hard Copy	9 stations
Radiosonde	1977-Present	VAX	Mandatory level data only

SPECIALIZED DATA BASES (continued)

TYPE DATA	PERIOD	MEDIUM	REMARKS
Doppler Sodar	1986-Present	VAX	Discontinuous, unedited data
Wind Profiler	1990-Present	VAX	Formats under development

CLIMATOLOGY

Climatological weather summary for DPG is presented next. The fog and thunderstorm day averages reflect only those events observed during the operating hours. Consequently, these figures are biased toward daylight hours and should be increased by a factor of 7/4 to compensate for the Friday through Monday closure.

CLIMATOLOGY

DUGWAY PROVING GROUND
DUGWAY, UTAH

	WINDS (knots)			TEMP (°F)					REL	CLD	PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	HUM	CVR	MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	%	TENS	AVG	MAX
JAN	NW	4.5	64	66	36	26	16	-25	75	4	.52	.79
FEB	NNW	6.2	51	71	43	33	23	-29	70	4	.57	.84
MAR	SE	8.2	58	80	53	41	29	-6	57	3	.75	1.15
APR	NW	8.4	82	88	63	50	36		44	3	.75	.95
MAY	NNW	8.0	62	98	73	59	44	21	41	3	.96	.96
JUN	NNW	7.6	58	107	85	70	54	28	31	2	.51	.69
JUL	S	7.0	62	109	94	78	62	27	26	2	.53	1.11
AUG	SE	6.4	56	108	91	76	60	39	33	2	.62	1.46
SEP	NNW	6.8	52	101	80	65	49	22	35	1	.59	1.17
OCT	NW	6.0	54	89	67	52	37	9	46	2	.66	1.07
NOV	SE	6.8	45	78	50	38	26	-8	62	3	.57	.95
DEC	NW	4.9	45	64	39	29	18	-23	74	3	.56	1.01
YRLY	SE	6.6	82	109	65	51	38	-29	50	3	7.59	1.46

Note: Wind direction distribution is bi-modal, with peaks at SE and NW.

6585TH TEST GROUP
(6585 TG)

INTRODUCTION

The 6585th Test Group, located at Holloman Air Force Base, New Mexico, is a subordinate unit of the Air Force Development Test Center (AFFTC), Eglin Air Force Base, Florida. The Test Group performs testing and evaluation of aircraft, missile, and space systems and subsystems and conducts both flight and ground tests. All flight tests are conducted over White Sands Missile Range and more information can be found in the WSMR section of this document. Ground tests are conducted on the High Speed Test Track and at the Radar Target Scatter Facility.

Holloman Air Force Base is located in the Tularosa basin of south-central New Mexico. Holloman is adjacent to WSMR. The Tularosa basin is a desert valley bounded on the west by the San Andres Mountains and on the east by the Sacramento Mountains. Holloman is 4,093 feet above mean sea level (MSL). A significant feature of the basin is the White Sands National Monument, which has a large area of gypsum dunes. The monument is southwest of Holloman, and the dunes are encroaching on the base.

Meteorological data are collected at two places on Holloman. The Holloman Base Weather Station, located adjacent to the flight line, maintains 24 hour/day surface observing. This observing site is approximately 5 miles from the south end of the High Speed Test Track. The other observing site is located beside the test track approximately 3 miles from the south end. Only maximum and minimum temperatures and winds are routinely recorded here. The Radar Target Scatter Facility is located on WSMR which provides their weather support.

The major weather concern for the ground test facilities is wind. The prevailing wind direction at Holloman is from the south during March through November. During the other months winds prevail from the north. Spring is the windiest time of year. March through June are the only months a direction prevails over calm. Even so, supersonic and hypersonic test track missions are extremely sensitive to low wind speeds. These missions are conducted shortly after sunset because the wind dies off and the birds cease activity. At this time, no procurement of geophysical equipment is planned.

METEOROLOGICAL SERVICES/CAPABILITIES

SERVICE	HOURS	REMARKS
Surface Observations	Daily 24 Hours	Air Weather Service Detachment (Det 14, 25 WS)
Weather Warnings	Daily 24 Hours	Det 14, 25 WS
Radar Observations	Daily 24 Hours	Det 14, 25 WS
Forecasts	Daily 05-18L	Det 14, 25 WS
Capabilities	M-F 07-1530L	Staff Meteorology Office
Climatology	M-F 07-1500L	Staff Meteorology Office

TYPICAL METEOROLOGICAL SUPPORT REQUIREMENTS

FACILITY	DATA REQUIRED	RESOLUTION	REMARKS
High Speed Test Track	Winds	Up to 4 points	Anemometers are placed at critical points determined from test profile.
	Temperature	One Point	Measured at approximately midpoint of the track
	RH	Same as Temp	Same as Temp
	Pressure	Same as Temp	Same as Temp

DATA SETS/DATA BASES

LOCATION	TYPE DATA	PERIOD	MEDIUM	FORMAT
High Speed Test Track	Surface Winds	Sep 80 - Aug 86	IBM Comp Spreadsheet	ENABLE
High Speed Test Track	Max/Min Temps	Sep 80 - Present	IBM Comp Spreadsheet	ENABLE

CLIMATOLOGY

6585TH TEST GROUP
HOLLOMAN AIR FORCE BASE, NEW MEXICO

	WINDS (knots) PREVAILING			TEMP (°F)							PCPN (inches)	
MONTH	DIR	SPD	PEAK	ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	MON AVG	24 HR MAX
JAN	N	4	67	78	54	41	28	-11	41	5	.5	1.2
FEB	N	4	49	80	60	46	31	0	31	5	.4	.6
MAR	S	6	51	90	66	52	37	9	22	5	.3	1.3
APR	S	6	69	94	76	61	45	23	17	5	.2	.7
MAY	S	6	57	103	84	69	54	26	16	4	.4	1.8
JUN	S	5	55	109	93	78	63	44	19	4	.8	1.9
JUL	SSE	5	57	108	93	81	68	52	29	5	1.3	1.4
AUG	S	4	58	106	91	79	66	54	36	6	1.3	1.2
SEP	S	4	45	102	86	73	60	38	38	5	1.2	2.1
OCT	S	4	50	92	75	62	48	26	34	4	1.0	1.8
NOV	S	4	58	82	63	49	35	3	36	4	.4	1.2
DEC	N	4	49	75	55	42	29	2	39	5	.5	1.4
YRLY	S	5	69	109	75	61	47	-11	28	5	8.3	2.1

U.S. ARMY ELECTRONIC PROVING GROUND (USAEPG)

INTRODUCTION

The United States Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona, is an independent test and evaluation activity under the command of the U.S. Army Test and Evaluation Command. Since its establishment in 1954, the proving ground has been involved in testing communications and electronics equipment and systems which are intended for use by the military services. Items such as manned and unmanned aircraft, avionics, aircraft survivability equipment, tactical radio transceivers, telephone switching centers, radars, navigation devices, cameras, tactical computers, jamming and anti-jamming devices, surveillance sensors, and radiological survey instruments have all been tested by USAEPG.

The availability of massive real estate in southern Arizona (which includes more than 70,000 acres on Fort Huachuca, 23,000 acres at Wilcox Dry Lake, and approximately 1.5 million available acres near Gila Bend) is a major factor in the support of the total test program. The USAEPG is ideally situated between two other national ranges and provides overlapping, compatible instrumentation facilities for all types of in-flight test programs including first orbit tracking of the space shuttle. The quiet electromagnetic environment, the excellent climatic conditions, and the freedom from aircraft congestion make Fort Huachuca an excellent area for testing of command, control, communications, and intelligence (C^3I) systems.

LOCAL TOPOGRAPHY

Fort Huachuca is located in the foothills of the Huachuca Mountains in the western margin of the San Pedro River Valley of southeastern Arizona. With an average elevation of 5,000 feet, this area is part of the plateau region of the southern Continental Divide which has important implications for local climatic conditions. Fort Huachuca has an average annual rainfall of about 15 inches, 65 percent of which falls during the summer months. Flying missions are practical almost every day of the year because minimum ceilings and visibilities are rarely persistent.

With a peak elevation of 9,466 feet mean sea level (MSL), the SE-NW-oriented Huachuca Mountains are about 30 miles long by 10 miles wide, making them a typical fault-block mountain range of the basin and range topography of the southern Continental Divide. To the east and northeast are the Mule, Dragoon, and Chirachaua Mountains which are other similar ranges lying 30-60 nautical miles (NMI) away. The Wilcox Dry Lake lies just east of the Dragoons in the Sulphur Springs Valley which extends to Douglas. To the southeast is a long, open slope that extends with few mountains to the Gulf of Mexico near Brownsville, Texas. This factor is important in relation to the summer rainfall season. To the west and northwest between Fort Huachuca and Tucson, lie the Santa Rita and Catalina Mountains which are the northward extension of the Sierra Madres of Mexico. These mountains form an important barrier for moisture influx into Tucson and into Fort Huachuca. The floor of San Pedro Valley ranges from alluvial fans near the canyons leading out of the mountains, talus slopes close to the mountains, to river alluvium in the valley floor near the northward-flowing San Pedro River.

EFFECT OF WIND PATTERNS ON FLYING WEATHER

The general wind regime at Fort Huachuca is basically a mountain-valley breeze pattern ranging from an easterly upslope flow in the early morning into early afternoon hours to a westerly regime in the late afternoon and evening hours. In the summer, this westerly flow will initially begin as an upslope flow through the Babocomari Valley northwest of Fort Huachuca which brings air up from the lower desert areas around Tucson, then reverts to a downslope flow after sunset. In the winter, the flow will almost always become downslope when it changes direction. Variations on this flow pattern are directly related to patterns of a seasonal nature which will be covered later.

The primary type of cloud observed at Fort Huachuca year-round is usually cirriform in nature although cumuliform becomes the dominate type in the summer. A healthy sprinkling of lenticular and other wave-type clouds are also observed in the winter and spring. Flying weather is usually quite excellent year-round, although summer thunderstorms can cause temporary minimum conditions. Turbulence, besides that associated with thunderstorms, occurs frequently during the winter and spring when gusty winds are occurring. Fog is strictly a winter weather phenomenon with an average of 8 days per year when the visibility is restricted below 7 miles in fog. Ceilings/Visibilities <3,000 ft/3 miles occur about 2 percent of the time with a distinct peak in winter. Ceilings/Visibilities <1,000 ft/2 miles occur less than 1 percent of the time while values less than 200 ft/1/2 mile are transitory phenomena that occur briefly in thunderstorm activity or infrequent heavy snow showers.

SEASONAL TRENDS

The strongest surface winds occur mainly in the winter and spring in association with cold-frontal passages through southeastern Arizona. The term "front" is used advisedly here as the weather more directly associated with the upper-air trough rather than with any surface front. This situation is very common in the interior west. The southwest flow ahead of the trough blows perpendicularly to the Huachuca Mountains which results in a very pronounced mountain wave developing to the leeward side of the mountain range extending over Fort Huachuca. Under these conditions, a strong downslope wind component develops close to the mountains and is funneled through the canyons. Such events resulting in wind gusts of 30 knots or more occur, on the average, 51 days out of the year. There is a distinct peak in these wind occurrences in March through June. In the summer, the winds are usually associated with thunderstorms. Because of the general ground cover, blowing dust is not a severe problem locally, but during the late spring and early summer, large dust devils are very common, particularly in the ranges. These dust devils can be quite large and can have damaging winds in excess of 50 knots.

Summer in far southeastern Arizona is a season with a marked dichotomy. The first half extending normally into mid-July is usually rather warm and dry. The highest daily mean and extreme temperatures usually occur during this period. Daily highs will be in the mid-90s with lows in the mid-60s. Humidity values are usually quite low (<20 percent); however, this is also the time of the year when highs reach extreme temperatures of 100 °F or higher. Mid-July marks the onset of the summer rainy season which usually lasts until just after Labor Day in September. During this period, better than 80 percent of an approximate 60 percent annual average of thunderstorms occur. It is both interesting and important to note that the southeastern corner of Arizona has the third highest annual average of thunderstorm days in the entire 48 contiguous states. What impresses first time visitors is that most of these storms occur in an 8-week period. Another important fact relating to thunderstorm activity is that the storms can be quite severe. Actually, the highest wind gusts measured to date (83 knots at valley level and at the 32-meter level on a tower in the East Range) were caused by thunderstorms. Because of the high elevation, hail is quite common, although large hail (=>3/4 inch) occurs only infrequently. Tornado or funnel cloud activity is observed in the vicinity about one to three times a year, usually in August. Instantaneous (1-min) hourly rainfall rates of 7.2 inches/hour have been observed during strong thunderstorm activity, which is well within the calculated theoretical maximum rate of 10 inches/hour. It goes without saying that given the local topography, such intense rainfall can produce a very high flash flood potential. Yet, despite the frequent thunderstorm activity, ordinarily confined to the afternoon and early evening hours, weather conditions are normally quite good for testing activities.

Fall is the best time of the year to be at Fort Huachuca, because days are pleasantly warm and the nights are cool. The presence of moisture will lead to occasional shower or thunderstorm activity as late season moisture from the Tropics moves into the moisture area or as the first cool season systems begin to enter the state. By late October, the first frost can occur, and snow becomes a possibility by then as well. Winds are at their lightest from September through December with the strongest winds associated with cool season storm systems. Although tropical cyclones are not a factor in Arizona weather, their remnants can move into the state on occasion during the fall. These remnants can result in an influx of tropical moisture which produces late season showers and thunderstorms. On occasion, a well-defined remnant will be accelerated into the state ahead of an approaching trough in the Westerlies, causing heavy rainfall and significant winds. The last time this phenomenon occurred was in October 1989 when an ex-hurricane swung into Arizona. The still well-defined center passed 4.5 km west of the weather station producing surface wind gusts as high as 50 knots and dumping over 3 inches of rain on a 100-mile-wide path to the right of the center.

Because of the elevation, winter temperatures are somewhat cooler than expected from this latitude (31.6 °N). In December and January, daily highs average in the upper-50s while lows are in the mid-30s; however, extended cold spells can drop morning lows to into the 20s or even lower. In fact, single-digit temperatures have been measured at various range locations as recent as 1987. From reviewing historical records, temperatures at or below zero have been measured in and around Fort Huachuca within the last 40 years. Such extremes are rare, however. More important are the extreme differences in measured low temperatures within the confines of the test range which result from cold-air drainage into local cold-pockets or pneumonia hollows. These differences, of course, are not reflected in the climatic data records from the main weather station. Winter also marks the appearance of two different wind regimes that bring significant winds to the area. Because no barrier exists at the Continental Divide, cold fronts that move south into west Texas can push as far west as central Arizona when the pattern aloft is favorable. These "backdoor" cold fronts will bring gusty east to southeast winds and cool temperatures, but rarely any other weather. The winds can occasionally gust up to 35-40 knots but most often the gusts are under 30 knots. The other strong wind problem is related to the passages of extra-tropical systems through Arizona. Ahead of the troughs, the upper-level wind flow is normal to the Huachuca Mountains and it sets up a mountain-wave situation. A downslope flow near the range occurs and becomes funneled through and down the canyons. These canyon winds can reach speeds in excess of 60 knots and are extremely gusty, blowing strongest at night. Because there are several canyons within the confines of Fort Huachuca, these winds are a critical factor in testing. Based on historical evidence, extreme wind speeds of hurricane force are not impossible in this situation. Unfortunately, the weather station is not situated well to study or record these winds. Since the installation of a SAMS network, USAEPG can monitor the trouble spots on a regular basis.

Although most winter precipitation at Fort Huachuca falls as rain, snow does occur annually. The average annual snow fall is 9.4 inches, which falls on 6.3 days annually. The vast majority of snowfalls occur at the tail end of a system passing through the state, totally 1 inch or less. It is important to note that the record snowfall at Fort Huachuca is 18.1 inches, which occurred in December 1978. The heaviest recent snowfall occurred early Christmas Day 1987 and totalled up to 7 inches. Snowfalls of 6 inches or more have occurred as late as March. Measurable snow has fallen as early as October and as late as May in recent years. Until 1989, freezing precipitation had never been observed at Fort Huachuca, but a significant episode occurred in February of that year.

Nature quickly turns the water spigot off in the spring which is the driest and clearest time of the year. It is also the windiest overall as significant troughs pass through the area as late as May, followed by the subtropical jet stream. Strong insolation in the late spring combined with elevation allows coupling up to the 550-millibar level providing the means for the downward transport of the winds at that level. Generally, the springtime winds, unlike the winter events, are very diurnal and although some funneling occurs, the winds do not extend into the nighttime hours. Although temperatures are steadily warming on the average, it can still be below freezing as late as the end of April. Cloud cover is usually minimal and, as a rule fairly high. Thunderstorms are not common and occur in conjunction with cold-core lows aloft over the state, resulting in snow showers as late as May which last occurred in 1990. By late May into June, thunderstorms tend to be high based and dry, when they occur at all, and have strong downburst winds of short duration. The lightning combined with these winds and lack of rain creates a severe fire danger in the ranges.

DATA COLLECTION AND REDUCTION

The meteorological data were recorded over a 35-year period from 1956 to present and the extremes are based upon this period of record. In addition, historical data of a limited nature is available for the period of 1905-1956. Normals are based upon the latest 35 years of record. Since 1987, the SAMS network has provided data from the various test and radar sites on Fort Huachuca. Once a 5-year data base is established for each site, an initial climatological summary will be prepared for each one.

Until 1987, surface winds were measured with a Bendix Frieze Model 120 Wind Sensor. Temperature and humidity were recorded with a hygrothermograph and pressure with a microbarograph. Soil temperature is measured with a thermocouple. Vertical Incidence Solar Radiation was measured with an Eppley Pyrheliometer and precipitation with a weighing bucket rain gauge.

Since 1987, a SAMS Data Collection Platform has provided data at the weather station which is used for climatic data summaries. The sensors used on the DCP are

Wind Sensor	R M Young Model 102 Wind Sensor
Temperature	YSI 703 Thermistor
Soil Temperature	YSI 703 Thermistor
Humidity	PCRC-11 RH sensor
Precipitation	Weather Measure P501 Tipping Bucket Rain Gauge
Pressure	AIR-DB-2B Digital Barometer
Solar Radiation	STAR 3020 Pyranometer
Vertical Wind	R M Young Vertical Wind Sensor

RANGE SERVICES/CAPABILITIES

All meteorological services for the Instrumented Test Range (ITR) at Fort Huachuca are performed by the U.S. Army Atmospheric Sciences Laboratory, Fort Huachuca Meteorological Team. Aviation surface observations at Libby AAF located at Fort Huachuca are taken by OL-A Detachment 13, 25th Weather Squadron (USAF). No services provided by OL-A are listed below.

SERVICE	HOURS	EQUIPMENT	REMARKS
Surface Observations, Climatology, Advisories	M - F 04-18L		
Forecasts	M - F 06-17L		
Consultation, Range Climatology	M - F 06-18L		
Solar/Geophysical Data and Advisory Service	M - F 06-18L		
Range Weather Support	M - F 04-18L		
Upper Air Sounding	Daily 04&16L	Vaisala Digicora (Fixed)	Sfc to termination for range forecast and customer support
Upper Air Sounding		AIR ADAS System (mobile)	As required by test requirements
PIBAL		AIR ADAS System	As required by test requirements
Surface Observations		Surface Automated Measuring System (SAMS)	As required by test requirements

Operating hours indicated are normal work hours modified as needed to meet support requirements. Operating hours in effect at any time can be obtained by calling the Team at DSN: 879-3906/3908. The Vaisala Digicora Sounding System is located at the Team Weather Station in Building 85846 on Arizona Street at Fort Huachuca. Soundings are relayed over COMEDS under the WMO Number 72273 which is the number assigned to the Upper Air Observatory.

The fixed SAMS Stations, including the 32-meter tower site at the USAEPG Compact Range site, relay data every 15 minutes to the Weather Station and store the data in an HP1000 microcomputer. Data is also displayed on monitors at the station. In addition, the capability exists for customers to receive data displays via modems on their own terminals. Certain mobile sites are designed to be read out on site by the user.

The Solar/Geophysical Data and Advisory Service provides real and near real-time advisories of solar and geophysical activity that could adversely affect test operations at Fort Huachuca. At present, the Team has two meteorologists, three meteorological technicians, and one electronics technician assigned to it. All personnel are Department of the Army civilian employees.

MAJOR PROJECTS SUPPORTED

AQUILA UAV, USCS SOWRBALL AEROSTAT, GPS, EPLRS, IEW UAV, PIONEER UAV, AN/TRC-170 OT, ALQ-136, EXDRONE UAV, AN/TRC-170 DUAL NODE CHARACTERIZATION, JTIDS, VEMASID, FIDS, CL 227 UAV, AGES II, SPACE SHUTTLE

PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

EQUIPMENT	PURPOSE	LOCATION	QUANTITY	PURCHASE	REMARKS
PC	Data Processing	Weather Station	3	Continuous upgrades	Customer
Work Station	Forecasting	Weather Station	1	CY 92	Satellite and data readout
SAMS Upgrade	Data	Fixed/ Mobile	21	CY 93	Upgrade all sensors and ACU.

Most upgrades and purchase of new equipment have been accomplished already. Several new equipment items are now on hand. Site surveys and installation of this equipment are being done as the test support workload permits.

SPECIALIZED DATA BASES

Archiving of upper air data in the Lotus 1-2-3 Spreadsheet began last year and is in progress. Eventually, when all data is archived, a climatological summary of upper-air data will be published.

LOCATION	TYPE	PERIOD	MEDIUM	FORMAT	REMARKS
Weather Station	Surface Obs	1956-Present	IBM PC-XT Computer	LOTUS 1-2-3 Spread-Sheet	Monthly Summary
Weather Station	Surface Obs	1987-Present	HP1000 Computer	RAW Tape minute data. Also available in hardcopy printouts	SAMS Meso Net 21 Stations-15
Weather Station	Rawin Obs	1985-Present	Zenith Computer	Floppy Disk LOTUS 1-2-3 Hardcopy	1000 foot/ mandatory & significant levels

CLIMATOLOGY

U.S.ARMY ELECTRONIC PROVING GROUND
FORT HUACHUCA, ARIZONA

	WINDS (knots)			TEMP (°F)							PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	REL HUM	CLD CVR	MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	%	TENS	AVG	MAX
JAN	SSW	5.3	51	81	58	46	35	9	50	-	.78	1.15
FEB	SSW	5.7	49	84	62	50	38	14	40	-	.59	1.53
MAR	SSW	6.4	57	89	65	53	41	19	35	-	.60	1.16
APR	SSW	7.1	52	94	73	60	50	26	29	-	.26	1.21
MAY	SSW	7.0	53	100	81	68	55	34	27	-	.12	.36
JUN	SW	6.7	53	105	90	78	64	48	26	-	.39	1.04
JUL	WSW	5.3	83	105	89	77	66	58	49	-	3.90	2.55
AUG	SW	4.6	56	98	86	75	65	53	53	-	3.32	2.72
SEP	SW	4.4	44	98	83	72	61	42	49	-	1.88	2.40
OCT	SSW	4.7	46	93	76	63	52	18	47	-	1.20	2.09
NOV	SSW	4.7	60	88	65	53	41	18	45	-	.56	1.36
DEC	SSW	5.0	54	78	59	47	36	10	47	-	1.14	1.94
YRLY	SSW	5.6	83	105	74	62	50	9	41	-	14.77	2.72

Notes: - = no data

TONOPAH TEST RANGE
(TTR)

INTRODUCTION

The Tonopah Test Range (TTR) is operated by Sandia National Laboratories (SNL) and is a major test facility for the Department of Energy (DOE)-funded weapons program. The TTR presents an integrated system for ballistic test vehicle tracking and data acquisition. Multiple radars, mobile and fixed optical trackers, telemetry stations, a central computer complex, and combined RF/landline communications systems ensure full coverage for any type of test. The primary function of TTR is to support DOE weapons-test activities. In addition, the range regularly supports other government agencies and their subcontractors.

The TTR is located in the northern end of the Nellis Bombing and Gunnery Range (Reserved Airspace R-4809), about 140 air miles northwest of Las Vegas, Nevada. It is bounded on three sides by the Gunnery Range and on the north by public lands administered by the Bureau of Land Management and the U.S. Forest Service.

The TTR is about 24 miles east-west by 26 miles north-south and occupies an area covering 525 square miles. The Cactus Range, a string of low, rocky mountains whose highest peak is 7,480 feet mean sea level (MSL), borders the range on the west. The Kawich Range extends along the east side of TTR with peaks up to 9,400 feet MSL. Vegetation varies from sparse to none.

This high-desert location has little precipitation, averaging only about 5 inches a year. There is very little cloud cover and only occasional air pollution intrusions, so visibility is generally good year-round. Average relative humidity ranges from 14 to 77 percent. Average temperatures run from 40 °F in winter to 86 °F in summer, with extremes of -24 to 102 °F. Storms reaching TTR are usually of short duration and carry little moisture.

Six permanently defined targets are located on a series of dry lake beds averaging about 5,300 feet MSL. These targets are spaced along a flight line through the range on a heading of 347° true. Soil composition and target construction offer users a variety of surface conditions including sandy soil, hard-packed clay base, or concrete. Gravel and rocky or solid rock impact areas are also available when desired.

Air traffic to the range is served by the TTR airfield with a 12,000-foot long by 150-foot wide runway with an asphalt and concrete surface. The runway, on a 320° (magnetic) heading, has a field elevation of 5,540 feet MSL and is equipped with ILS and TACAN navigational aids. Special advance permission is required to use the runway.

Further details of range capabilities may be found in: SAND81-1871 (rev. June 1985), *Technical Manual, Tonopah Test Range Capabilities,* available from NTIS or Sandia. Government agencies and their contractors who wish to conduct tests on TTR should make preliminary contact with the Test Director for discussion of technical requirements and tentative schedules: Test Director, Tonopah Test Range, P.O. Box 871, Tonopah, Nevada, 89049; Telephone: (702) 295-8235, FTS: 575-8235; or (702) 295-8236, FTS: 575-8236.

RANGE SERVICES/CAPABILITIES

Normally, meteorological data are collected only as a specific test program request. These data include surface measurements, tower measurements, and upper-air measurements. Almost all test activities require some meteorological support. Following are the types of support that TTR regularly furnishes.

a. **Surface Observations and Measurements**. When requested, TTR personnel will make routine weather observations and report them to the requesting agency. A ground weather station is located about 500 feet east of the flight line near the dry lake bed target area. This station is equipped with sensors for measuring wind direction and speed, temperature, dew point temperature, and barometric pressure. This information is digitized and displayed at numerous locations as well as entered in the central computer where it is used in calculations and listed with other test data.

b. **Tower Measurements**. The TTR maintains a 300-foot wind tower located in the rocket launcher and gun area. This tower is instrumented with wind direction, speed, and temperature sensors at the 50-, 150-, and 300-foot levels. This information is displayed in the rocket blockhouse and operations center and is entered into the central computer for data reduction. Three portable towers can be instrumented with wind sensors and used on special tests. Two of these towers can be elevated to 15 m, while the third will extend to 29 m.

c. **Upper Air System**. Balloons for determining upper atmospheric winds and radiosondes for measuring temperature and humidity as well as the upper winds can be tracked by any one of the tracking radars. The radar and radiosonde data are recorded in the central computer for post test reduction and printout. In addition, a real-time printout of all upper-air data is available from the graphics display facility.

If low-level wind data are desired to a greater accuracy than the radar can provide, a 100-g balloon is released and tracked by cinetheodolites, thus providing a three-station solution for balloon position from which wind direction and speed vs. altitude may be very accurately derived. These balloons may be released from any point on the range from a portable, remotely actuated balloon-release trailer.

d. **Satellite Information**. The operations center is equipped with a Harris 550 Laserfax machine for receiving and printing information from the GOES satellite system.

e. **Rocketsondes**. Though it is not listed as a standard feature, TTR has the capability to track and record data from meteorological rockets and has, in the past, tracked Dartsondes when requested by the user.

f. **Special Instrumentation**. Certain special equipment may be available from time to time from other SNL organizations engaged in various environmental studies. Typical instrumentation may include

Tethered balloon sounding systems	Free-flight balloon sounding systems
Nephelometer (ground-based and balloon-borne)	Air samplers
Particle spectrometers	Portable meteorological tower with logger
Twin engine sampling and monitoring aircraft	Teleradiometers
Optical anemometer	Data acquisition system
Modified cielometer to lidar	Tracer Balloon

TYPICAL RANGE REQUIREMENTS SUPPORTED

Various testing activities supported by TTR include

SRAM	Parachute Development Units
MLRS	Bomb Development Units
Senior Year	Honest John Rockets
EW/CAS	Ground-Launched Penetrator Units
Joint Fixer	MX Explosive Tests
B-52 OAS	Teal Ruby
Tomahawk	SECORS
ALCM	Malemute Rockets
Busy Luggage	ZAP Rockets
Bullet Blitz	Dropsondes
Seek Eagles	Walleye
Ave Fria (Barium Rockets)	Nova Rockets
8" Gun	Tater Rockets
155-mm Guns	Zuni Rockets

CLIMATOLOGY

TONOPAH TEST RANGE
TONOPAH, NEVADA

	WINDS (knots)			TEMP (°F)					REL	CLD	PCPN (inches)	
	PREVAILING			ABS	AVG		AVG	ABS	HUM	CVR	MON	24 HR
MONTH	DIR	SPD	PEAK	MAX	MAX	AVG	MIN	MIN	%	TENS	AVG	MAX
JAN	WNW	7	-	65	44	29	13	-24	54	-	.18	-
FEB	NW	7	-	70	49	35	21	-5	51	-	.50	-
MAR	NW	10	-	78	53	39	24	1	40	-	.19	-
APR	NW	11	-	82	62	47	31	9	36	-	.45	-
MAY	S	13	-	92	71	55	39	19	33	-	.49	-
JUN	S	11	-	102	80	64	47	30	29	-	.58	-
JUL	S	10	-	100	90	72	54	41	24	-	.30	-
AUG	S	10	-	98	87	71	54	33	29	-	1.02	-
SEP	S	10	-	91	78	61	44	25	30	-	.54	-
OCT	S	11	-	87	71	53	34	15	34	-	.12	-
NOV	SSE	7	-	74	54	40	25	-3	51	-	.35	-
DEC	WNW	8	-	64	44	31	17	-15	58	-	.22	-
YRLY	S	10	-	102	65	50	34	-24	39	-	4.94	-

Notes: - = no data

NAVAL AIR WARFARE CENTER-AIRCRAFT DIVISION, PATUXENT RIVER, MARYLAND (NAWC-AC, PAX RIVER)

INTRODUCTION

The Naval Air Warfare Center-Aircraft Division, Patuxent River (NAWC-AC) is located at NAS Patuxent River, on the south bank of the Patuxent River, approximately 60 miles southeast of Washington, DC. It occupies a broad headland known as Cedar Point at the Patuxent River's effluence into the Chesapeake Bay. The Naval Air Station, located in scenic St. Mary's County, is bounded on the north by the Patuxent River and on the east by the Chesapeake Bay. The Potomac River is approximately 10 miles southwest and the Atlantic Ocean is 60 miles east. West-northwest lies a roughly triangular peninsula, the only uninterrupted land expanse. Another peninsula, averaging 5 miles wide, extends north-northwest and forms the north shore of the Patuxent River. The eastern shore of Maryland, about 10 miles east, is a broad, low peninsula separating the Chesapeake Bay and the Atlantic Ocean. The station height is 40 feet.

The NAWC-AC, Pax River functions as the Naval Air Systems Command's principle site for developmental testing and performs test and evaluation of overall aircraft systems, mission systems and equipment, maintenance and support systems, and aircraft operations. The center provides technical advice and assistance to other RDT&E activities and conducts test pilot training and develops and documents test and evaluation technology. The NAWC-AC, Pax River is organized into seven directorates to accomplish its mission:

a. <u>Strike Aircraft Test Directorate</u>. Tests and evaluates experimental and production fixed-wing fighter, attack, and other designated aircraft including VSTOL. Tests and evaluates airborne systems and flight trainers related to assigned aircraft.

b. <u>Force Warfare Aircraft Test Directorate</u>. Tests and evaluates all fixed-wing anti-submarine, airborne, early warning, and other specially designed aircraft, systems, and components.

c. <u>Rotary Wing Aircraft Test Directorate</u>. Tests and evaluates all rotary wing and tilt rotor aircraft, systems, and components.

d. **Systems Engineering Test Directorate**. Tests and evaluates aircraft ground support, electrical, aircrew, communications, identification, navigation, and armament systems.

e. **Range Directorate**. Provides range operation, instrumentation, and tracking and supports east-coast fleet missile testing and training. The Chesapeake Test Range is a component of the Range Directorate.

f. **Computer Sciences Directorate**. Provides programs and operates computer and automated data processing systems in support of the other directorates.

g. **U.S. Naval Test Pilot School**. Trains experienced aviators to become fully qualified test pilots and develops new flight-testing methodology and technology.

RANGE SERVICES/CAPABILITIES

The majority of the environmental services provided to NAWC-AC, Pax River originate at the Naval Oceanography Command Detachment. The Chesapeake Test Range retains some meteorological measurement capability to collect rawinsonde data and surface observations. The National Weather Service operates a weather radar site at NAS Patuxent River.

SERVICES/ CAPABILITIES	NOMEN- CLATURE	OPERATIONAL HOURS	REMARKS
Forecasts		24 hrs	Local area forecasts, warnings, specialized forecasts, flight weather briefs
Project Support		24 hrs	Climatological studies, environmentally based recommendations, individually tailored project support
Consulting Service		M - F 0730-1630	Provide consultant service for environmental support to NAWC-AC, Pax River Projects

RANGE SERVICES/CAPABILITIES (continued)

SERVICES/ CAPABILITIES	NOMEN- CLATURE	OPERATIONAL HOURS	REMARKS
Rawinsonde Observations	Vaisala RS-80	24 hrs	CTR personnel provided. Loran positioning for winds
Radar Observations	WSR-74C	24 hrs	National Weather Service (NWS) Operated, dial-up capability for NWS Radar Network. Display Kavourous RADAC.
Satellite Data GOES,	UNIFAX	24 hrs	Global coverage. Data Hardcopy images of METEOSAT, GMS, and NOAA Polar Orbiter.
	Northern Graphics	24 hrs	Animation of UNIFAX imagery. 48 pages of memory.
Surface Observations		24 hrs	Aerodrome observations hourly, specials and record specials.
Automated Surface Observations	GMQ-29	24 hrs	Centerfield, Thermoscreen and Rain Gauge Sensor Data Display.
Surface Observations (Mobile)		24 hrs	CTR personnel
Wind Observations	ABWIS	24 hrs	Airfield boundary wind indicator system. Warning of wind shear to weather office and control tower.

RANGE SERVICES/CAPABILITIES (continued)

SERVICES/ CAPABILITIES	NOMEN- CLATURE	OPERATIONAL HOURS	REMARKS
Wind Observations	UMQ-5	24 hrs	Centerfield sensor.
WeatherVision		24 hrs	Closed-circuit television for the display of various weather data.
Bay Water Temperature	Honeywell Electronix III	24 hrs	Sensor located in Patuxent River near Chesapeake Bay.

TYPICAL RANGE REQUIREMENTS SUPPORTED

The primary environmental requirement of NAWC-AC, Pax River is weather-related safety of flight. The timely, accurate warning of hazardous weather conditions and phenomena is essential to the safe conduct of flight operations at NAWC-AC, Pax River. A communications network consisting of radio circuits and telephone call lists along with WeatherVision closed-circuit TV enable rapid dissemination of time-critical weather information. Flight-weather forecasts and surface-weather observations are routine services that contribute to flight safety.

The ability to coordinate and to provide specialized offshore weather forecast support to Range Directorate missile testing is also a requirement. Mission and contingency planning for Tomahawk and Harpoon cruise missiles and Penguin missile tests is dependent on accurate forecasts of test-limiting environmental parameters.

A significant number of the current 750 active NAWC-AC, Pax River projects entail some degree of environmental sensitivity. The majority of NAVOCEANCOMDET's project support consists of climatological studies or environmental consulting. During 1989, the Detachment provided weather data for 50 various projects. Occasionally, more in-depth support is provided by the Detachment's Officer in Charge, who also functions as the NAWC-AC, Pax River staff oceanographer.

PLANNED PROCUREMENT OF GEOPHYSICAL EQUIPMENT

The planned upgrades of environmental equipment at NAWC-AC, Pax River are geared toward improved detection and tracking of thunderstorms and their associated hazardous phenomena and automating weather observing functions.

EQUIPMENT	MANUFACTURER	DELIVERY	REMARKS
NEXRAD Principal Processor (PUP)	UNISYS	CY 92	Dial-up User Doppler from Sterling, Va.
Lighting Detection and Tracking System	Atmospheric Research Systems	CY 92	Readout from Norfolk, Va. network
Automated Surface Observing System (ASOC)		CY 94	Stations located at NAS Patuxent River and OLF Webster Field

SPECIALIZED RANGE EQUIPMENT

The Range Directorate operates IR and laser trackers. The MINILIR provides real-time tracking of IR sources such as missiles, aircraft, and shells. The Automatic Laser Tracking System (ALTS) determines azimuth, elevation, and range to retroreflector fitted targets.

DATA SETS/DATA BASES

The NAWC-AC, Pax River gains access to all available Naval Oceanography Command data bases through the NAVOCEANCOMDET. Included in these are meteorological data bases resident at the Fleet Numerical Oceanography Center, Monterey, California; climatological data bases from the Naval Oceanography Command Detachment, Asheville, North Carolina; and oceanographic and tactical data bases for the Geophysics Fleet Mission Program Library (GFMPL) from the Naval Oceanographic Office, Bay St. Louis, Missouri.

A primary site-unique data base of climatic information is the Summary of Meteorological Observations, Surface (SMOS) produced by NAVOCEANCOMDET Asheville. This data base is updated at 5-year intervals. Climatology for NAS Patuxent River has a period of record of 41 years, extending from 1941 to 1986. The SMOS is available in hardcopy and on 5 1/4-inch floppy disk for Z-248 (or compatible) computers using MS-DOS.

A small data base was developed as a result of a detachment study into the utility of night-vision goggles at various sites around the continental United States.

CLIMATOLOGY

The Patuxent River and the Chesapeake Bay produce a moderating influence on local temperatures and create a sea breeze. Air-mass thunderstorms have a tendency to follow the course of the Potomac River, thus avoiding the station. The Appalachian Mountain range provides an important obstruction to advancing fronts, often causing distortions which may produce cyclogenesis. Low pressure systems advancing from the Gulf of Mexico often fracture as they reach the southern Appalachians with one center moving northward west of the mountains to the St. Lawrence Valley, and the other drifting east northeast along the Atlantic Coast. Occluded systems with primary low centers in the eastern Great Lakes will sometimes form a secondary low center at the point of occlusion in the Ohio Valley. A secondary low-pressure center will occasionally develop in the vicinity of Cape Hatteras.

Aside from the important large-scale feature of NAS Patuxent River's location on the eastern edge of a large continent, the influence of the Cape Hatteras area is paramount in the winter and transitional months. It has long been known as a region of sudden vicious storms. Any front moving into this area is susceptible to cyclogenesis because of the marked temperature contrast in the underlying water masses. Low-pressure development on advancing fronts and intensifying Hatteras lows result in periods of extended inclement weather at Patuxent River.

The orientation of any front is of extreme importance. Normally, a NE-to-SW orientated front will produce fair weather and little development of frontal waves. A NNE-to-SSW orientation normally produces significant weather; however, an E-to-W oriented cold front tends to be initially dry, but then as it stagnates south of Patuxent River near the Norfolk area, waves often develop on the front and produce locally inclement weather at Patuxent River.

The following Naval Air Station Patuxent River climate summary is a product of the Summary of Meteorological Observations, Surface (SMOS) climatological data base.

a. **Winter (December-January-February).** During the winter months, the Bermuda High has moved into its southernmost position in the southeastern Atlantic with a relatively weak pressure gradient over the western Atlantic. High pressure persists over Canada and the polar region with one or two outbreaks of cold air per week. The Icelandic Low has intensified and the strong polar trough aloft acts as the steering influence on the low-pressure systems developing over Texas and the Gulf of Mexico. The most influential factor determining the movement of cold lows is the jet stream. The worst weather occurs with the jet stream located east of the Appalachians and orientated SW-NE along the East Coast. The coldest winters occur when the jet stream persists in this position.

The polar front is displaced to its southernmost latitude with the mean position extending from Louisiana or southeast Texas across southeast Georgia and northern Florida to Bermuda. In conjunction with the polar front, the jet stream is oriented furthest south and extends eastward across the Gulf of Mexico and to the east of Patuxent River. Waves frequently develop on the polar front in the vicinity of the northwest Gulf of Mexico and move northeastward off Cape Hatteras where intensification occurs. These systems, accompanied by strong northeasterly winds, are known as "northeasters."

Early in the season, occasional outbreaks of maritime tropical air will cause unseasonably warm temperatures usually of two or three days duration. An E-to-W oriented cold front will stagnate to the south of the station on the average of once or twice a month during the winter. Rapid generation of waves on the front, or a slow north and south oscillation of the front, will cause continued inclement weather with fog, rain, and low stratus for periods of two to four days. Flying conditions will fluctuate between IFR and VFR. A fresh outbreak of continental polar and maritime polar air is needed to bring good flying conditions. Occasionally, this stationary front will drift to the north of the station bringing springlike temperatures, high humidities, and VFR conditions.

The prevailing and strongest winds come from the northwest and occur most commonly after a cold frontal passage. Winds behind a cold front are usually gusty. A northeaster moving along the Atlantic Coast and a high pressure area over New England will cause persistently strong northeasterly winds usually not of a gusty nature. Fog is a major hazard to flying during the winter months. Visibilities are less than 7 miles in fog on 11-13 days per month.

Because of the moderating effect of the adjacent water areas, occurrences of continued snowfall are less frequent and of less intensity than in areas inland. Mean snowfall per month is 2-6 inches. The extreme 24-hour snowfall is 14.2 inches on 11 February 1983. The extreme accumulated snow depth is 31 inches in February 1966.

b. **Spring (March-April-May)**. In spring, the Bermuda/Azores high intensifies, moves northward, and builds to the west. The Icelandic low is in a weakening phase. The mean position of the polar front is through the central U.S. and middle Atlantic States. The polar front and the jet stream recede to the Great Lakes by the end of the season. Cold fronts continue to stagnate to the south of the station but with less frequency, intensity, and duration than during the winter months.

Late in the period there is often sharp contrast in the weather with balmy days giving way to a thrust of polar air from Canada. Under such conditions temperatures may fall 20 to 25 degrees. Thunderstorms accompanying such fronts are normally very strong to severe.

A continued increase in convective activity with a corresponding increase in showers and thunderstorms occurs during the entire period. Offshore fog and low stratus occur less frequently because of the warming of the sea water. During the latter part of spring, the slower movement and stagnation of high-pressure centers over the East Coast result in haze becoming prevalent. Winds are predominantly from the northwest early in the period becoming southerly late in the season. Southerly winds under the influence of the Bermuda High are normally moderate with the exception of those associated with thunderstorm activity.

c. **Summer (June-July-August)**. During the summer months the Bermuda High dominates the weather along the east coast and western Atlantic. In mid-season, the Icelandic Low almost disappears. The eastern United States is under the influence of a southerly flow with periods of predominant high-zonal index. During periods of low index, one or two outbreaks per month of polar air from eastern Canada will reach this area.

Cold front passages usually diffuse and come through dry. A common occurrence is a pressure trough forming to the east of the Appalachians in advance of the front. The wind shifts to the northwest ahead of the front with a squall line of thunderstorms developing parallel to and ahead of the front with gusty surface winds and heavy rain showers. Occasionally, cold fronts become orientated E to W and stagnate to the south of the station, but the weather associated with such is not as adverse as in previous months.

Warm fronts in this season are not well defined and are not very common. They often form a large area of low ceilings and visibilities. The layer of cool air to the north of the warm front is extremely shallow and may be wiped out by daytime surface heating, thus giving the appearance of a rapid northward jump of the warm front during the day. Regardless of the air mass, the contrast across the front is generally slight. The majority of the thunderstorms experienced during the summer months are prefrontal squall lines or air mass. Thunderstorm activity reaches its peak in mid-summer with associated heavy precipitation of short duration and strong wind gusts from varying directions.

The persistence of haze increases throughout the summer reaching its peak during the latter part of the season. Visibility is less than 7 miles from 50 to 59 percent of the time in these 3 months because of the haze. Fog is not a major problem during the summer, but does occasionally occur as a result of a weak warm front in the area. June marks the beginning of the hurricane season. It is usually not until the middle of August that the probability of hurricanes increases to a point of concern for the Middle Atlantic States.

d. **Autumn (September-October-November).** Autumn marks the transition from a maritime tropical air-mass regime to that of continental polar. During autumn, the Bermuda high recedes to the southeast, weakening the ridge in the southeast United States. The Icelandic low intensifies and begins to act again as an attraction for low-pressure systems developing off the eastern seaboard. The Canadian high takes a more southerly orientation with the mean Polar frontal position shifting southward, bringing about a preponderance of continental polar air, a more definite sharpness to frontal passages, and a northwesterly prevailing wind.

Late in the season, the intense lows that form over Texas or over the Gulf of Mexico bring strong northeast winds and rain to the area as they move to the northeast. As strong winds and rapidly moving lows move offshore to the south of Cape Hatteras, contact with the warmer water causes them to deepen very rapidly with an accompanying sudden increase in wind velocity. This rapid deepening is difficult to detect in advance and can be quite unexpected without careful surveillance. Hurricanes reach their maximum frequency during early autumn. Out of all the days in the year, Labor Day in September is the most likely to have a hurricane somewhere in the western Atlantic.

Lows form more rapidly in the southcentral and southeast United States with a tendency to move northeastward on either side of the Appalachians. Those moving up the western slope of the Appalachians bring prolonged periods of low ceilings, reduced visibility, fog, and occasional periods of freezing precipitation, particularly during late November. Lows moving east of the

Appalachians will derive more energy from the warmer coastal waters and intensify into more violent storms, but are normally of shorter durations.

In September and October, during periods of high index, fronts move rapidly eastward with little or no weather and little temperature contrast. In November and December, occasional outbreaks of maritime tropical air occur when an air mass moves northward from the Gulf of Mexico or the Caribbean. These air masses will cause unseasonably warm temperatures usually of only one or two days duration. Radiation fog is generally of little significance in the local area because of the water influence around the station. Advection and prefrontal fog are major hazards to flying and occur 11 to 14 days each month. From 1945 to 1985 snow has not occurred in September. The earliest recorded snow is 0.1 inch on 10 October 1979. The extreme occurrence in autumn is 7.1 inches of snow on 30 November 1967.

CLIMATOLOGY

NAVAL AIR WARFARE CENTER-AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	NW	12	62	78	43	36	29	-3	67	9	3.1	2.1
FEB	NW	12	61	81	46	38	30	6	62	9	2.9	3.1
MAR	NW	12	62	86	54	46	37	13	60	9	3.6	2.7
APR	NW	11	63	92	64	56	47	26	59	9	3.0	2.6
MAY	SE	9	77	97	73	65	56	36	65	9	4.0	4.3
JUN	S	7	61	101	81	73	65	45	68	3	3.4	5.9
JUL	SW	8	65	103	85	78	70	55	69	6	4.1	4.6
AUG	S	6	69	103	84	77	69	52	69	3	4.3	5.9
SEP	S	6	58	99	78	71	63	45	71	3	3.2	3.9
OCT	NW	9	96	93	68	61	53	30	67	9	3.0	3.6
NOV	NW	11	55	85	57	50	42	16	66	9	3.4	4.2
DEC	NW	12	53	77	47	40	33	6	67	9	3.3	3.2
YRLY	NW	10	96	103	65	58	50	-3	64	9	41.3	5.9

SPACE TEST RANGE
(STR)

INTRODUCTION

The Space Test Range (STR), Onizuka Air Force Base, California, was established to meet the needs of the Department of Defense (DOD) space programs for safely conducting tests in space. In addition to concerns for safety, the high costs of testing in space made it apparent that available resources had to be used more efficiently. The STR represents a concerted effort to coordinate the use of available resources for multi-range supports to avoid unnecessary duplication among the ranges and networks. Most importantly, STR was developed to protect people, property on earth, and other space systems.

The mission of the STR is to support and conduct systems testing in earth orbit, assuring that all tests are accomplished safely with respect to all other space operations, current and future. In addition, the mission includes ensuring that these tests pose no undue threat to life, property, or the environment.

ENVIRONMENTAL SUPPORT TO STR

Det 3, HQ AWS coordinates environmental support to the Space Test Range through the Consolidated Space Test Center, STR Office (CSTC/OS).

Det 3 HQ AWS arranges weather support through Air Force Global Weather Central (AFWGC) Offutt Air Force Base, Nebraska; the U.S. Air Force Environmental Applications Center (USAFETAC), Scott Air Force Base, Illinois; or the Air Force Geophysics Laboratory (AFGL), Hanscom Air Force Base, Massachusetts.

Det 3, HQ AWS arranges space environmental support through the Air Force Global Weather Central Space Environmental Branch (AFGWC/WSE) and the Space Forecast Center (SFC) (IOC March 1991, FOC March 1992) at Falcon Air Force Base, Colorado; the Space Environmental Services Center (SESC), Boulder, Colorado; and AFGL.

The STR customers are advised to establish their weather/space environmental requirements early in the planning process. Some missions may require new technologies to meet their requirements. New technologies can take years to develop and test.

WRIGHT LABORATORY
(WL)

INTRODUCTION

The Wright Laboratory (WL) operates the Electro-Optical Sensor Evaluation and Analysis Facility (EOSAF), located at Wright-Patterson Air Force Base, Ohio. The EOSAF was designed to quantitatively relate the performance of Electro-Optical (E-O) targeting and navigation sensors to the natural environment in which they will be required to operate. In the past, sensor performance was estimated by the developer and verified only by the user. Traditional ways of determining sensor performance are not satisfactory or complete. Laboratory measurements establish only baseline performance in a benign environment, and flight testing, while realistic, is time consuming and expensive. The EOSAF allows sensor users to collect high-quality sensor performance data under completely characterized weather conditions with well-instrumented target and background information.

FACILITIES

a. **Sensor Platform**. The sensor platform is located on the upper floors of building 620 twin towers. The 18-by-18-foot platform is fully enclosed and serviced by a large freight elevator. The platform is equipped with 400-cycle, 28-volt dc, aircraft-type power as well as traditional 110 volt, 60 cycle ac. The platform can house a variety of experimental and operational sensors and is equipped with several high-resolution, 8-12 micrometer, forward looking infrared (FLIR) systems and visible TV cameras whose operating characteristics are well known. These systems can be operated as "reference" sensors for side-by-side comparative testing.

b. **Target Complex**. Located 3 km west of Building 620 is the Wright Field Complex which is no longer active. This complex is 10,000 feet long by 2,800 feet wide and contains flat, grassy fields, tree lines, and a 7,000 foot east-west runway/taxiway system. Field elevation is approximately 800 feet mean sea level (MSL). This area is ideal for the operation of static or mobile targets; the latter are useful for the testing of any type of tracker or moving target acquisition system. A number of tracked (armor) and wheeled military targets are available on site, or easily obtained from local guard units. The natural and man-made environment (considering its location in a major mid-western industrial area) offers a diversity of backgrounds and weather phenomena.

c. **Meteorological and Path Property Instrumentation**. On the ground at the target site, instrumentation gathers data on meteorological parameters. Measurements include air and soil temperature, dew-point, wind speed and direction, air pressure, total rainfall, rain rate, raindrop size distribution, forward and integrated scattering coefficient, and all sky and ground broadband radiation. Transmission in the visible and near-middle and far infrared for narrow and broad wavelength bands is measured over the entire 3-km slant path. The transmissometer source is located atop building 620, and the receivers are positioned in the Wright Field Complex. Data from these systems can be delivered on paper printouts, digital tape, or computer diskettes. A partial list of some of the EOSAF instrumentation follows:

1. **Rain and Snow Gauge**. The Weathertronics model 6021A is designed to measure all forms of precipitation. The tipping rain bucket accumulates rain water in a small outlet directly over a tipping-bucket mechanism. The bucket is divided into two equal compartments. When one compartment fills, the bucket tips, momentarily closing a switch, and empties into the overflow reservoir. The tip indicates a specific amount of rain has fallen over a given period of time. Accuracy of the model 6021A is ±0.5 percent at 0.5 inches per hour. Resolution is 0.25 mm.

2. **Rate-of-Rainfall Gauge**. The Weathertronics model 6070 rate-of-rainfall gauge is designed to give a digital output proportional to the rate of rainfall. A light source, inside the gauge and located at one end of the optical chamber, produces a narrow beam of light which is detected by a photoresistor located on the opposite side of the optical chamber. As the drops of water fall through the reservoir fluid and pass the beam of light, the photodetector will detect the disruption of the light and generate a pulse at a rate proportional to the rate of rainfall. Instrument sensitivity is .0083 mm/hr.

3. **Pyranometer**. The Eppley model PSP measures global solar radiation over the wavelength band of 0.3 - 3.0 micrometers. A circular-radiation receiver, which is coated with Parson's black lacquer, transfers the absorbed heat to a circular wirewound, copper-constant thermopile. The instrument is independent of ambient temperature. The output of the thermopile is in microvolts. Accuracy is ±0.5 percent from 0 to 2800 watts/meter^2.

4. **Pyrgeometer**. The Eppley model PIR measures the intensity of incoming or outgoing terrestrial infrared radiation (long wavelength only). The receiver is similar to the pyranometer. Accuracy is ±1 percent linearity over the range of 0 to 700 watts/meter^2.

5. **Normal Incidence Pyrheliometer (NIP)**. The Eppley model NIP pyrheliometer measures solar radiation at normal incidence. An E6-type wirewound thermopile is mounted at the end of a brass tube, which is coated with 3M Velvet Black. The NIP has a nine-position filter wheel that can be configured for selected spectral regions. Accuracy is ±0.5 percent from 0 to 2800 watts/meter^2.

6. **Dew-Point/Temperature**. The General Eastern model 1200 MPS provides an accurate determination of atmospheric dew-point and ambient air temperature. The dew-point temperature is measured with a direct measuring sensor using a Peltier-cooled mirror surface automatically held at the dew-point temperature by a photoresistive, condensate-detecting optical system. A linear thermistor is embedded in the mirror and measures the true dew-point temperature. Dew-point accuracy is ±0.4 °C over the range of +25 to -40 °C. Ambient-air temperature is also measured by a linear thermistor thermometer, which is mounted in a thermally shielded and aspirated thermometer well. Accuracy is ±.15 °C over the range of +95 to -100 °C.

7. **Integrating Nephelometer**. The Belfort model 1550B is an instrument which makes a continuous, objective, and reproducible measurement of the visual quality of the ambient air it samples. The air quality is determined by the measurement of the atmospheric extinction coefficient caused by light scattering by both gases and aerosols in the air. The humidity of the unit's sample should be less than 60 percent, so that pollution particles, not water droplets, are measured. Accuracy is ±10 percent of 0.1 to 100 x 10^4/meters.

8. **Optical Hygrometer**. The OPHIR IR-2000 Optical Hygrometer is an electro-optical instrument that measures humidity by sensing attenuation of infrared radiation. The basic humidity measurement of the instrument is absolute humidity in g/m^3. A concurrent measurement of environmental temperature allows absolute humidity to be converted to other systems of units such as dew point and relative humidity. The sensor head is connected to the data output unit with a 15-foot cable. The unit is mounted with a platform on a camera tripod. Accuracy is 1.0 °C above 0 °C and -1.5 °C below 0 °C.

9. **Visibility Sensor**. The VF-500 is a forward-scatter visibility sensor; that is, it belongs to the class of nephelometers that measures the amount of light scattered at angles less than 90° by small particulates suspended in or large particles passing through its sample volume. This unit is used in one of the AARI portable weather stations. The sampling head and electronics are rugged and need no protection from the outside environment. Instrument accuracy over the range 0-16 km is ±5 percent.

10. **Long-Path Visibility Transmissometer**. The long-path visibility (LPV) transmissometer is designed to measure atmospheric transmittance at four different colors and output the result on a RS-232 serial channel. These colors are defined by interference filters mounted in the receiver-radiometer head. The wavelengths of operation are 550, 750, 800, and 900 nanometers. The transmissometer consists of a constant output light source transmitter and a computer-controlled photometer receiver. Both the receiver and transmitter operate from a 12-volt dc source. Data collection is accomplished by the use of a lap-top computer which easily interfaces with the LPV. The LPV transmission accuracy is ±3 percent with extinction accuracy of ±.003/km for a 10-km working path.

11. **Precision Radiation Thermometer for Apparent Temperature**. The Barnes PRT-5 consists of an optical unit, an electronics unit and interconnecting and power cables. It is designed to yield readings of equivalent blackbody temperature covering a range from -20 to +75 °C. For a radiation detector, it uses a hyper-immersed thermistor bolometer. The PRT-5 has a built-in rechargeable battery pack. These units are considered portable and require protection from the outside elements. They can be used as part of either the AARI portable weather station or as stand-alone units. The PRT accuracy is ±0.5 °C.

d. **Target/Background Signature Information**. Imaging and non-imaging radiometers calibrated for the visible and infrared wavelengths are available to measure the absolute radiance from targets and backgrounds located on the range. Data from these systems are available in a wide variety of analog or digital formats depending on the user's requirements. The 1.06 micrometer laser detectors are also available to track the position and beam wander of laser-designator systems.

e. **Mobile Capability**. This capability allows targeting sensor evaluation/experimentation over paths other than the fixed 3-km path between building 620 and the Wright Field Complex. This facility is comprised of three distinct units.

1. <u>**Meteorological Monitoring and Control Package (MMACPAC)**</u>. This unit is a self-contained, 400-pound package with instruments for meteorological and path-property measurements. This unit can make most of the measurements described previously at 3 minute or greater intervals. The MMACPAC can be deployed to any remote location via air or surface transport and can be erected by two to three people in approximately 30 minutes.

2. <u>**Mini-Mobile Infrared Lab (MMIRL)**</u>. This unit is a self-contained, 200-pound package with instruments for target and background signature measurements. This unit can make imaging-radiometric measurements in the infrared (8-12 micrometer) at 5 minute or greater intervals. The MMIRL can be deployed to any remote location via air or surface transport and can be erected by two to three people in approximately 30 minutes.

3. <u>**Flight Line Collimator (FLC)**</u>. This unit is a self-contained, 125-pound package that can simulate an infrared scene of well-known radiance projected at infinity (collimated). This unit can be used to perform quantitative-sensor minimum resolvable temperature (MRT) tests on narrow field of view (NFOV) FLIRs. This unit is fully weatherized for use on a flight line or in a maintenance shop. The FLC can be mounted on standard USAF bomb loaders for testing wing or centerline podded sensors.

ADDITIONAL CAPABILITIES AND SERVICES

a. <u>**Wright-Patterson Air Force Base and Vicinity**</u>. These facilities provide observations and forecasts for Patterson Field (FFO) and Weather Radar (5 cm) at FFO.

b. <u>**NWS Rawinsonde Station**</u>. Located approximately 7 miles northwest of EOSAF, this station provides upper-air observation twice daily (00GMT and 12GMT). Special releases for test support may be obtained at cost from the National Weather Service.

c. <u>**Staff Meteorologist Support to EOSAF**</u>. Duties included assisting with sensor evaluations, gathering meteorological and climatological data for interpretation and analysis, transmission modeling and numerical simulation, planning measurement programs, and providing links to other NWS, AWS, and STAFFMET organizations.

RANGE USAGE AND INFORMATION

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STAFFMET SUPPORT

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CLIMATOLOGY

WRIGHT LABORATORY
WRIGHT PATTERSON AIR FORCE BASE, OHIO

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	W	7	64	72	35	28	20	-18	72	8	2.9	3.8
FEB	W	6	85	74	39	31	23	-11	71	7	2.4	2.6
MAR	W	7	76	82	50	41	31	-4	69	7	3.4	3.4
APR	W	6	58	89	62	52	41	18	65	7	3.6	2.4
MAY	N	5	68	96	72	62	51	26	64	6	3.7	3.9
JUN	SW	5	66	102	82	71	61	40	65	6	4.5	4.7
JUL	W	4	56	102	85	75	65	45	64	6	3.4	3.7
AUG	SSW	3	70	102	84	73	63	40	72	6	3.5	5.3
SEP	N	4	57	102	77	66	55	28	70	6	2.6	2.7
OCT	N	5	56	91	66	55	44	20	68	6	2.3	3.8
NOV	W	6	59	81	51	43	34	1	69	7	3.0	3.3
DEC	SSW	7	56	74	40	33	25	-11	71	8	2.8	1.7
YRLY	W	5	85	102	62	53	43	-18	69	7	38.1	5.3

UTAH TEST AND TRAINING RANGE (UTTR)

INTRODUCTION

The Utah Test and Training Range (UTTR) is located west of Hill Air Force Base in the Salt Lake Desert. It has almost two million acres of land and 10.5 million acres of airspace. Flight tests and tactical combat training missions are conducted in restricted airspace and military operation areas covering a large part of Utah, Idaho, and Nevada.

Owned and operated by the Army, Dugway Proving Ground (DPG) is located 120 miles southeast of Hill Air Force Base. The ranges north and west of DPG are used by the Tactical Air Command (TAC), and some of the best "dummy targets" in the world are placed there. Eagle Tower is located 50 miles west of Hill Air Force Base. From this site, surface and upper wind observations are taken to satisfy customer requirements. Weather observations are taken only when the range is used.

The UTTR is a consolidation of the former Hill, Wendover, and Dugway ranges and is managed by the Air Force Systems Command (AFSC). Most support activities at the UTTR are provided by subordinate units with maintenance or range telemetry and tracking equipment provided by the range support contractor and in-service personnel. The major range activity is tactical weapons employment by Air Force, Navy, Marine, and Army aircraft. The UTTR also is used for development, test, and evaluation for such projects as the Cruise Missile and for munitions and remotely piloted vehicle testing.

Prospective users should first contact the 6501st Range Squadron/RC. The UTTR requirements can be broken down into support for TAC, AFSC, AFLC, and SAC. Each support branch requires its own unique weather support.

TYPICAL RANGE SUPPORT/REQUIREMENTS

The Tactical Air Command uses the most aircraft with most missions originating at Hill Air Force Base. Weather requirements for these missions consist of surface and upper-wind observation support at Eagle Tower. Routine operational weather support such as point forecast of environmental conditions at the target area, generalized range forecast, severe weather warnings, advisories, and terminal forecasts is provided from the Hill AFB, Base Weather Station.

RANGE SERVICES/CAPABILITIES

SERVICE	HOURS	EQUIPMENT	REMARKS
Surface Observations	During Flying		Base Weather
Forecasts	During Flying		Base Weather
Range Climatology	M - F 0730 - 1700		Base Weather
Consulting Services	M - F 0730 - 1700		Staff Meteorologist
Upper Wind (PIBAL)	As Requested	Theodolite	Base Weather
Rawinsondes	As Requested	Bukers	Contractor

NOTE: Upper wind observations and surface weather observations are available from Eagle Range and Dugway Proving Grounds. Additional measurements using meteorological instrumentation are also taken as needed to support field tests. Operational hours may be modified to meet test requirements.

FLYING WEATHER

Flying weather at UTTR is generally good, characterized by mostly high cirriform clouds and visibilities exceeding 50 miles. The average yearly cloud cover is five-tenths. Turbulent flight conditions occasionally occur when a west-east jet stream crosses the mountains, causing lee-side waves. Intense surface heating during the summer months causes convective downbursts that are significant aircraft hazards. Thunderstorms also create turbulent flying conditions. The UTTR has an average of 17 thunderstorm days per year, mainly during the late spring and late summer. Winter time air stagnation conditions lead to reduced visibility in fog and low stratus. The UTTR has an average of 22 days with fog per year. Measurable precipitation can be expected on 50 days and snowfall on 15 days.

SEASONAL WINDS

Wind patterns during spring and fall are dominated by the movement of synoptic-scale features across Utah. The synoptic features include strong prefrontal winds from the southeast through the south, followed by a rapid shift to the northeast with frontal passage and strong northerly through northwesterly winds after the front is well past the area. Strong winds with gusts in excess of 35 knots are expected 30 days per year, mostly associated with thunderstorms or strong prefrontal conditions during the spring or fall.

Summer wind patterns are dominated by local heating effects and mesoscale circulation patterns within the Great Basin. The dark basaltic rocks of mountain ranges surrounding UTTR absorb and emit heat faster than the salty lake bottom with its high moisture content and albedo. Consequently, summertime diurnal heating during the day causes a northwesterly flow across test grids toward higher terrain south of UTTR with a southeasterly downslope flow toward the salt flats at night. Summer time winds are typically 4 to 10 knots with occasional gusts exceeding 35 knots in convective downbursts or thunderstorms.

Winter wind patterns at UTTR are dominated by high pressure and stagnation conditions, periodically punctuated by winter storms. Weak diurnal heating causes weak and disorganized wind patterns to predominate throughout the Great Basin. Surface wind speeds are typically around 5 knots with occasional winds exceeding 35 knots in snowstorms and thunderstorms.

CLIMATOLOGY

UTAH TEST AND TRAINING RANGE
HILL AIR FORCE BASE, UTAH

MONTH	WINDS (knots) PREVAILING DIR	SPD	PEAK	TEMP (°F) ABS MAX	AVG MAX	AVG	AVG MIN	ABS MIN	REL HUM %	CLD CVR TENS	PCPN (inches) MON AVG	24 HR MAX
JAN	S	4	64	66	36	26	16	-25	70	6	.53	.79
FEB	S	4	50	71	43	33	23	-29	66	6	.59	.84
MAR	S	6	59	50	51	40	28	-6	57	6	.78	1.15
APR	S	6	81	88	63	49	35	13	50	6	.79	.95
MAY	S	6	62	98	71	57	43	21	44	5	.95	.96
JUN	S	6	58	107	82	67	52	31	39	4	.52	.69
JUL	S	5	62	107	92	77	261	27	31	3	.54	1.11
AUG	S	5	51	108	89	74	59	39	34	3	.63	1.46
SEP	S	5	52	101	78	63	48	22	36	3	.58	1.17
OCT	S	4	54	89	65	51	36	9	47	3	.65	1.07
NOV	S	4	44	78	49	38	26	-8	60	5	.55	.95
DEC	S	3	45	64	38	28	18	-23	74	6	.56	1.01
YRLY	S	5	81	108	63	50	37	-29	51	5	7.64	1.46