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FORECASTER'S HANDBOOK

FOR

MARINE CORPS AIR STATION (MCAS),

CAMP PENDLETON

Ca[illegible]1

FORWARD

This publication was revised in accordance with COMNAVMETOCOMINST 3140.2F_ dated Aug 95, and is a complete revision dated 27 Aug 98.

The Forecasters Handbook is an unclassified publication setting forth, in some detail, climatological summaries and local forecasting rules employed by the meteorological section when forecasting local weather.

One of the primary purposes of a Forecaster's handbook is to provide inexperienced or newly assigned forecasters with guidelines on local area weather conditions associated with typical synoptic scale developments. The Handbook also serves as a ready reference and review for forecasters already familiar with the weather conditions in the Camp Pendleton area. This handbook includes topography, local climatology, special features and forecasting rules, and aids used by MCAS Camp Pendleton forecasters. It is primarily an empirical study of weather patterns that affect the local flying area at Marine Corps Air Station, Camp Pendleton, California.

This Handbook is not the work of any one individual, but a compilation of many past and present Camp Pendleton forecasters. Their contributions are appreciated. Each forecaster attached to Marine Corps Air Station, Camp Pendleton will be issued a handbook and is encouraged to recommend changes or additions to improve the effectiveness of the forecasting methods discussed in the handbook. In addition, this publication will be reviewed at least annually and revised per the reference. Local reproduction of this data is authorized and encouraged. Additional information regarding this publication may be submitted in letter format to the following address:

Commanding Officer
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Weather Service Officer

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CHAPTER 1

BASIC DESCRIPTION

1. **The Geographic Region**

a. Marine Corps Air Station (MCAS) Camp Pendleton, California. Located at 33° 17' 54" North, 117° 21' 06" West, at an elevation of 78 feet above sea level. The field is located in the south central portion of Marine Corps Base, Camp Pendleton, which is a military reservation of approximately 125,000 acres extending from Oceanside, California to San Clemente, California and from the Pacific coast inland to an average of ten miles. MCAS is five miles inland from the Pacific coast in a valley oriented northeast to southwest approximately seven miles long and two and one half to three miles wide with the surrounding foothills at an elevation of 500 to 3000 feet. The prominent feature of these foothills is the San Onofre Mountains, (1,725 feet) 8 miles west-northwest of the Air Station. The Santa Margarita Mountains, with a maximum elevation of 3,189 feet, extend from a point 14 miles north-northwest to seven miles north-northeast of the Air Station.

b. Inner Southern California Operations Area (SOCAL OPAREA). The SOCAL OPAREA extends from 28°N to 35°N, and from the coast to 125°W. The Inner SOCAL OPAREA extends in an arc from Point Mugu southeast to the southeast point of San Clemente Island, then due south to a point due west of the International Border with Mexico.

2. **Local Effects.** MCAS Camp Pendleton is generally an area of little rainfall and dry streams. Even with these conditions the Southern California area has the greatest variability of runoff in the United States. Flooding conditions can cause considerable damage to property and endanger life. Flooding can develop slowly as a result of extended rainfall, or rapidly, as flash floods precipitated by heavy downpour, dambreak, or as a secondary result of natural activity such as rock slides or earthquakes. Flooding can occur aboard Camp Pendleton through the watershed that traverses the area via the Santa Margarita and Deluz Rivers, as well as numerous smaller rivers and creeks which originate in the Murrietta and Temecula communities, 30 miles to the northeast. A 100 year flood plain boundary has been set up for the Camp Pendleton area.

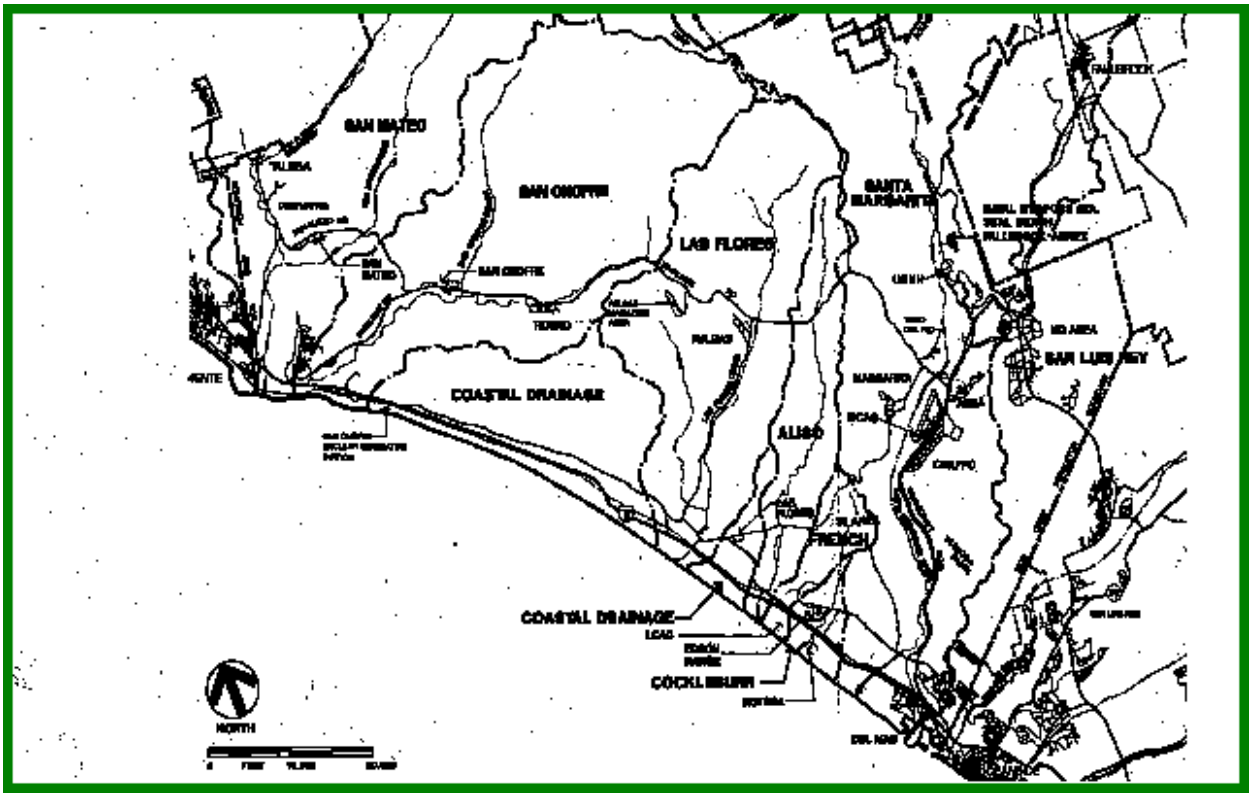


Figure 1.1 Geography of MCB Camp Pendleton

3. **Meteorological Equipment**

a. METOC INTEGRATED DATA DISPLAY SYSTEM (MIDDS). MIDDS is a client server based state-of-the-art system for the simultaneous ingestion, display and dissemination of meteorological data. MIDDS currently ingest satellite imagery, digital facsimile (DIFAX charts), alphanumeric weather data, radar data, NODDS/ OPARS, AFDIS, and unclassified GFMPL modules. The MIDDS Briefing/BBS Support modules automatically update this WEB server. The server is driven by Microsoft Windows NT 4.0 and has four separate workstations. Workstation number one is the primary station and controls the ingest of METOC data for display on the other workstations and the MCAS Camp Pendleton Weather Service Homepage on the World Wide Web (HTTP://158.238.61.11:9361 or HTTP:/ /middsknfg.cpp.usmc.mil:9361). It is equipped with a 21-inch monitor and operates with a dual-processor computer with 64-megabytes of RAM and 2 gigabyte hard drive and CD-ROM. Another feature of the MIDDS, which has essentially eliminated the need for paper charts is the Wall of Thunder. It consists of four separate monitors allowing multiple charts to be easily displayed, manipulated and transferred from one screen to another, or to be spread over several monitors at the same time. The entire MIDDS system has printing capability via a Hewlett Packard (HP) Color LaserJet 5 printer or HP LaserJet 5P black and white printer.

b. Automated Surface Observing System (ASOS). ASOS is the official instrument for measuring and recording temperature/ dew point, pressure, precipitation and wind direction/speed. It is also equipped with a laser ceilometer and visibility sensor to aid observers in evaluating sky condition and visibility. The Sensors & Data Collection Package (DCP) are located approximately .75 mi. NW of Building 2399 at an elevation of 76 ft MSL. The Acquisition Control Unit (ACU), Operator Interface Device (OID) and Video Display Unit (VDU) are located within the weather office spaces. The ASOS replaces the AN/GMQ-29 Semi Automatic Weather Station, RO362/UMQ-5 Wind Measuring Set, AN/GMQ-32 Runway Visual Range and the AN/GMQ-13 cloud Height Set.

c. Weather Surveillance Radar (WSR-88D). The WSR-88D is the latest state of the art weather radar. It combines conventional Doppler radar, utilizing various scanning strategies and volume coverage patterns to provide forecasters with the most accurate representation of the storm environment. MCAS Camp Pendleton System includes a PUP group only at Camp Pendleton. It is located in the Observer area of the Weather Office and the associated workstation is located in the Forecaster area. The actual radar site is located 30NM southeast of MCAS Camp Pendleton.

d. Contel Meteorological Workstation (CMW). The CMW is the primary means of disseminating and receiving alphanumeric weather data. It is equipped with Automatic Response to Query (ARQ) capabilities and is capable of graphically displaying selected alphanumeric data. MCAS Camp Pendleton has two separate CMW terminals, one designated for use by forecasters and one for observers.

e. Aneroid Barometer. Serves as a back up to the ASOS for pressure readings. The ML-448 is a wall mounted precision aneroid barometer located on the wall of the observer's area at an elevation of 78 feet MSL.

f. Marine Barograph. The Belfort Microbarograph also acts as a back-up pressure indicator for the ASOS and is located on the observer's desk at an elevation of 76 feet MSL.

g. OPTIMUM PATH AIRCRAFT ROUTING SYSTEM (OPARS). Version 2.11 located on the forecasters desk and in Observer area using Pentium processors and modem with LaserJet printers.

h. (NAVY OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM) NODDS. Located on the forecasters desk and in Observer areas utilizing the same CPU's as OPARS.

4. **Communication Equipment**

a. Meteorology & Oceanography Integrated Data Display System (MIDDS). Main Terminal & Wall of Thunder located in the Forecaster Area. The MIDDS provides Geostationary Operational Environmental Satellite (GOESS) imagery, which originates from the National Weather Service, via Equatorial Communication Company's satellite system. The satellite dish is located on the roof of building 2399. Information on the MIDDS comes from Redwood City, California through MCAS Yuma to MCAS El Toro, then to MCAS Tustin and on to Camp Pendleton via dedicated phone lines. The MIDDS also provides Weather Related charts via the same phone lines from NOAA. GOESS Variant (GVAR) Satellite imagery is also provided. The GVAR images are ingested via Satellite dish into the GVAR server located at NAS North Island. The MIDDS will then dial up to receive these shots via NIPRNET.

b. Optimum Aircraft Routing System (OPARS). Prepared in support of aviation to aid the aircrew in flight planning and navigation. The data can be retrieved using a modem to connect to the FLENUMMETOCCEN in Monterey, California. Information the system displays will help the requestor determine the best routing, fuel efficiency and cargo depending on the type of aircraft and maximum weight allowance. This data base will also prepare a wind forecast for specified points along the aircraft

route and time between NAVAIDS/WAYPOINTS for a given altitude. The forecaster will utilize the reference material located in the forecaster ready reference to prepare an OPARS worksheet for the product requested. The types of aircraft supported at MCAS Camp Pendleton may not always be in the OPARS database. In this instance the forecaster must request additional data from the requestor to aid in the input of information so the flight plan may be completed.

5. **Pilot to Forecaster Service (Metro)**

a. The pilot to forecaster frequency for MCAS Camp Pendleton is 344.6 MHz, normally referred to as "Camp Pen Metro". The transmitter is located on forecasters briefing counter.

b. The radio unit and all associated components are the responsibility of the Air Traffic Control Maintenance Branch (ATCMB) at MCAS Camp Pendleton.

6. **Telephones**

a. Tower Phone. Located in the Observer area and connected directly to the Tower.

b. Telephone Extensions

OIC	5-8373	AREA CODE:	760
NCOIC	5-8026	PREFIX:	725
BRIEFING COUNTER	5-3327	DSN:	365 FCSTRS
DESK/FAX	5-8012		
TRAINING NCO	5-8388		
OBSERVERS DESK	5-8374		

7. **Organizational Support**

a. Tenant units aboard Marine Corps Air Station Camp Pendleton, California consist of squadrons containing UH-1N and AH-1W aircraft, with additional squadrons relocating to Camp Pendleton as MCAS Tustin ceases operations. Transient aircraft at the Air Station includes all aircraft up to and including C-5A/B. The following information is provided to these aircraft, by the forecaster on duty, on a daily basis or as needed:

- DD 175-1's
- Terminal Aerodrome Forecasts (TAFs)
- Weather Warnings and Advisories

w WEAX

b. Primary Aviation support is provided to the flying squadrons attached to Marine Aircraft Group 39 and Marine Aircraft Group 46 "Det A" at MCAS Camp Pendleton. The following squadrons are assigned those Groups.

SQUADRON	AIRCRAFT		CALL SIGN
HMLA 169	AH1W	UH1N	VIPER
HMLA 267	AH1W	UH1N	STINGER
HMT 303	AH1W	UH1N	ATLAS
HMLA 367	AH1W	UH1N	SCARFACE
HMLA 369	AH1W	UH1N	GUNFIGHTER
HMLA 775	AH1W	UH1N	COYOTE
MCAS	C12		

(1) ***AH-1W Super Cobra Helicopter***

Speed: 147 knots (169.05 mph) in basic combat attack configuration.
Maximum takeoff weight: 14,750 lbs. (6,696.50 kg).
Range: 256 nautical miles (294.4 miles) in basic combat attack configuration.
Ceiling: 18,700 ft (5703.5 m) in basic combat attack configuration (limited to 10,000 ft (3050 km) by oxygen requirements).
Armament: One 20MM turreted cannon with 750 rounds; four external wing stations that can fire Hydra 2.75” or Zuni 5.0” rockets and a wide variety of precision guided missiles, to include TOW/Hellfire (point target/anti-armor), Sidewinder (anti-air) Sidearm (anti-radar).

FIG 1.2 AH-1W Super Cobra Helicopter

(2) ***UH-1N Huey Helicopter***

Speed: 121 knots (139.15 mph) at sea level.
Maximum takeoff weight: 10,500 lbs. (4,767 kg).
Range: 172 nautical miles (197.8 miles).
Ceiling: 14,200-ft (4331 m) (limited to 10,000 ft (3050 km) by oxygen requirements
Armament: M-240 7.62mm machine gun or the GAU-16 .50 caliber machine gun or the GAU-17 7.62 mm automatic gun. All three weapons systems are crew-served, and the pilot in the fixed forward firing mode can also control the GAU-2B/A. The helicopter can also carry two 7-shot or 19-shot 2.75″ rocket pods.

FIG 1.3 UH-1N Huey Helicopter

8. **Additional Aviation Support**

a. Additional aviation support units are located in the vicinity of MCAS Camp Pendleton as part of the 3rd Marine Aircraft Wing Aviation element. These units are as follows

MWSG - 37	MACG - 38	MAG - 39
MWSS - 372	MACS - 1	MALS - 39
	MASS - 3	
	3RD LADD BN	

b. The following products are provided to the above units aboard MCB Camp Pendleton on a REQUEST basis only:

- Horizontal Weather Depictions (Cross Sections)
- Change of Seasons Briefs
- Safety Stand Down Briefs

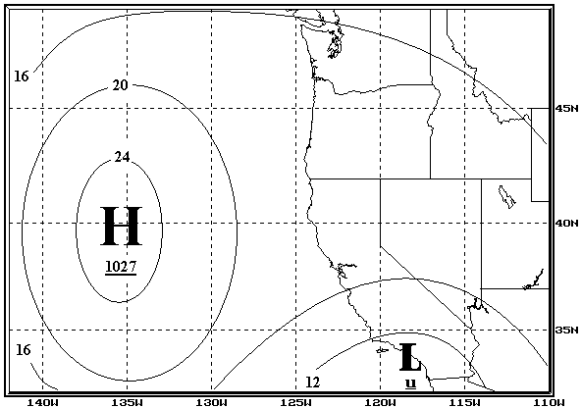
- Instrument Ground School Briefs
- OPARS
- EOTDA's

CHAPTER 2

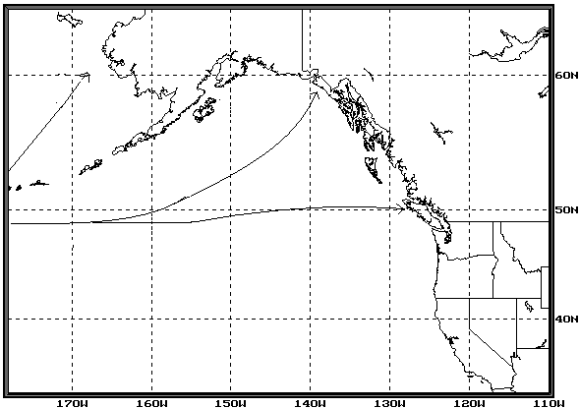
Climatology

1. General

a. Summer (June - August). During the summer, the Eastern Pacific High is quasi-stationary approximately 2000 miles west to northwest of Camp Pendleton. The anticyclonic flow around the High persists, providing a northwest flow over Southern California. A thermal trough enhances this flow over the California desert regions. Low stratus forms along the coast during the evening and early morning and dissipates by late morning. Visibility during late morning through evening, is normally greater than 7 miles; on occasion the visibility will be reduced by fog, haze, and/or smoke. Precipitation is at a minimum during this season. It most often occurs in the form of drizzle associated with low stratus clouds. On occasion a shower or thunderstorm will form over the mountains and deserts. This occurs when moisture from tropical storms is advected over this region as they track along the Mexican coast. These thunderstorms infrequently will drift toward Camp Pendleton when there is a strong easterly flow (see figures 2.1 and 2.2).

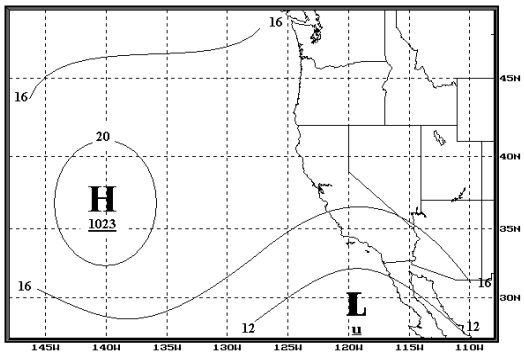


AVG POSITION OF PACIFIC HIGH & AVG SEA LEVEL PRESSURE JUN-AUG
FIGURE 2.1

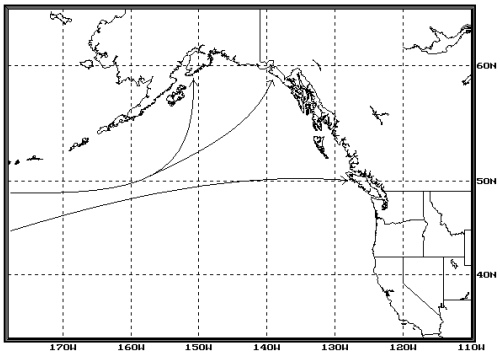


AVG LOW PRESSURE CENTER TRACKS JUN-AUG
FIGURE 2.2

b. Fall (September - November). The fall season is marked by improved flying conditions. Cold frontal passage may begin to happen as the Eastern Pacific High begins its migration equatorward to its wintertime position. Santa Ana conditions may develop during this season. The stratus clouds that are so dominate in summertime will occur less often as the transition into the wintertime regime begins (see figure 2.3 and 2.4).

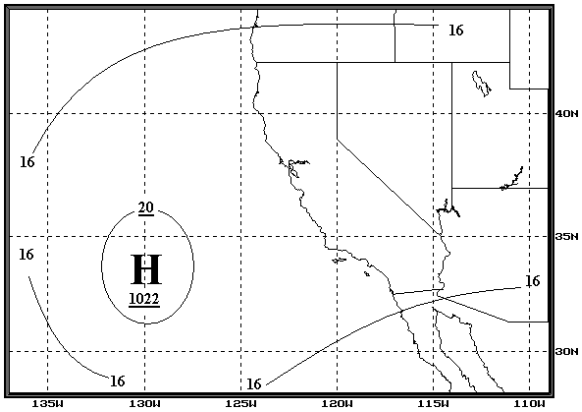


AVG POSITION OF PACIFIC HIGH &
AVG LOW PRESSURE CENTER TRACKS
AVG SEA LEVEL PRESSURE SEP-NOV
FIGURE 2.3

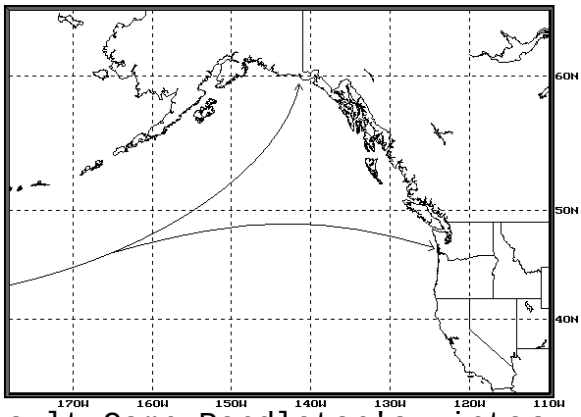


SEP-NOV
FIGURE 2.4

c. Winter (December - February). The winter season is usually mild and is considered the rainy season for this region. Cutoff Lows, Nevada Lows, and cold frontal passages are the main causes for adverse weather. Frontal systems continue to influence the weather pattern even more as the position of the Eastern Pacific High is established further south (approx. 1200 miles west-southwest of Camp Pendleton). As these fronts move south they lose energy and as a



AVG LOW PRESSURE CENTER TRACKS
AND SEA LEVEL PRESSURE DEC-FEB
FIGURE 2.5



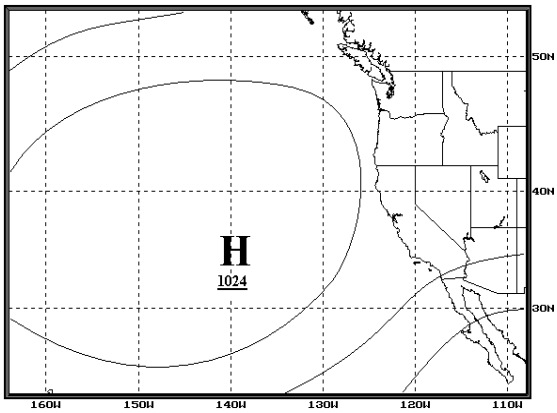
result Camp Pendleton's winter

AVG POSITION OF PACIFIC HIGH &

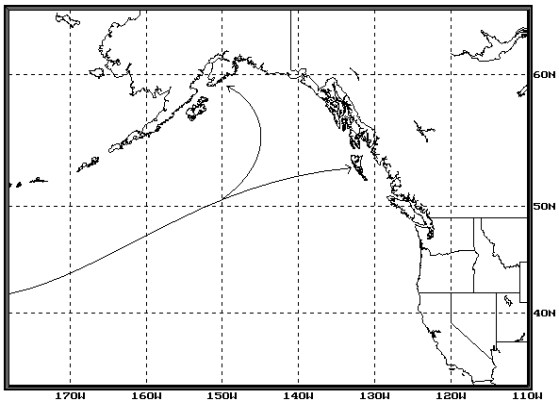
DEC-FEB
FIGURE 2.6

d. Spring (March - May). The spring season brings a decrease in precipitation and frontal passage become less

pronounced and does not progress as far south. The low stratus clouds that are a normal presence in the summer during the early morning hours begin to influence the local weather pattern. The Eastern Pacific High begins its migration north to its summertime position (see figure 2.7 and 2.8).



AVG POSITION OF PACIFIC HIGH
AVG LOW PRESSURE CENTER TRACKS
MAR-MAY
FIGURE 2.7



MAR-MAY
FIGURE 2.8

2. **Climatology Discussion**

The Pacific coast region of the United States and the adjacent ocean areas are located along the eastern portion of the Pacific high-pressure system. This high, when well developed, forms the principal circulation control, forcing most of the low-pressure systems to follow a course to the north of the contiguous United States. This action damps out weather changes that might otherwise occur and brings a stability factor that would not otherwise exist.

Air, which reaches the coast as a result of the prevailing westerly winds, acquires much moisture during its ocean passage. A cooling effect in summer and a warming effect in winter evidences this.

Winds in the Camp Pendleton area are strongest from November through April, when they blow 17 knots or more about 2 percent of the time.

Over the Gulf of Santa Catalina and along its shores, fog is a problem during fall and winter. This is most often a land (radiation) fog that drifts out over the gulf at night. By late morning, conditions begin to clear, particularly along the coast. Offshore, fog reduces visibility to less than 0.5 nautical miles on about 4 to 9 days per month from September through February. May, September and October are the worst months. Along the coast, visibility's drop below 0.5 nautical mile on about 2 to 8 days per month from August through April. November, December and February are the worst months.

There are three climate anomalies, which warrant attention. One is tropical cyclones: another, Santa Ana winds; and the third, the El Nino/Southern Oscillation (ENSO).

Tropical cyclones originate south of the area, off the Mexican coast, in summer and autumn. About 15 form each season, of which 7 reach hurricane intensity. Few come far enough north to affect U. S. coastal waters. The ones that do have usually lost their hurricane intensity and are short-lived; however, these storms can be dangerous and have generated winds of more than 120 knots in the operating area.

The Santa Ana is an offshore desert wind that occurs along the coast. While infrequent, it may be violent; speeds have been measured at more than 50 knots. These winds diminish little, if any, immediately after passing over water, and can extend up to 50 nautical miles out to sea. They are most likely in autumn or winter.

The ENSO represents an environmental extreme in the eastern boundary regions the Pacific Ocean and is a coupled atmospheric/ oceanographic phenomenon. The oceanic component of the ENSO begins in the western Pacific and propagates eastward. It manifests itself by, first causing a large change in the sea surface temperature of the equatorial Pacific, then major changes in the position and strength of the atmospheric pressure patterns affecting the California Current system, with somewhat unpredictable results. This can cause a strengthening of the Aleutian Low, with associated southward movement, causing severe storms along the California coast. At other times, the Low strengthens but remains farther offshore, diverting storms to the north of their normal track (e.g. a drought). A strong, ENSO event seems to occur every 1 to 20 years.

In the winter, off northern and central California, storms bring a preponderance of southeast through southwest winds, but this is matched by northwest and northerly winds that blow around the subtropical highs. These highs either form in the Pacific or migrate from Asia. They dominate the weather off the southern

California coast, where westerly through northerly winds blow more than 60 percent of the time. These highs; however, are weakest during winter, and occasionally storms move close enough to bring some clouds, rain and wind. Rain occurs about 5 to 10 days per month off central and southern California. Gales and rough seas are rare south of Los Angeles. In late winter off southern California, prevailing northerly and north- westerly winds become increasingly persistent. By March, southerly and northerly winds share equal billing.

In the Gulf of Santa Catalina area, visibilities are reduced to less than 0.5 nautical mile, mostly by radiation fog, about 3 to 7 days per month, from September through April. December is the foggiest month. Clearing will normally occur 2 to 4 hours after sunrise.

Summer conditions in southern California bring generally lighter and calmer seas than farther north. In March, temperatures are kept in the fifties by north to northwesterly winds with mid-fifties to mid-sixties occurring in May.

The California Current and coastal upwelling are responsible for the poor visibilities of mid-to late summer and fall. Upwelling is weak in the spring. The most dense and frequent fog occurs over the narrow stream of coldest water, just off the coast, and is often limited to a band of 50 nautical miles or less.

At other times, fog covers large areas, both in latitude and longitude, and may extend for hundreds of miles. The effect is even more pronounced onshore. The California Current's effect in summer extends along the entire coast.

Summertime temperatures are most often in the seventies. September is usually the driest month in offshore waters. September air temperatures hover in the mid- and upper-sixties.

Gale force winds near occur as much as 1 percent of the time in the Gulf of Santa Catalina. At Camp Pendleton, winds less than 3 knots occur 40 to 50 percent of the time from September through March.

3. **Oceanography**

a. General Bathymetry. Depths along the Pacific coast from Point Loma to the Oceanside/Camp Pendleton area decrease too rapidly to seaward to be of any practical use as an aid to navigation. The 100-fathom curve lies at an average distance of less than 10 miles from the shore. The closest major submarine features are La Jolla Canyon, whose mouth is just to the north of

Point La Jolla, and deepens rapidly to the west-northwest; and Carlsbad Canyon, which faces the west-southwest off the town of Carlsbad. The SOCAL OPAREA contains an array of small islands, sea mounts, trenches, and basins, which are collectively referred to as the Southern California Borderland. Some distinguishing features in the area are the San Nicholas Basin, Cortes Bank, and Tanner Bank; all of which are located in the northwest portion of the OPAREA.

b. Sediments. The principal sources of beach sediments along the southern California coast are the streams which periodically bring large quantities of sand directly to the ocean, and the sea cliffs of unconsolidated material which are being eroded by the waves. In some isolated cases, sediment may be supplied by erosion of older unconsolidated deposits in shallow offshore areas. The wave erosion of rocky coasts in southern California has been negligible during the last several decades, even where the rocks were relatively soft shells. On the other hand, there has been a retreat of as much as a foot a year in unconsolidated formations. In the nearshore area off Camp Pendleton there is a mixture of sand and shells. Streams are by far the most important source of sand and beaches may receive sand from beaches many miles away.

c. Bottom Characteristics. A narrow band of sand borders the coast. Offshore, the bottom is mainly mud. Along the coast, approximately 2 miles to the southeast of the specified area, the bottom is rocky. A few miles offshore, there are places where the bottom is rocky, or consists of a mixture of mud and sand. Bottom sediment color in the vicinity of Oceanside/Camp Pendleton is olive green, with a patch of gray at about the center of the specified area.

d. Dangers to Mariners. The following dangers are noted:

New Hope Rock/Wreck - 32° 49'N/117° 16'W.

Bird Rock - 32° 49'N/117°16'W.

Oceanside - Pleasure pier partially collapsed. Fish-haven covered by only 10 feet of water at seaward end of Pleasure pier.

Oceanside Harbor - Submerged jetty close to the north side of the harbor entrance channel. Entrance channel subject to severe wave action and shoaling.

Del Mar Boat Basin - Restricted Area off the outer breakwater at the entrance to the basin (common entrance with Oceanside Harbor).

Obstruction (submerged buoy) - Approximately one nautical mile west - northwest of Point La Jolla.

Sewer - Extends seaward from north side of San Elijo Lagoon.

Sewer - Extends seaward at 33° 07'N/116° 20'W.

Pipeline - Extends seaward at 33° 08'N/117° 20'W.

Pipeline - Extends seaward at 33° 21'N/117° 34'W.

Submerged oil wells may or may not be marked, depending on their location and depth of the water over them.

e. Anchorages. There are few places where shelter can be found for large, vessels outside of the enclosed harbors and bays. There is a mooring buoy off Camp Pendleton at approximately 33° 20'N/117° 37'W.

f. Obstructions. Disposal sites and dumping grounds are rarely mentioned in the Coast Pilot, but are shown on nautical charts. Spoil areas are for the purpose of depositing dredged material, usually near and parallel to dredged channels. They are usually a hazard to navigation. Navigators of even the smallest craft should avoid crossing spoil areas. Private interests, usually sport fishermen, to simulate natural reefs and wrecks that attract fish, establish fish havens. The reefs are constructed by dumping assorted junk ranging from old trolley cars and barges to scrap building material in areas which may be of very small extent, or may stretch a considerable distance along a depth curve. Navigators should be cautious about passing over fish havens or anchoring in their vicinity.

Fish trap areas are established by the Corps of Engineers, state or local authorities, and are built and maintained in accordance with established regulations. This limit of a fish trap area is *usually* charted.

g. Riverine Environments. The following streams and rivers pour either into harbors or directly into the ocean:

Santa Margarita River - 1.7 nautical miles northeast of the Del Mar Boat Basin.

San Mateo Creek - Mouth near San Mateo Point.

San Onofre Creek - 1 nautical mile southeast of San Mateo Creek.

San Luis Rey - Mouth at Oceanside Harbor.

Caution: Waters near the mouths of rivers bay and harbors may contain agricultural and industrial pollution and waste, as well *as untreated sewage.*

Sandbars build up at the mouths of river and stream entrances where they empty, into the Pacific Ocean. Fresh water input to the Gulf of Santa Catalina is insignificant.

h. Tides. Tides along the West Coast of the United States are mixed and semidiurnal. In general, the tides exhibit a large inequality in the heights of the two high waters and of the two low waters of each tidal day. On the outer coast, the average difference in the heights of the two high waters of the day is from 1 to 2 feet and the average difference in the heights of the two low waters, from 2 to 3 feet. This inequality changes with the declination of the moon. When the moon is near the equator, the difference is relatively small, but when the moon is near its greatest northern or southern declination, the difference in the heights of the two high waters or of the two low waters of each day reaches a maximum. The tides at this time are called Tropic Tides.

i. Currents

(1) Off-Shore Currents. The California Current is the major eastern boundary current off the West Coast of the United States. Its outer limit extends more than 300 nautical miles offshore. It flows approximately parallel to the U. S. Pacific Coast from latitude 50° N to 30° N. The current direction is south throughout most of the year. Its velocity, usually about 0.2 knots, is greatly influenced by the prevailing winds. Northerly winds increase it; southerly winds diminish it. The average temperature gradient between the current and the surrounding water is 1-3° C. In the summertime, intense jets carrying cold water from nearshore, with upwelling occurring toward offshore characterize the California Current. These jets are delimited by sharp, thermal velocity fronts, which are often convergent and subject to small-scale instabilities. Upwelling brings cold, nutrient-rich water from the depths to the surface. The fronts are made visible when wind waves and swell are undergoing refraction by the current sheer, resulting in increased amplitude, and when waves are damped by the biological films concentrated in the convergence zones. The California Current induces southward currents over the shelf.

(2) Nearshore Currents. Along the coast during certain periods, there is a weak northerly flow known as the Davidson

Inshore Current. This current is evident between San Diego and Point Conception from July through February. Alongshore and off the entrance to inland waterways, the currents depend to a great extent upon tidal and drainage effects.

CAUTION: At unpredictable intervals, a warm core eddy may appear in the nearshore area, resulting in temperature, salinity and water clarity anomalies. This warm water may contain jellyfish and other marine animal life, which may be a nuisance to swimmers. The eddy propagates along the coast under the influence of the Davidson Inshore Current, and the vertical axis may extend from the surface to depths greater than 300 feet. Caution is advised when the water temperature departs significantly from that expected.

(3) Rip Currents. Longshore currents are generated when waves approach the beach at an angle. Such currents flow parallel to the beach and result in a littoral drift of sand along the beach. Such is the case at Oceanside. The momentum of these breaking waves has a component along the beach in the direction of wave propagation. This results in the generation of longshore currents inside of the breaker zone. After flowing parallel to the beach, the water is returned seaward along relatively narrow zones. The seaward return of the flow through the surf zone by rip currents constitutes a nearshore circulation system. The pattern, which result from this circulation commonly, takes the form of an eddy or cell with a vertical axis. In places where relatively straight beaches are terminated on the down-current side by points or other obstructions, a pronounced rip current may extend seaward.

(4) Tidal Currents. The tidal currents at the mouths of many rivers and streams can attain considerable velocity, especially when the ebb tide is reinforced by river runoff. The most dangerous condition prevails when a swift ebb current meets heavy seas rolling in the Pacific at shallow river entrances. The water piles up, breaks and creates a bar condition too rough for small craft. In a bar area, sea conditions can change rapidly and without warning.

(5) Seasonal Variation

(a) Winter and Spring. During the winter and spring, the California Current in the western portion runs from the west to northwest at a speed of 0.1 to 0.5 knots. For the remainder of the OPAREA north of 31°N, the Davidson Current prevails and runs from the south to southwest at 0.1 to 0.4 knots. South of 31°N the California Current runs from the north to northwest at 0.2 to 1.2 knots.

(b) Summer and Fall. During the summer and fall the California Current in the northwestern portion is from the northwest to west at 0.1 knots, increasing to a maximum of 0.9 knots in the south. For the remainder of the SOCAL OPAREA, the Davidson Current is less active and flows from the southeast to south along the coast a 0.3 to 0.6 knots. South of 31°N the California Current is from the Northwest to north at 0.5 to 0.9 knots.

j. Oceanside Harbor and Surrounding Area/Camp Pendleton

(1) General. Oceanside Harbor is located on the California coast approximately 80 nautical miles south of Los Angeles and 30 nautical miles north of San Diego. The harbor complex includes the Del Mar Boat Basin (also known as Camp Pendleton Harbor) and the Oceanside Small-Craft Harbor. While the Del Mar Boat Basin is used entirely for military purposes, Oceanside Small-Craft Harbor is used primarily for recreation. The two basins share a common entrance, but have separate channels leading to their respective berthing areas. A 4350-foot north breakwater and 1330 foot south jetty currently protect the harbors. The north breakwater and south jetty have crest elevations of 21 and 14 feet, respectively. The Federal channel commences approximately 400 feet seaward of the navigation opening between the heads of the north breakwater and south jetty, and extends to the Del Mar Boat Basin and Oceanside Small-Craft Harbor basin entrance. The authorized channel depth is 20 feet, and the width of the approach channel is 750 feet.

(2) Hazards to Navigation. Accumulation of sediment in the harbor entrance creates hazardous navigation conditions for both commercial and recreational craft, due to breaking waves and shallow depths. These breaking waves cause boats to broach, capsize, run aground, and/or collide with other boats and/or the jetty. Strong local wave-induced currents can also drive vessels toward the south jetty once they are in the entrance. Eleven persons have lost their lives attempting to navigate the entrance since 1963.

CAUTION: Shoaling in the entrance to Oceanside Harbor is causing severe surf conditions.

(3) Waves. Due to the configuration of the harbor, waves from critical directions can penetrate relatively uninterrupted through the main channel entrance and into the inner harbor berthing area of Oceanside Small-Craft Harbor. Excessive wave-related damages are experienced in the berthing areas.

k. Sea State/Conditions. During the fall, winter, and spring, the combined average Sea State for the Inner SOCAL OPAREA ranges between 3 and 6. During the summer, the average decreases to less than 3 feet.

(1) Northern Hemisphere Swell. These waves are generated by extra-tropical cyclones of the North Pacific. They approach Oceanside from the west through narrow corridors between Santa Catalina, San Nicholas and San Clemente Islands. The swell occurs primarily, during the months of November through April.

(2) Southern Hemisphere Swell. Oceanside Harbor is exposed to Southern Hemisphere swell through a wide corridor from the south to southwest. Most of the swell arrives during the months of May through October. Because of the great decay distances, these waves have low heights and long periods. Typical southern hemisphere swell rarely exceeds 4 feet in deep water, with periods of 18-21 seconds.

(3) Seas Generated by Local Winds. Steep, short-period waves generated by local winds may occur from all offshore directions throughout the year. Fetch lengths for seas generated from the northwest are limited to a maximum of about 120 miles. Due to the Santa Barbara Channel Islands, wave heights are usually 2-5 feet, with an average period of 7 seconds.

(4) Sea and Swell Generated by North Pacific Tropical Cyclones. Cyclones of hurricane intensity have the potential of generating some of the largest waves at Oceanside. These waves approach from the south through the southwest from May through November; however, a hurricane track that would produce large waves at this site seldom occurs.

(5) Representative Wave Characteristics and Recurrences. The following table may generally categorize waves:

Period/Height*	Recurrence Interval
8,4	weekly
14,10	Annual
16,13	20-year
16,17	50-year
16,20	100-year

* Period represented in seconds. Height represented in feet.

(6) Surf/Breakers. In the Gulf of Santa Catalina, seas are most likely to get choppy from November through April, when distant storms south of 40°N generate westerly swells. These

swells are 6 feet or more about 2 to 5 percent of the time. In winter, they occasionally exceed 9 feet, and some 12-foot swells have been reported.

l. Sea Surface Temperatures. The mean sea surface temperature during the summer and fall ranges between 62°F and 66°F. A permanent warm coastal eddy located near 33°N increases the temperature to 66°F. During the winter and spring the average sea surface temperature ranges between 56°F and 62°F.

m. Salinity. The difference in salinity for this area between surface and the bottom typically varies less than 1 ppt and ranges between 34.4 and 35.4 ppt. These salinity variations are not large enough to be significant to any operations in the area.

n. Mixed Layer (Sonic Layer) Depth. The mixed layer depth for the Inner SOCAL OPAREA averages 160 feet during the winter. The average mixed layer depth decreases to 118 feet during the spring. The mixed layer depth continues to decrease in the summer to an average of 65 feet. During the fall, the mixed layer depth averages 78 feet.

o. Thermal Gradient. During the winter, when the water is colder and isothermal to a greater depth, the average thermal gradient is -5.6^{o}F/100 feet. The average gradient increases to -6.4^{o}F/100 feet in the summer and to -13.3^{o}F/100 feet in the fall.

p. Acoustics. The best antisubmarine warfare (ASW) ranges in the area occur during the winter and spring when mixing produces deeper sonic layer depths. Ranges are poorest during the summer and fall when shallow sonic layer depths and strong below-thermal gradients prevail. Due to depth limitations, convergence zone propagation will not occur in the area. The bottom loss propagation is poor in the area.

q. Offshore Islands. The following islands of the Channel Island group border the area in question:

(1) San Clemente Island. This is the southernmost of the Channel Islands. The island stretches northwest to southeast for 26 nautical miles, and is approximately 7 nautical miles wide. The climate is marine, featuring cool summers and mild winters.

(2) San Nicholas Island. North west of San Clemente Island.

(3) Santa Catalina Island. Due north of San Clemente Island.

(4) Santa Barbara Island. Between San Nicholas and Santa Catalina Islands. Much smaller than the other three Islands.

r. Marine Animal Life. Marine mammals are the major contributors to biological ambient noise along the coast of California. The occurrence of whales, seals and sea lions peaks during the winter months. Porpoises and dolphins are more prevalent during summer, where they may be found in-groups as large as several hundred. Whales normally inhabit the offshore areas; however, they occasionally enter the nearshore area. Seals and sea lions may be found in all areas. Large numbers of snapping shrimp may be found off Point Loma.

s. Marine Plant Life. Kelp grows on nearly every danger with a rocky bottom and is particularly heavy at various points in Santa Barbara Channel and in the vicinity of San Diego Bay. It will be seen on the surface of the water during the summer and autumn; during the winter and spring it is not always seen especially where it is exposed to a heavy sea. Many rocks are not marked by kelp, as a heavy sea occasionally tears it away, and a moderate current will draw it under water, out of sight. When passing on the side of a kelp patch from which the stems stream away with the current, care should be taken to give it a good berth. Dead, detached kelp floats on the water curled in masses, while live kelp, attached to rocks, streams away level with the surface. Live kelp is usually an indication of depths less than 10 fathoms. There is a very large bed, which is regularly harvested to the west and south of Point Loma. This bed extends from the south side of the entrance to Mission Bay to the point. Smaller beds exist along the entire coast, and appear disappear at unpredictable intervals.

t. Biofouling. Slight to moderate fouling can be expected throughout the entire year. The most abundant and varied infestations may be expected in nutrient rich water, such as off coasts near cities and towns. Of the various types of foulers in the area, sea urchins are capable of drilling holes in rock and concrete.

u. Bioluminescence. During the spring and summer months, coastal regions within 5 miles of shore experience sheet-type displays which indicate conditions of red tide. At these times, light levels may be high enough for swimmers to be observed at night with the human eye.

v. Vegetation. The largest algae (kelp) grow abundantly in patches of rock, gravel or shell between low tide level and a depth of 100 feet. Kelp beds are usually best developed where

they are protected from heavy waves. Under favorable conditions, some species grow to more than 100 feet in length. They may form dense beds which interfere with military operations. East of Point Conception, one bed covers more than 4 square miles. Beds covering 6 square miles are found off San Miguel and Santa Rosa Islands. Off San Nicholas Island, one bed covers more than 12 square miles. Kelp frequently dominates many of the algae communities; however, smaller algae of many kinds sometimes grow luxuriantly as an understory between kelp beds. Most of the algae that may affect military operations become most luxuriant during July through September. When parts of a plant or the entire plant dies, large masses of vegetation float as rafts between the sea surface and the bottom. Rafts of algae may not only entangle gear, but also may clog condensers and ship intakes. Drifting masses may pile up around equipment, reduce its sensitivity, or make it less stable and likely to be upset by waves surges and currents.

w. Grasses. One type of eelgrass commonly grows on mud flats and in bays and estuaries from low- tide level to depths of 20 feet or more. Another type grows abundantly on rock or gravel bottoms on surfy shores to depths of 50 feet. Although some plants may reach a length of 6 feet, most of them are smaller. Sea grasses may be so dense in places that they stabilize the bottom and trap shifting sediments. Like the algae, sea grasses shed parts of their foliage periodically and contribute some material to the rafts of vegetation. Surface salinities in the nearshore ocean area range from 33.3 to 33.6 ppt throughout the year.

4. **Persistent and Transitory Weather Regimes Affecting Southern California**

a. Fog and Stratus. California, because of its coastal cold water, is one of the most common areas where fog and stratus will form. The anticyclonic circulation around the Eastern Pacific High causes the prevailing winds to parallel the California coast. These winds cause the upwelling of deeper colder waters near the coast. Fog is then formed along the coast by the warm wind flowing over the cold sea surface. The following are types of fog experienced most at Camp Pendleton.

(1) Radiation Fog. Produced over a land area when radiational cooling reduces the air temperature to or below its dew point. A strict radiation fog is a nighttime occurrence, although it may begin to form by evening twilight and often does not dissipate until after sunrise. It can be difficult at times to differentiate between this and other types of fog, especially since night time cooling intensifies all fogs. It can be most

confusing near seacoasts with cold coastal water such as that found in California.

(2) Sea Fog. A type of advection fog, which is formed when air that has been lying over a warm water surface is transported over a colder water surface, resulting in cooling of the lower layer of air below its dew point. Sea fog occurs, in this area, chiefly in the spring and early summer. When a forecaster determines that conditions are favorable for the formation of sea fog, the problem then becomes one of low level wind forecasting. For short term forecasting, periods of less than three hours before occurrence, the speed of a low-level wind can be used with a good degree of success to forecast the onset of advection fog from the sea.

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NOTE: Fog almost always forms during the early morning hours (0330L to 0900L) on the second day after the dissipation of a TRUE "SANTA ANA" condition due to the re-establishment of the Marine Layer.

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(3) Stratus. A common mode of stratus development is the transformation of fog. As can be expected by its close relationship to fog, stratus follows a diurnal cycle with a maximum (over land) in the night and early morning. Insolation tends to dissipate this cloud rapidly and often bring about the transformation of stratus fragments into stratocumulus clouds. Fog arriving from the sea frequently becomes stratus over adjacent land areas. The first process is simply "Advection" where already cloudy, saturated air is moved from its ocean source into the local area. The second process responsible for stratus onset is "Formation". The moist, cool air containing abundant condensation nuclei cools further; and when saturation is reached, stratus clouds form. The air is sufficiently cool but stratus does not appear until there is an influx of a sufficient number of condensation nuclei. However; smoggy or very hazy air does favor the process of formation by allowing condensation at lower relative humidities than would otherwise occur.

b. Pacific High. The North Pacific Subtropical Ridge (PACIFIC HIGH) is a large area of high pressure which seasonally dominates the northern Pacific Ocean areas. The Pacific High is a semi-permanent feature, but its exact position and intensity are variable, especially during the winter when it migrates to the south to approximately 30^0N, and weakens, allowing upper-level troughs to become more active and influential in Camp Pendleton's weather pattern. During the summer the Pacific High increases intensity and persistence as it shifts to its northern

location to (approximately 40^0N) forcing the effects of extra-tropical lows to remain north of the San Diego area. Generally, the intensity and displacement of the Pacific High is directly related to the amount of solar insolation. The air which flows around the ridge of the Pacific High from the northwest approaches the coast, subsides from above and heats at the adiabatic rate of about 5.5^0 Fahrenheit per 1000 feet of descent arriving at lower levels as a hot dry air mass. A shallow stratum of surface-based marine air protects the coastal area from this hot, dry air. This forms a very pronounced subsidence inversion, which is strongest on the eastern edge. As a result, the creation of the Southern California Marine Layer.

c. Marine layer. The Marine Layer is a shallow layer of relatively cool, moist air. A constant mixing of low-level air with a marine trajectory forms it. It is normally restricted to a depth of 2000 feet or less by a temperature inversion created by the subsiding air from the Pacific High. This inversion caps the maritime air, often trapping pollutants and smog as well as moisture and salt particles within the Marine Layer. As the maritime air cools through mixing and radiation to saturation, stratus and fog are formed by condensation of moisture on the numerous salt and pollution particles present. The Marine Layer helps maintain the coastal air temperature near that of the sea surface (see figures 2.9 & 2.10).

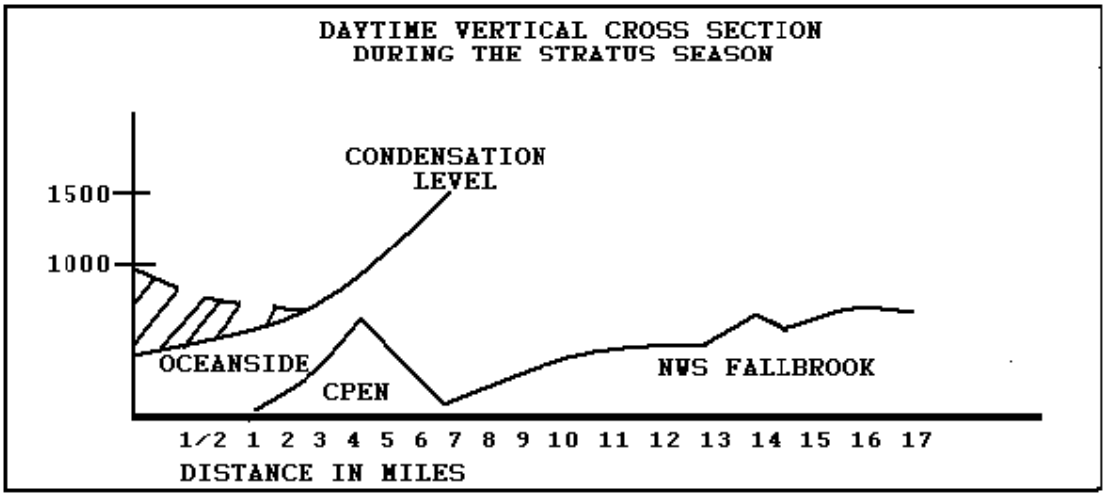


FIGURE 2.9

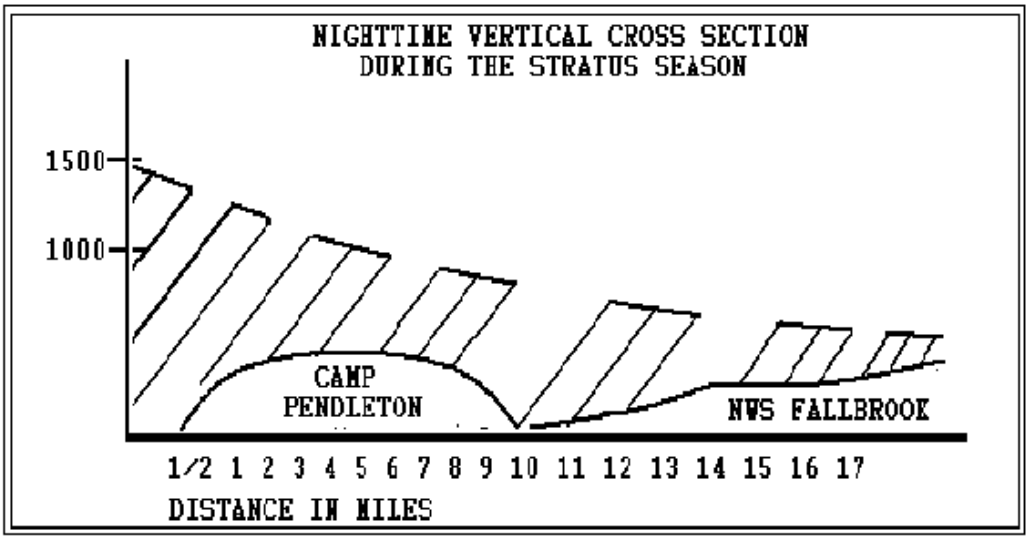
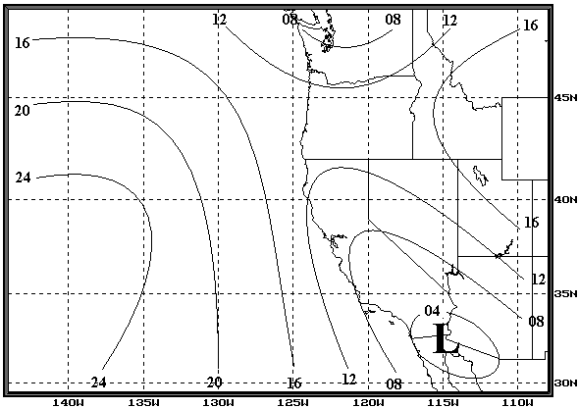


FIGURE 2.10

d. Thermal Low/Thermal Trough. The hot, dry air that results from intense daytime heating over the sandy and rocky areas of the Desert Southwest, produce a stationary heat induced surface low pressure cell or thermal trough that seldom extends above 5,000 feet. The thermal trough is a semi-permanent feature which is located over Northern Mexico in the interior desert region, during summer extending into Oregon and at times into Canada by midsummer. The extreme temperature gradient created between the thermal trough and the cold coastal water temperatures produce a flow which brings the Marine Layer onshore (see figure 2.11 and 2.12).



THERMAL LOW
THERMAL TROUGH
FIGURE 2.11

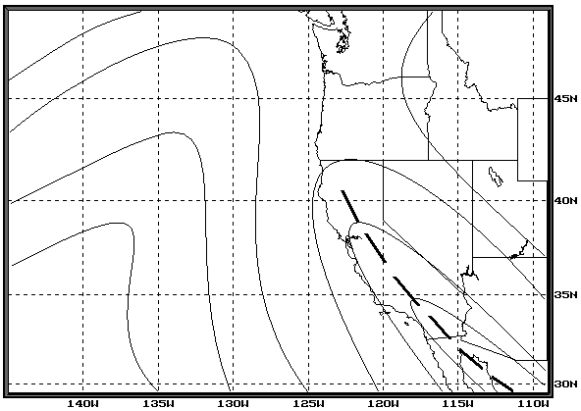


FIGURE 2.12

e. Land & Sea Breeze. As a result of radiational heating during the daytime, the coastal land surface air temperature becomes warmer than the adjacent sea surface. This in turn sets

up a horizontal temperature gradient, which produces an on-shore wind flow (Sea-Breeze). The Sea Breeze begins approximately 4 to 8 hours after sunrise and obtains a maximum intensity of 10-12 knots during the late afternoon; its effect ranging 30 to 40 miles inland from the coast. At night, the radiational cooling of the land surface and surrounding mountains is greater than that of the sea, thus reversing the temperature gradient. This produces an offshore wind flow (Land Breeze) which reaches the maximum intensity 4 to 8 hours after sunset. The Land Breeze or drainage wind is weaker than the Sea Breeze and seldom exceeds 5 knots. Seasonally, the Sea Breeze is strongest during the summer months. Due to the intensity of the heating, this produces the greatest land-sea temperature gradient. With the exception of the Subtropical Ridge, synoptic features are characteristically weaker during the summer, with no significant cold air being advected into the Camp Pendleton area from polar outbreaks in the northern latitudes. At Camp Pendleton, the anticyclonic flow around the eastern side of the Pacific High normally produces a persistent west-northwesterly flow, which is a normal wind for the city of Oceanside and adjacent coastal areas. Because of Camp Pendleton's surrounding terrain (see location & topography), the wind is funneled through the Margarita Valley (Punch Bowl), and this produces a south-southwesterly wind during the afternoon, and an east-northeasterly wind during late night and early morning hours aboard the Air Station.

5. **Santa Ana.** The Santa Ana or Foehn wind may occur in almost any month of the year; however it is predominantly a winter phenomenon. The normal season runs from October through April, reaching a maximum frequency in the months of December, January, and February. The geographic region for formation is the upper plateau of Northern Nevada flanked on the west by the Sierra Nevada Mountain range, and on the east by the Rocky Mountains. There are three main canyons or passes that channel the flow from the plateau to the coastal region. These are the El Tejon (Newfall/Gorman) Pass, the El Cajon (San Bernadino) Pass and the San Gorganio (Banning) Pass. The San Gorgonio Pass is the pressure outlet affecting Camp Pendleton the most. This is due to the orientation of the pass in respect to this station. The El Cajon pass lies 65NM to the NNE, while Banning pass lies 55NM to the ENE of Camp Pendleton.

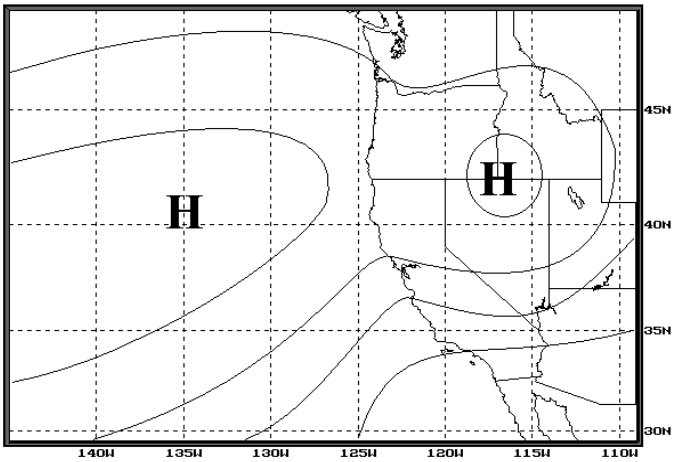
a. Synoptic Features

(1) Great Basin High. A primary synoptic feature associated with the Santa Ana is the Great Basin High. This is a relatively cool, dry airmass with highest pressure situated over the plateau of Northern Nevada (see figure 2.13). The most common source for this airmass is Pacific Maritime, usually part of the Pacific High, which moves eastward behind a frontal

system. The density of this air mass is less than the airmass in the Los Angeles basin, due to orographic and adiabatic processes, causing weak offshore flow, which seldom reaches the surface in the Los Angeles basin. The second source is either polar or arctic in origin, being much colder and dryer in its original stages. This air mass is much denser than the Los Angeles basin air mass causing the Santa Ana flow to underrun the Los Angeles Basin air mass, reaching and affecting the surface. The Great Basin High reverses the usual onshore pressure gradient to offshore, resulting in a subsiding outflow of air from the Great Basin across the desert, through the passes to the coastal area where it arrives as a dry adiabatically warmed wind. The colder the Great Basin and the higher the pressure, the stronger the wind flow will be.

SANTA ANA SURFACE PATTERN
FIGURE 2.13

(2) Frontal Passage. The movement of a new air mass of high pressure into the Great Basin is preceded by the passage of a frontal zone representing the leading edge of new air. The associated front can be either active or inactive as evidenced through empirical observations. Sometimes there is no physical evidence other than wind shear, while at other time's shower activity has accompanied the passage. The orientation of the front is a strong factor regarding the time of onset. This will be discussed in greater detail later in this chapter.

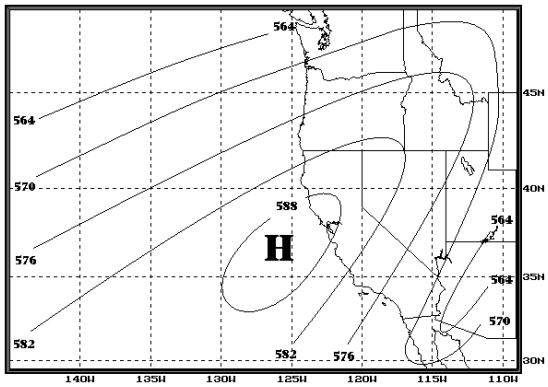


(3) Ridge/Aloft. Nearly every Great Basin High has the vertical support of a pronounced ridge upper-level over, or just situated coast which off, the west subsiding air feeds level outflow into the low- Basin High. of the Great The stronger the subsidence from the ridge, the more enhanced are the Santa Ana wind at the coast. When a long wave ridge, steered by the belt of westerlies toward the coast, becomes entrenched over the West Coast, short wave troughs moving through the ridge may temporarily flatten it. These short wave troughs normally support a surface frontal system, such that the ridge and associated Great Basin High usually rebuilds sharply following passage, often resulting in the establishment, or re-establishment of a Santa

Ana (see figure 2.14).

SANTA ANA 500 MB PATTERN

FIGURE 2.14



(4) Termination. When the Great Basin High begins to weaken and move eastward toward the Rocky Mountains (usually in response to the upper air pattern), warming of the desert interior usually takes place. This heating leads to the formation of a surface thermal trough. The offshore pressure gradient in coastal Southern California greatly relaxes and finally reverses to onshore, thus ending the Santa Ana. Since the decrease in wind is gradual, Santa Anas do not end nearly as dramatically as they begin. With the return of the moist onshore flow at the surface, a strong inversion is immediately established along the coast; the temperatures Lower, and dew points become higher than those observed during the Santa Ana. The upper-level wind normally shifts from north to northeasterly back to a westerly direction with the abatement of the Santa Ana.

b. Associated Weather. Santa Ana conditions seldom have a significant effect upon the weather at the Air Station but does effect the inner portion and higher elevations aboard Camp Pendleton. The main factor for this is the local topography.

(1) Wind. The north to northeast wind exhibits a diurnal dependency being stronger at night and early morning enhanced by land breeze and can obtain gusts in excess of 60 to 70 knots by midday. The developing Sea Breeze along with daytime heating may decrease the effects rapidly. Santa Ana wind speeds increase rapidly with height over the air station, creating a strong Low Level Wind Shear (LLWS) and severe turbulent conditions.

(2) Temperature. Generally, the maximum temperature recorded in the coastal regions of Southern California has occurred during Santa Ana's. However, a Santa Ana will occasionally be "Cold" due to differences in air mass temperatures, and the amplitude of upper level troughs and ridges. If a cold trough at the 850MB and 700MB level is located over the coastal region, the subsidence is shallow and the area affected by Santa Ana wind is close to the source region; thus producing colder than normal wind.

(3) Humidity. The dryness of Santa Ana air may be attributed largely due to the adiabatic process for subsidence and the down slope movement of air through the passes. The relative humidity during a Santa Ana will usually be less than 10 percent and the dewpoint temperature will be in the 20's.

(4) Visibility. The effects of Santa Ana's on visibility are complicated and, at times, contradictory. With weaker Santa Ana's, visibility's are usually excellent because of the lack of pollution and dust particles that are suspended in the air. However, if the wind is strong, a layer of blowing dust and sand may extend several hundred feet above the surface and severely restrict visibility, often times to less than one mile. Occasionally, the industrial pollutants in the Los Angeles Basin will be blown out to sea by a strong Santa Ana, drift south with the cold coastal currents, then return to land over Camp Pendleton by the sea breeze, reducing the visibility. The polluted marine layer may cool to the saturation point during the night time hours resulting in dense fog and visibility near zero. These conditions very seldom occur.

6. **Fronts**. Frontal passage is normally experienced during the months of October through April. Fronts, which traverse the local area, are usually weak and diffuse except during the months of December through February. Occluded systems passing through the area are noted for unstable air masses with no definite zones and usually account for diffuse and continuous precipitation. Prognostication of frontal passages often prove difficult as no definite rate of movement can generally be determined once the system moves south of Santa Barbara approximately 165NM northwest of Camp Pendleton. Local weather associated with frontal passage varies widely with each front. Some fronts progress through with little or no indication of their passage, while others are marked with multi-layered fluctuations. During the winter season, fronts are generally of sufficient strength to produce weather and several unique conditions.

a. Frontal Guidelines

(1) The tendency of cold fronts is to pivot into a north-south orientation in the vicinity of Los Angeles and approach Camp Pendleton from the west.

(2) Fronts move southward 30% to 50% slower, south of the Los Angeles area.

(3) The Laguna Mountain Range retards fronts moving inland and showers can persist for 12 to 24 hours after the front transits the local area.

(4) Gusty surface wind will accompany the front if it is in phase with the pressure trough aloft.

(5) Coastal surface winds backing to the southwest after a frontal passage indicates the approach of a secondary front or frontal wave.

(6) Stronger wind and more intense shower activity usually accompany secondary fronts.

(7) Warm frontal dissipation of the frontal system prior to its arrival in the local area decreases the possibility of experiencing rain/or drizzle; however, showery type precipitation will be observed in association with the cold frontal passage.

(8) Rapid clearing behind a cold front occurs only with an associated cold tongue of air aloft.

(9) If the trailing edge of a cold front approaching the coast does not extend below 30^0 north, precipitation will be rare with passage.

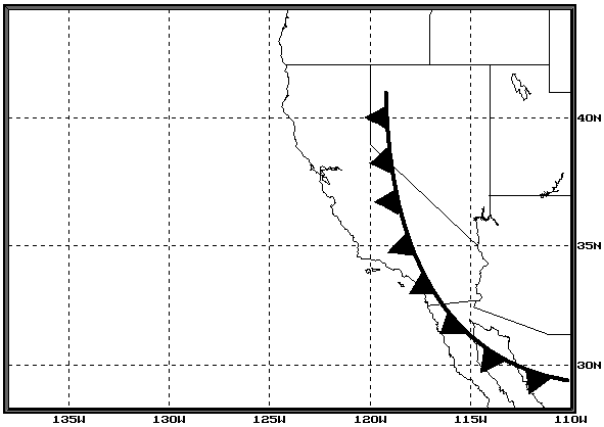
(10) If a transiting cold front is weak and diffuse and a Nevada Low is well established, frontal intensification can be expected. Precipitation will be governed by the strength of the intensifying front. Frontal systems which pass through the Camp Pendleton area may be categorized as either "wet" or "dry" depending upon the amount of cloudiness and precipitation associated with the front at the time of passage. Cold fronts tend to dissipate on the surface before reaching the Camp Pendleton area during the summer.

(11) As the fall season transitions to winter, fronts begin to pass through with greater regularity and increased intensity. Eventually, the fronts will maintain their intensity all the way south past the tip of Baja, California. The fronts slow drastically as the frontal surface become relatively shallow and the east-west oriented mountainous terrain near Point Conception provides an orographic barrier. Most forecasters will arbitrarily decrease the frontal speed by 50 percent in order to forecast a reasonable speed of movement for the front over the coastal areas south of Point Conception. The more active fronts having large temperature and wind discontinuities will pass over the area in a rather smooth and unbroken track.

b. East-West Frontal Orientation. Cold fronts passing through Southern California with an east-west orientation usually precede a Santa Ana condition by 6 to 18 hours. The high pressure behind the front is usually a blend of maritime air and

counterparts. As high pressure area moves southward from Canada toward the Great Basin, less building of pressure is required to produce a Santa Ana. However, the timing of the onset of a Santa Ana from this type of front is complicated. The front moves southward more slowly than the northeast-southwest oriented front and there is usually less visible "weather" associated with east-west fronts making tracking extremely difficult.

c. "Backdoor" Frontal Orientation. "Backdoor" fronts are those that approach Southern California from the east and are orientated either southeast-northwest or south-north. Although infrequent, this situation generally occurs when the front is oriented along the eastern slopes of the Sierra Nevada mountain range bordering California and Nevada. Due to the completely continental nature of the high pressure behind the front, these highs are usually cold, dry, and intense and are already positioned over the Great Basin when the front reaches Southern California. The onset of Santa Ana wind may be forecast to begin with the frontal passage (see figure 2.15).



BACKDOOR FRONT
FIGURE 2.15

d. Northeast-Southwest Frontal Orientation. This is the most frequently observed orientation in Southern California and is indicative of westerly or northwesterly flow aloft. The time lag between frontal passage and the onset of the Santa Ana is normally 12 to 36 hours; the amount of time required for the airmass to be modified, and for the high to build sufficiently to cause an offshore flow along the coastal areas of Southern California. In addition to a strong ridge over the West coast, during favorable Santa Ana conditions, a deep trough is usually located downstream over the Rocky Mountains which extend through the western United States including Utah, Colorado, and Northern New Mexico. Variations in the strength and position of the ridge-trough pattern can produce marked changes in the character of the Santa Ana wind. As mentioned earlier, when the downstream trough is located close to the West Coast, there is less subsidence aloft, and the offshore flow tends to be colder and more unstable with a chance of convective cloudiness and showers. The orientation of the ridge and trough usually result in an upper-level northeasterly flow over Southern California.

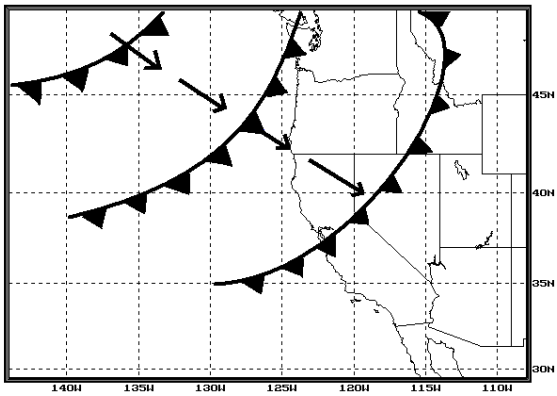
There appears to be a direct correlation between the depth of the northeasterly flow and the duration of the Santa Ana. For a

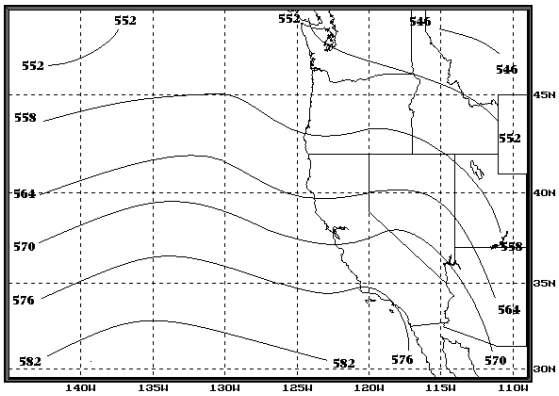
typical synoptic pattern at the surface and 500MB level which is conducive to Santa Ana conditions (see figures 2.16 and 2.17).

COLD FRONT APPROACHING FROM THE WEST
FIGURE 2.16

TYPICAL 500 MB FLOW FOR COLD FRONT APPROACHING FROM THE NORTH
FIGURE 2.17

e. "Active" Fronts. An active cold front can be thought of as the leading edge of an unmodified surge of polar air. Accompanied by a relatively strong upper-level cold trough, this type of front produces precipitation as it moves through Southern California. This severe frontal weather is infrequent in the Camp Pendleton area, but does occur. The more active winter fronts may contain gusty wind in excess of 25 knots in heavy showers and thunderstorms. Thunderstorms accompanied by soft hail and/or snow pellets have been observed in the more severe fronts. With the approach of an



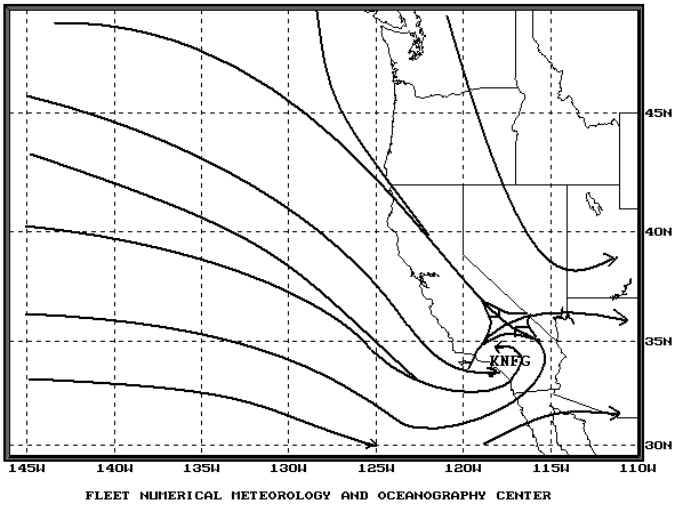


active front from the west or northwest, middle and high clouds associated with the trough aloft will move into the local area, thicken, and lower with low scattered stratocumulus clouds forming over the water off the Southern California coast. Indicating large-scale vertical motion within the frontal zone and rainshowers at Camp Pendleton are forthcoming. Frequently, a secondary trough or convergence line will follow the actual passage by twelve to twenty four hours, such that the forecaster should not forecast clearing behind the front until the post frontal trough passes. The air mass between the frontal passage and the postfrontal trough is usually conditionally unstable, producing scattered thunderstorms. The wind ahead of a well-defined front will normally become south to southeasterly 8 to 16 hours preceding frontal passage, veering west to northwest immediately following frontal passage. If the front is followed by a post frontal trough as mentioned above, the wind will remain westerly, or southwesterly behind the front until passage of the post frontal trough. The winds vary in velocity and gustiness, depending upon the intensity of the front. The strongest wind

normally occurs within four hours of frontal passage. Satellite pictures are an excellent aid in determining frontal location and characteristics. Forecasters should take into account the general weakening of the front as it moves into the Southern California area and also the slowing of frontal speed as mentioned earlier in this section.

f. "Inactive" Fronts. The majority of fronts, which pass through San Diego, are inactive. At time of passage there is no precipitation and little cloudiness associated. During the cooler months, inactive fronts are frequently marked by variable high cirrus and scattered to broken middle clouds. In the summer, the middle and high clouds may be absent from inactive fronts, and the fronts serve only to temporarily raise the height of the inversion and associated stratus, occasionally dissipating the stratus in the process. The inactive front is usually associated with a weak, low amplitude trough aloft. When the inactive front is fast moving, the wind will be moderate ahead of the front, and usually has strong west to northwesterly wind immediately behind the front. The slow moving inactive front, has little effect on the seasonal wind pattern. Many of the winter time inactive fronts are initially active and wet, but they dry out because of subsidence caused by the northern extension of the Subtropical Ridge before reaching Southern California.

7. **Catalina Eddy.** Catalina Eddy is the name given to a series of small cyclonic circulations which occur within an area enclosed by a line connecting San Diego and San Nicholas Island, Point Conception, and Ontario, with the center frequently located near Santa Catalina Island. Although the Eddy is a sub-synoptic feature, the orographic effects of the coastal mountains of Southern California of the southwesterly flow preceding an upper-level trough plays a major role in the formation. The Eddy is a sub-synoptic feature. It is difficult to detect on a conventional surface analysis due to the sparsity of offshore observations and the fact that the few available island wind and pressures are often unrepresentative (see Pseudo-Catalina Eddy, paragraph 8). A good streamline analysis of the gradient level wind in the Southern California operating area, with the use of available ship reports, provide an excellent tool for determining the existence of a Catalina Eddy (see figure 2.18).

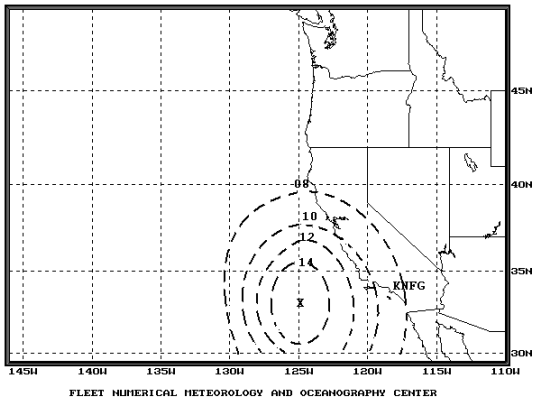


CATALINA EDDY
FIGURE 2.18

The occurrence of southerly surface wind at San Diego with a speed of 5 to 10 knots that persist for 3 hours or more is also an excellent indicator of formation. A Catalina Eddy can be detected in its initial stages on satellite pictures, which show the cyclonic turning of the stratus band immediately off-shore of Southern California (see figure 2.18). The Eddies vary considerably in size, intensity, and duration, making their effects on stratus predictable only in general terms. The most significant effect of the Catalina Eddy appears to be deepening of the coastal marine layer with a corresponding rise in the base of the inversion and in the height, thickness, inland extent, and duration of the stratus. The cloud ceilings in San Diego and Camp Pendleton area will rise as much as 1000 to 1500 feet. The stratus ceiling normally persists throughout the life of the Eddy rather than "burning-off" near mid-day. After a protracted period (5 to 6 days), the Eddy may lift the inversion to the extent that the marine layer lacks sufficient moisture to produce clouds and the skies at Camp Pendleton will become mostly clear. This situation does not necessarily mean that the Eddy has dissipated. If enough moisture can be advected into the marine layer, the stratus will reform. Occasionally, the offshore flow around the northern portion of the Eddy will result in extended periods of fog, north of Long Beach. The Catalina Eddy is frequently responsible for rapid advection of stratus to previously clear regions and for markedly improved ceilings and visibility's over coastal regions while the higher inland terrain experiences low ceilings and poor visibility. Smog may be advected from the Los Angeles Basin out to sea as it becomes vertically mixed through the deepening marine layer. During the stratus season, a strengthened northwesterly surface flow at Point Conception and the approach of an eastward moving upper low or trough may be considered the most likely forerunners. In a study by Arthur Eichelberger, it was shown that a surface gradient of 5 to 10 MB between 35^0N 125^0W and Los Angeles, along with positive vorticity advection resulting in vorticity values of 7 to 10 units at Los Angeles, will generate Catalina Eddies. From May through October, the normal sea level pressure gradient

between 35^{0}N and Los Angeles falls within this 5 to 10 MB range. The northerly surface wind along the Southern California coast during the stratus season are nearly always strong enough to result in Catalina Eddies provided the necessary positive vorticity advection is also present (see figures 2.19 and 2.20).

500 MB TROUGH REATURES UPPER



SURFACE FEATURES FOR CATALINA TROUGH APPROACHING FROM WEST EDDY FORMATION

FIGURE 2.19

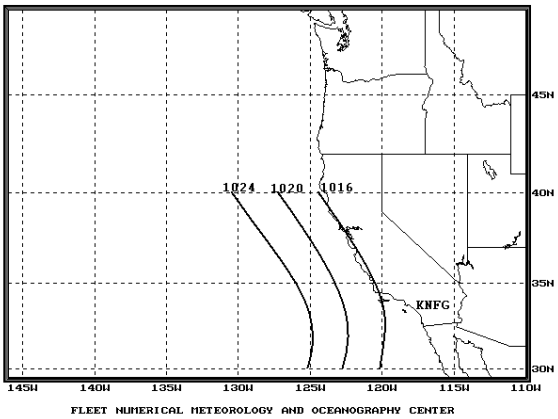
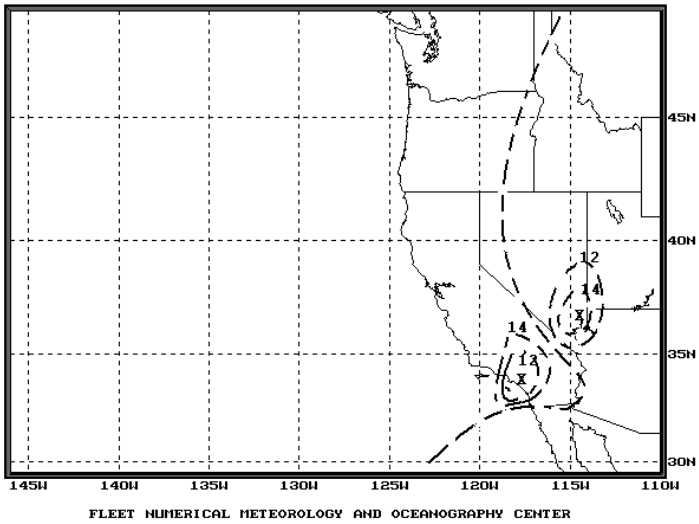


FIGURE 2.20

Eichelberger further states: "Stronger Eddy situations are those in which a decelerating frontal trough moves into Southwestern United States, accompanied by vorticity maxima of 14 units or more in Southern Nevada and 12 units at Los Angeles. Under these conditions and given the necessary strong northern wind along the coast, explosive deepening of the marine layer can be anticipated (see figure 2.21); however, if the vorticity reaches 13 units or more at Los Angeles and higher values prevail inland the Eddy will be swept away in a strong general onshore flow if a series of short-wave troughs with halfwave lengths of 600 miles or less are passing through the area. The Eddy, if formed, will be poorly organized and short lived and there will be insufficient time for any significant changes in Southern California coastal weather.



FEATURES OF A STRONGER EDDY SITUATION
FIGURE 2.21

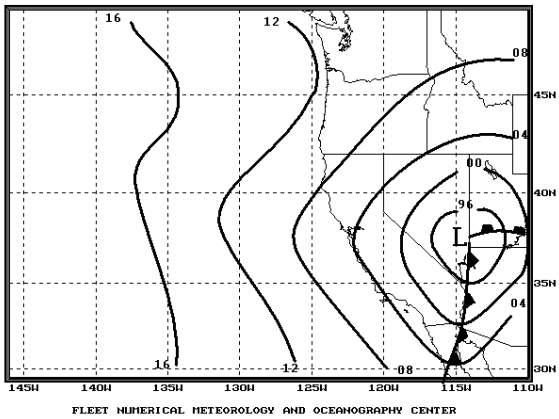
Normally an Eddy will persist until either frontal passage occurs, a vorticity maximum passes, the marine layer deepens to 5000 feet and spills over the coastal mountain range, or vorticity values over coastal waters increase to 13 units or more and a general onshore flow ensues."

8. **Pseudo-Catalina Eddy**. A microanalysis of the local pressure and wind fields will nearly always indicate a small surface low or trough in the vicinity of Santa Catalina Island during the stratus season. If the wind is light and the base of the inversion is below the altitude of the island weather situation, an analysis of a weak Catalina Eddy should be viewed with caution. Normally, reported sea level pressure from island stations located above or within a temperature inversion will be erroneously low.

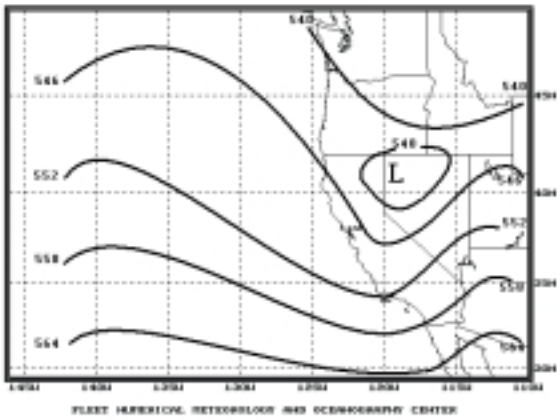
9. **Nevada Low**. "Nevada Low" is the local name given to the surface reflection over Southern Nevada of a closed low or deep trough aloft over inland California. This low system has been given the name "Tonopah Low", since the weather station at Tonopah, Nevada (THP), appears to be very sensitive to the formation of the low. The Nevada Low is typically a "cold" low, which develops during the late winter and early spring months, producing a strong onshore pressure gradient and resulting in strong, gusty, west or west-northwest wind over Southern California, especially in the desert area (see figure 2.22). The conditions for the formation of a Nevada Low are similar to

conditions for the establishments of both a cut-off low and Santa Ana (see figure 2.23).

NEVADA LOW
FIGURE 2.22



NEVADA LOW 500 MB PATTERN
FIGURE 2.23



Camp Pendleton may or may not experience frontal passage prior to Nevada Low formation; however,a well defined frontal zone is usually observed inland over the desert region once the Nevada Low is well established. Although copious amounts of precipitation and cloudiness are normally experienced at Camp Pendleton in conjunction with a Nevada Low, occasionally a trough associated with the Nevada Low will pass over the local area, producing cumuliform build-ups and thunderstorms. The primary forecasting problem with the Nevada Low is the intense wind associated with the system. Generally, if the low is well south (into Southern California), the strongest wind will be south of a line from Los Angeles to Las Vegas. If the low is in a more normal position (extreme Southern Nevada); the wind will be strongest from Santa Monica to Miramar. The best forecasting tool to determine the wind speed and area is a constant check of the gradient level wind and the surface pressure gradient. The Nevada Low will normally develop:

(1) As a wave on an east-west oriented front.

(2) As a secondary Low in an unstable airmass following the passage of a frontal low.

(3) Beneath a cut-off Low, or at the base of a long wave trough which has a jet maximum over the area.

10. **Cut-off Low**. A long wave trough, which is often slow-moving or nearly stationary, will sometimes become situated off the coast. A series of short-wave troughs traverse the area, new surges of cold air enter upwind of the long-wave trough and the trough undergoes deepening. When cold advection is very

pronounced in the rear of the trough, an isolated pool of cold air (closed Low) aloft may form. As this closed, cold Low, originally within the westerlies, becomes displaced equatorward, out of the westerly current; it becomes "cut-off”. Once the height contours and the isotherms become closed and nearly in phase, vorticity is no longer advected out of the low which becomes essentially stationary. Cut-off lows are usually associated with a blocking situation at upper-levels, such that a sharp ridge, located west of the long-wave trough (or cut-off low) positions oriented southwest to northeast at 500 millibars. Cut-off lows tend to occur just offshore of the California coast as cold air plunges down the eastern side of a large amplitude ridge in the Gulf of Alaska (see figure 2.24).

A strong ridge located in the Gulf of Alaska, which has shown a pronounced tendency of moving eastward onto the coast to produce a Santa Ana, suddenly stops and builds. As the ridge in the Gulf region intensifies, the anticyclonic curvature around the crest of the ridge becomes so great that the strong wind associated with the jet stream "overshoot" the top of the ridge and "cut-off" the trough forming a closed low aloft over the area. The formation of this cold cut-off low is the presence of a strong (1040mb or higher) stationary surface high at higher latitudes of the Gulf of Alaska. A well defined surface low center, which is a reflection of an upper level cut-off low seldom forms over the ocean areas. When sufficient moisture is advected into the coastal areas from the southwest around a cut-off low, Southern California will experience some of its heaviest most prolonged rains. The longer the low remains over the water, the greater the quantity of precipitable water vapor. Also, the colder the air aloft, the more unstable the atmosphere becomes; thus, enhancing the production of cumulonimbus build-ups. The cut-off lows follow the general schedule of 24 to 48 hours for formation, 24 hours to a week in the operating areas, then 72 hours to 2 weeks for dissipation. Once the forecaster has determined that conditions are favorable for the formation of a cut-off, they must determine if the low will occur over water or over land. If it forms over water, the forecaster must determine at what point sufficient moisture will be advected into the low to cause heavy rain showers. If the low develops directly south of San Diego, a situation resembling the Sonora may develop.

If a Santa Ana develops from the ridging associated with a cut-off low, there is a good chance that the extremely dry low-level wind over Southern California will cause the falling rain to evaporate prior to reaching the surface (see figure 2.25).

If a cut-off low occurs over Southern California, Nevada, and Eastern Arizona regions, it is called a Nevada Low. Assuming that all criteria for a cut-off low are met, sufficient moisture aloft is available, and no Santa Ana occurs, the forecaster may safely forecast overcast low clouds with multiple layers above, and precipitation with intensities varying to heavy for as long as 48 hours.

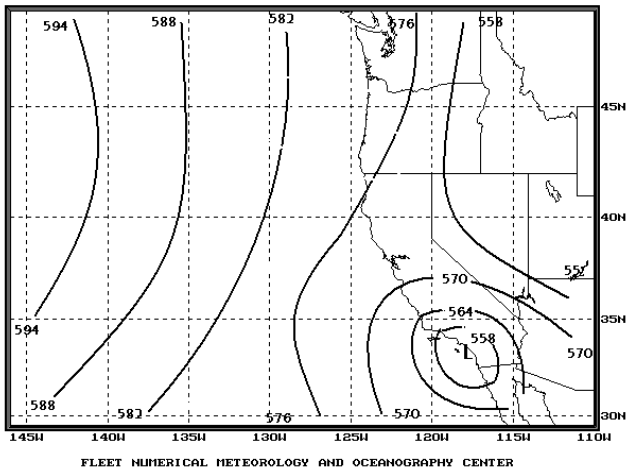
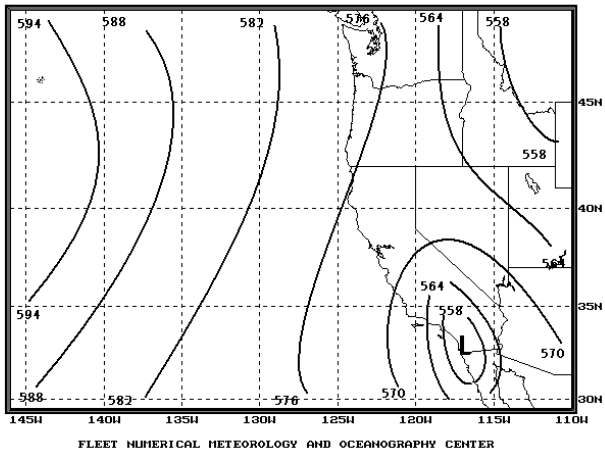


FIGURE 2.24



CUT-OFF LOW
CUT-OFF LOW SOUTH OF SAN DIEGO
FIGURE 2.25

11. **Thunderstorms.** Thunderstorms in the Camp Pendleton vicinity are rather infrequent (7 thunderstorm days per year). The thunderstorm activity, which occurs in Southern California, is usually confined to the inland areas. In the vicinity of mountainous terrain, due to the convective instability of orographic lifting, the solar heat of the terrain elevation, and to a higher air temperature compared to free air, at the same height. The occurrence of thunderstorm activity can generally be placed into two basic periods: Summer and Winter.

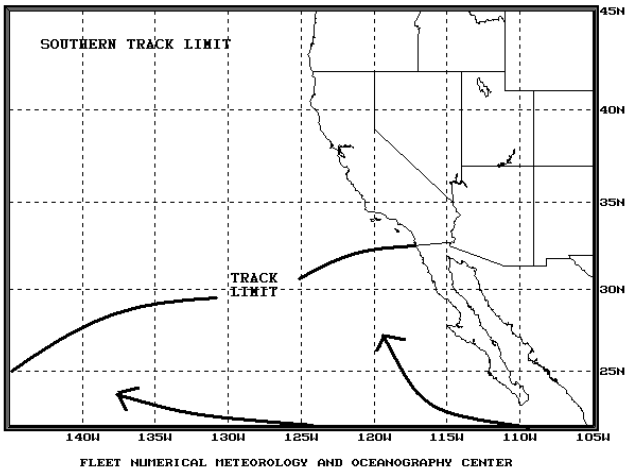
a. Summer. During the summer and early fall, the Southwestern United States is the source region for Continental Tropical air (CT). The (CT) air mass being capped by Maritime Tropical (MT) air. Ordinarily, this combination is occasionally disturbed by a flow of moist air into the area. Thunderstorms appear to have a diurnal preference for the period from late afternoon until midnight, although on occasion, appeared during daylight hours prior to noon.

b. Winter. Thunderstorms during the winter are uncommon but can occur over the Camp Pendleton area. They occur to the rear of a rapidly moving cold front, often in coincidence with a

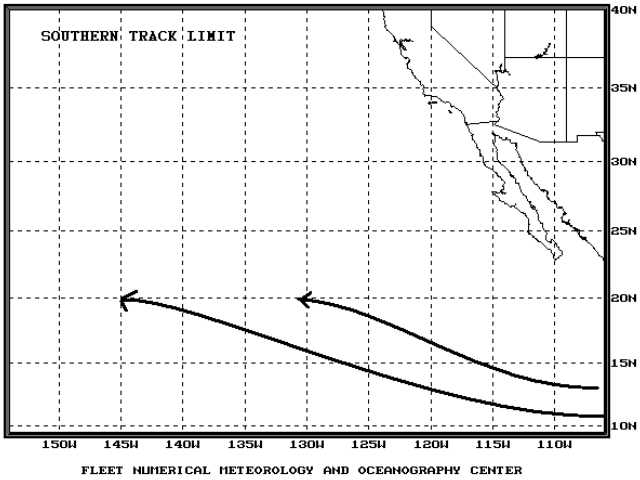
cold low aloft. The vertical air structure is cold, moist, and conditionally stable with a low freezing level. On occasion, localities in Southern California have recorded funnel clouds or tornadoes of very short duration.

c. Sonora. Sonora is a local name given to the thunderstorm condition created by an easterly flow of moist air across the Sonora Desert in Southeastern California. The easterly flow normally occurs when the high-pressure cell aloft persists over the central United States. In this situation, extreme temperatures and high humidities in the mountain and desert regions become common place. High level thunderstorms with bases 5000' to 10000', appear on the eastern slopes of mountains as moisture is advected from the Gulf of Mexico, across the southern states and into California. When the upper level flow has sufficient east to west energy, thunderstorms will move towards the coastal areas during the late afternoon. Another, but less frequent occurrence generates as an upper level upper level easterly flow and the presence of a low center over Baja California, advecting moist air over the Gulf of California. During a Sonora, low-level flying conditions become extremely hazardous, usually to the extent that adverse weather warnings are issued. High level flights are possible with circumnavigation of the individual thunderstorm areas.

12. **Tropical Storms**. Tropical storm development in the Eastern Pacific is most frequent during the summer and early fall, with the majority forming off the west coast of Mexico between 10^0N and 20^0N and moving west or northwest. Tropical storms or their remnants occasionally move north toward the Southern California coast. They tend to dissipate before crossing 30^0N due to strong vertical wind shear and cold surface water temperature (see figures 2.26 - 2.28). The moist tropical air from these storms is advected into higher latitudes at upper levels resulting in the appearance of middle and high clouds, with possible showers and thunderstorms in the Camp Pendleton area. When a tropical storm recourses to the northwest and crosses the Mexican mainland coast, or Baja California, it frequently results in impulses of tropical moisture into the local area. During tropical storm activity southwest of Camp Pendleton, the forecaster should always be alert for possible hazardous surf conditions resulting from southerly swells generated in the storm area.



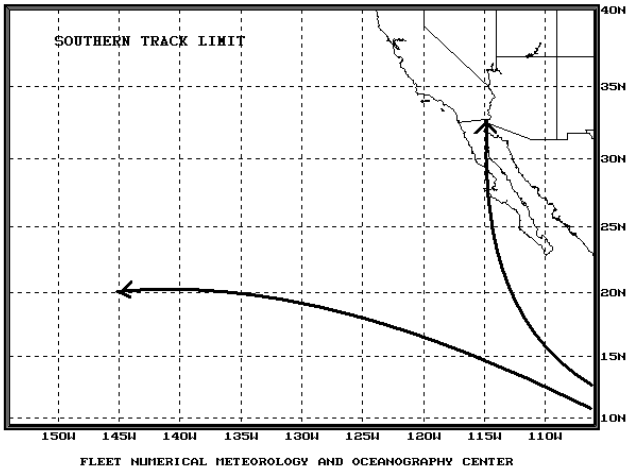
AVG TROPICAL CYCLONE TRACKS
AVG TROPICAL CYCLONE TRACKS
FOR MAY-JUL
FIGURE 2.26



FOR THE MONTH OF AUG
FIGURE 2.27

CYCLONE

SEP-OCT



AVG TROPICAL TRACKS
FOR MONTHS OF

FIGURE 2.28

CHAPTER 3

FORECASTING

1. **Introduction**. Weather at MCAS Camp Pendleton is mainly modified by the northeast-southwest orientation of the Margarita River valley and surrounding hills. The Pacific Ocean to the west tends to moderate temperatures in the lower layers of the atmosphere. Southwesterly flow, due to the sea breeze, advects low level moisture and lower temperatures over the Air Station. Another significant factor is the mountains and passes to the east which set up a northeasterly land or drainage wind at night or during periods of easterly flow. The hills to the northwest and southeast protect the Air Station from the affects of strong wind associated with frontal passage. The land/sea relationship between the cold water of the California Current and the temperatures of the desert southwest region is conducive to the formation of stratus and fog along the Southern California coast.

2. **Forecasting Considerations.** To arrive at the most accurate forecast, forecasters must take into consideration all techniques and rules that apply to a given synoptic situation. It is imperative to pilots and to supported organizations that the forecaster apply their experience and knowledge to produce a reliable and sound forecast.

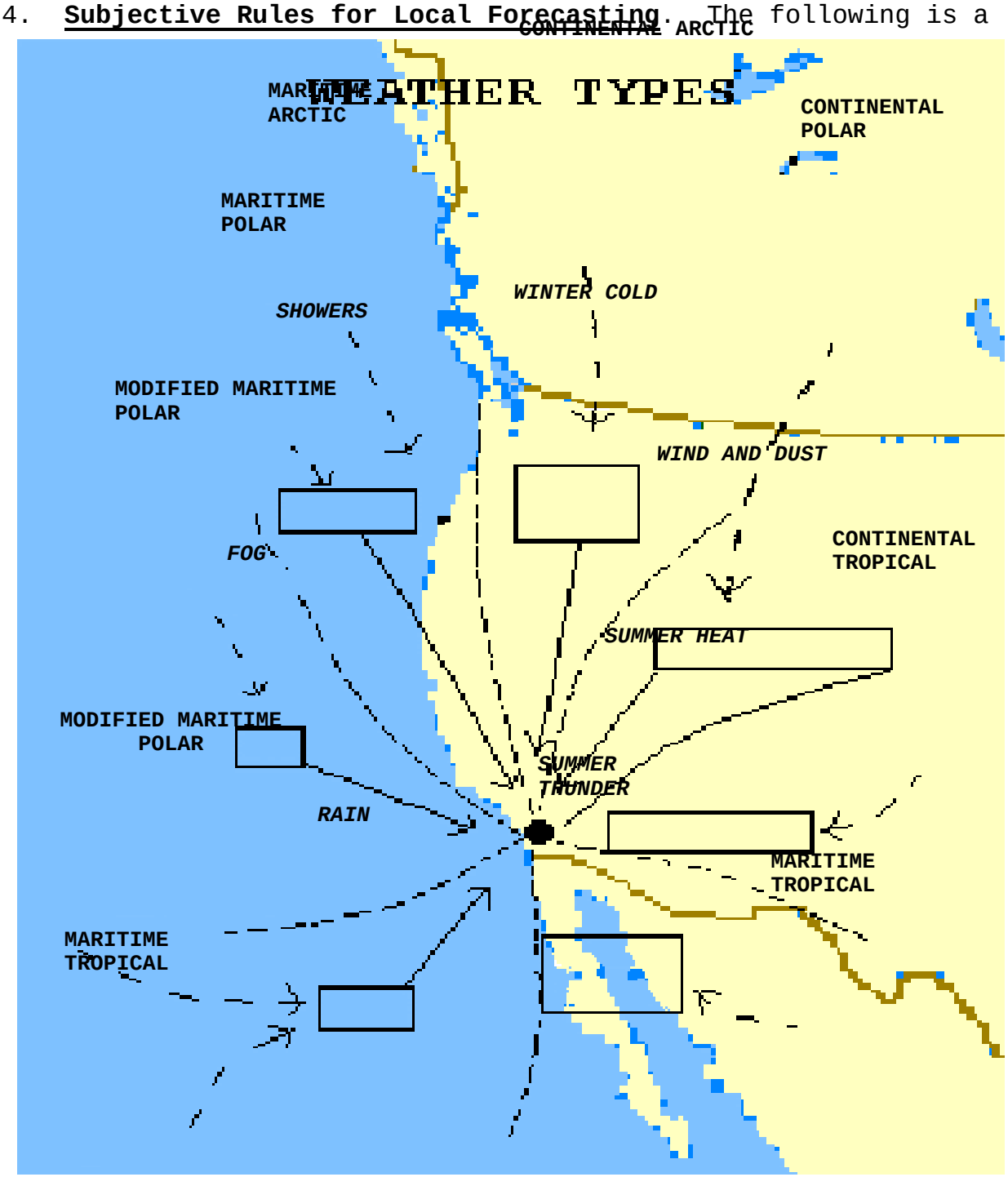
3. **Weather Types**. Climate has often been defined as average weather. This definition is unsatisfactory because it needlessly eliminates the irregular and short-term weather events that are concealed in averages. The cyclical influences of the day and the year would lead us to expect, for example, that it will be cool out-of-doors on a Southern California winter evening, but only by actually taking a look outside on a January evening will we determine whether it is clear or cloudy, calm or windy, wet or dry. Indeed, the fluctuations of daily weather are so important that they seem to transpose the seasons, making some winter days just like days of summer.

Figure 3.1 shows certain types of weather in SOCAL, with the regions in which air masses have formed and their paths of movement toward southern California. As the wind varies in direction, weather is imported from far-off places, thus bringing to SOCAL a far greater variety of weather types than would be expected from purely local circumstances. The sensitivity of weather conditions to strength and direction of wind is a matter of greatest importance in weather forecasting. Wind itslef is a variable element of climate, which means it can’t serve as a

ready-made key to all the details of local climate, but it is helpful, nevertheless, to know in a general way what is to be expected from the circumstances of air flow. Certainly in figure 3.1 it is clear that fog (also stratus, the low sheet-cloud often called “high fog” in Los Angeles) and rain are associated with circulations from the sea, and that the extremes of winter cold, summer heat (which includes some thunderstorm activity), and dust are related to movements of air from the land.

FIGURE 3.1

4. **Subjective Rules for Local Forecasting**. The following is a



list of thumb rules and empirically derived forecast aids which have been developed by various activities in the local area. There will be exceptions to all of these rules. They all have merit and provide valuable guidelines for the forecaster to use.

a. Stratus/Fog

(1) Stratus or Fog will form if the Pacific High and thermal trough combine to form a flow that will parallel the coast between Point Conception and Camp Pendleton. This results in an onshore flow of moist marine air.

(2) If heavy smog and haze are present during the day, stratus is likely the following morning.

(3) The higher the inversion, the higher base and thicker the stratus. The base of the inversion is a good approximation for the top of the layer.

(4) As the season progresses from mid spring (April) to the peak of the stratus season (June-July), mornings at Camp Pendleton see cloudy conditions and afternoons become clearer.

(5) If the onset of stratus occur prior to sunset, the stratus will persist longer than usual the following morning.

(6) Approximately 200 feet of clouds will be formed by one hour of sunrise. When the sunshine "s" and cloud thickness in feet Ice is known, the time of stratus dissipation "t" can be determined using the following formula: "c" cloud thickness/200 + "s" sunrise = stratus dissipation.

Example: 800'/200 + 0530L = 4 hours from sunrise or 0930L

(7) Stratus dissipation will occur later than indicated if there is:

(a) An upward trend of the inversion due to weaker pressure aloft.

(b) A lifting of the inversion due to horizontal convergence beneath the inversion (Catalina Eddy).

(c) Existence of high clouds or heavy moisture aloft inhibiting solar radiation.

(d) A pronounced backing of the wind with height at San Diego, indicating height falls at the 700 and 500 millibar levels, and results in a lifting of the base of the inversion at Camp Pendleton.

(8) A low stratus layer tends to dissipate more rapidly than a higher layer with the same vertical thickness.

(9) Decreasing pressure at the surface tends to lower the convective condensation level (CCL). (Note: The CCL must be below the inversion for stratus to form.)

(10) The later stratus forms in the evening, the earlier it will dissipate in the morning.

(11) The higher the interior temperature of Southern California, the lower the height of the inversion base on the coast; consequently, the lower the cloud ceilings heights.

(12) Radiation fog in the Punch Bowl, occurs during the winter months and during night and early morning hours in the summer. This is the primary cause of IFR conditions at the Air Station. The San Luis Rey river valley is a breeding ground for fog. During the daytime; dust, salt, and moisture are brought into the valley by the onshore flow. These particles stagnate and as rapid cooling occurs after sunset, visibility restrictions to less than 1/8 of a mile frequently occur.

b. Fronts and Precipitation

(1) Showers usually persist after the arrival of polar air. As air moves inland, the westerly wind component provides the mechanism for orographic lifting, creating showers in the vicinity of Camp Pendleton. This situation will persist until the wind profile backs to a southwesterly component indicating a return to a maritime influence.

(2) Drizzle from stratus may fall along the coast and adjacent valleys (Temecula Valley) and eastern mountain ranges during the summer. This is an indication that the layer is between 1500' to 2000' thick. The layer will extend further inland to the north and east of Camp Pendleton. This type of precipitation usually decreases the visibility from 1 to 3 miles at the Air Station and persists for extended periods.

(3) Rain/Rainshowers and isolated thunderstorms are usually associated with pre-frontal type passage. Precipitation after frontal passage in the form of rain/rainshowers can be attributed to passage of upper level troughs moving through the Southern California area. When a cold front moves through portions of Southern California, the front may become stationary south of Camp Pendleton in the vicinity of San Diego causing extensive periods of precipitation.

(4) Any type of precipitation, other than drizzle, is generally considered a winter time phenomena. During a rare occasion, thunderstorm activity may be caused by Sonora or subtropical moisture.

(5) If after the passage of a cold front the barometer remains steady or continues to fall, look for passage of a secondary front of a similar type, usually of greater intensity.

(6) When there is a southerly extension of a cold core high from the western United States deep into Mexico, a trough will develop off the coast to the southwest.

(7) Pressure falls between 0530 and 1000, demands a careful review of the latest reports. Often this indicates cyclogenesis over the Great Basin or surrounding regions and precipitation occurs within the next 16 to 24 hours.

(8) Rain, in any amount, normally should not be forecasted from a disturbance to the north if the barometer is higher between San Diego and Camp Pendleton. In other words, the precipitation will extend southwest only to the area of the highest pressure.

(9) The greater number of surface fronts occur in the fall months. The pressure distribution most likely to produce the surface fronts is a trough between weak highs over the Great Basin and the Pacific Ocean, west of California.

(10) If cumulus development is observed over the ocean after sunrise, showers usually develop along the coastal mountains in the afternoon.

(11) Significant rainfall in Southern California will occur when the wind at the 700MB level is southerly to south-easterly with speed in excess of 15 knots.

(12) Rainfall amounts increase sharply at the higher elevations inland.

c. Thunderstorms

(1) Summer. Areas for thunderstorm occurrence during the summer are confined to the mountain ranges of Central and Southern California and Arizona.

The synoptic situation which generates the conditions for probable thunderstorm activity over these areas is usually

depicted on the 700MB chart. Advection of moisture from either the Gulf of Mexico, Gulf of California, or the southeastern Pacific Ocean will produce conditions to create thunderstorms. Other conditions needed are normal summertime surface heating, Skew-T derived Showalter stability index of zero or less combined with relative humidity of 70 percent or greater at the 700MB level. During the summer and fall, several days of south to east wind aloft will almost always be followed by thunderstorms in the mountains. "Sonora" type thunderstorms occurring during late summer are generally restricted to the mountainous terrain in the eastern and northern portions of the base.

(2) Winter. Local thunderstorm occurrence during this season is rare, but does occur over higher terrain aboard Camp Pendleton. Thunderstorms are usually associated with a cold low aloft and found to the rear of a rapidly progressing cold front. This promotes a moist cold vertical air situation. Short lived tornadoes have been reported to the north in the San Fernando Valley with funnel clouds at Camp Pendleton.

The second type of wintertime thunderstorm that occurs in this area is associated with the "Catalina Eddy". The air within a well developed Catalina Eddy is very unstable and the thunderstorm activity is spawned within. Numerous waterspouts have been sighted in connection with the Eddy. The shower and thunderstorm activity associated with this system usually will be spotted by the weather radar. When the freezing level is near 1,500 to 2,000 feet, 1/4" hail is not uncommon in conjunction with these thunderstorms, even when the tops are less than 20,000 feet.

(3) A low at the 200MB level moving onto the coast, which dissipates at the surface as it moves inland, and continuing aloft over the station, is conducive for thunderstorms the first day after the surface low dissipates, and showers the second day.

(4) Thunderstorms can occur when convective cloud tops reach -28 degrees centigrade (14,000 -20,000 feet), hail should be forecasted. The freezing level should be between 1500 to 4000 feet.

(5) A LFC on the Santa Rosa Island (72291) sounding after cold frontal passage, below 900 feet indicates thunderstorm activity over coastal hills. A LFC between 900 feet and 1500 feet indicates thunderstorms developing over Case Springs and Fallbrook (Naval Weapons Station).

d. Santa Ana Wind. The following thumb rules were developed by various stations in the Southern California area for

forecasting Santa Ana wind conditions that effect MCB Camp Pendleton and the local flying area. Forecast for Santa Ana conditions to develop when the following criteria is met:

(1) A surface high pressure building over or moving into the Great Basin. The surface pressure in northern Nevada is 1035MB or more and is 14MB or greater than that of Camp Pendleton's.

(2) When a cold trough aloft is located to the east of Camp Pendleton and a ridge building onto the coast, with strong northerly or easterly wind aloft.

(3) The maximum Santa Ana wind gust averages 1.6 times the maximum sustained speed at MCAS Camp Pendleton.

(4) Santa Ana conditions usually last 24 to 30 hours, with the longer periods occurring in November through January.

(5) Santa Anas result in maximum temperatures of approximately 10 degrees Fahrenheit above normal in mid winter, and about 15 degrees Fahrenheit above normal during the early fall. Maximum temperatures may reach 90 degrees Fahrenheit or more during the fall months.

(6) Santa Anas result in humidities of less than 20 percent.

(7) Santa Anas at Camp Pendleton usually develop following the passage of a front or trough.

(8) Low Level Wind Shear (LLWS) will occur in the valleys and surrounding mountains (higher elevations) during Santa Ana conditions.

(9) Santa Ana wind normally cease and a seabreeze will start within one hour after temperature at WMC reaches 50 degrees Fahrenheit.

(10) During normal Santa Ana/easterly flow, use the 850MB temperature dry adiabatically to forecast the maximum surface temperature.

(11) If a light easterly flow of 5 - 20 knots exists from the surface to 850MB, use the temperature at 11,000' (height of San Bernardino mountains) dry adiabatically to the surface to forecast the maximum surface temperature. The sea breeze will re-establish from 1 to 4 hours after normal times dependent on the strength of wind. The stronger the wind the later the sea

breeze. Higher wind generally means stronger Santa Ana conditions and possibly no sea breeze.

(12) The most frequent time for Santa Ana termination is an hour before to an hour after 1200L.

(13) Consider the following rules.

(a) Generally at night Camp Pendleton receives its strongest wind of between 30 to 40 knots when the wind direction is from 360°.

(b) When the wind comes from 030 - 060 Camp Pendleton receives wind up to 25-30 knots at night. Generally the wind will be offset by the seabreeze in the afternoon.

(c) Unless a strong Santa Ana sets up, most wind at Camp Pendleton will stay below 12 knots from 030° - 060° at night and early mornings. Very few Santa Ana's will continue long enough to negate a sea breeze from developing. If the Santa Ana Condition is strong, a sea breeze will not develop.

(d) Wind from 360° are short lived (3 - 6 hours) as a strong Santa Ana is setting up. During a strong Santa Ana, when the wind direction is from 030° - 060° during the day it is rare for Camp Pendleton to exceed 30 knots.

(e) Visibility can be reduced by blowing sand or dust from the deserts after a Santa Ana condition persists from 4 to 5 days.

5. **Thumb Rules**. The following are general rules of thumb for use in forecasting weather conditions specific to Camp Pendletons local area.

a. Cyclogenisis normally occurs off the coast of Baja California only when there is a southerly extension of a Plateau High, or Great Basin High, well into Mexico.

b. There is a tendency to advance tropical storms, which develop off the West Coast of Mexico, too rapidly in areas of sparse data. The average rate of movement of tropical storms is about 12 to 15 knots. However, after the storm becomes extratropical, the unstable air aloft moves with the steering current and the storm may travel 30 to 35 knots.

c. Storms often appear on the coast of California a few days after slow moving cold waves enter Montana or the Dakotas.

d. Light southwesterly flow at the 700MB level with a thermal trough on the surface over Eastern California and Western Arizona will cause clear skies at Camp Pendleton and coastal fog at North Island and along the coast through Oceanside.

e. When tops of the cumulus clouds lean toward the south, their vertical formation will be arrested. When the tops lean toward the north, development into cumulonimbus can be expected.

f. If the surface temperature at 1730 local is abnormally high, the next day will also be warm.

g. If a deep current of air is moving southward in a straight or anticyclonic path and undergoing divergence, clear skies will prevail.

h. Strong wind will diminish when the direction shifts from the southwest to the northwest.

i. A sea breeze occurs almost every day of the year if no other major synoptic feature is dominating the local area.

j. Heavy smog conditions which occur in the Los Angeles Basin, and occasionally in San Diego, are not common in the Camp Pendleton area.

k. During the initial sea breeze, 1000L to 1400L, the outside air temperature will decrease 3 to 5 degrees Fahrenheit. The outside air temperature will start to rise 1 to 3 degrees Fahrenheit, after initial cooling of the air mass.

6. **Routine Forecasts**. On a daily basis, forecasts are issued to specific customers aboard MCAS and MCB Camp Pendleton. These following are daily products issued by this office:

a. Daily Forecast. Prepared year round and sent via the Local Area Network (LAN) by 0800L daily. This product is prepared and disseminated in the WEAX format contained in NAVOCEANCOMINST 3140.8

b. DD-175-1 Flight Weather Briefing. Performed in accordance with NAVOCEANCOMINST 3140.14_. Briefings are conducted by the duty forecaster in person, and are available to tenant aircrews via phone when a completed flight plan is received.

c. Horizontal Weather Depiction (HWD's). These products are prepared when requested by tenant aircrews and submitted as part of a flight weather packet for a specified route of flight.

The duty forecaster will follow guidelines set forth in accordance with the same directive as listed above.

d. Terminal Aerodrome Forecast (TAF). This forecast is prepared and disseminated longline every 6 hours at 03, 09, 15, and 21 ZULU. The proper format and procedures are contained in NAVOCEANCOM INST 3143.1_.

7. **Warnings/Advisories and Conditions of Readiness.** MCAS Camp Pendleton weather section issues significant weather warnings for the immediate local/flying area. These areas are defined in the Destructive Weather Readiness Bill (MCBO P3440.1_ & StaO 3145.1). The following definitions are provided:

a. Local Flying Area. (Area of Responsibility). See Figure 3.2.

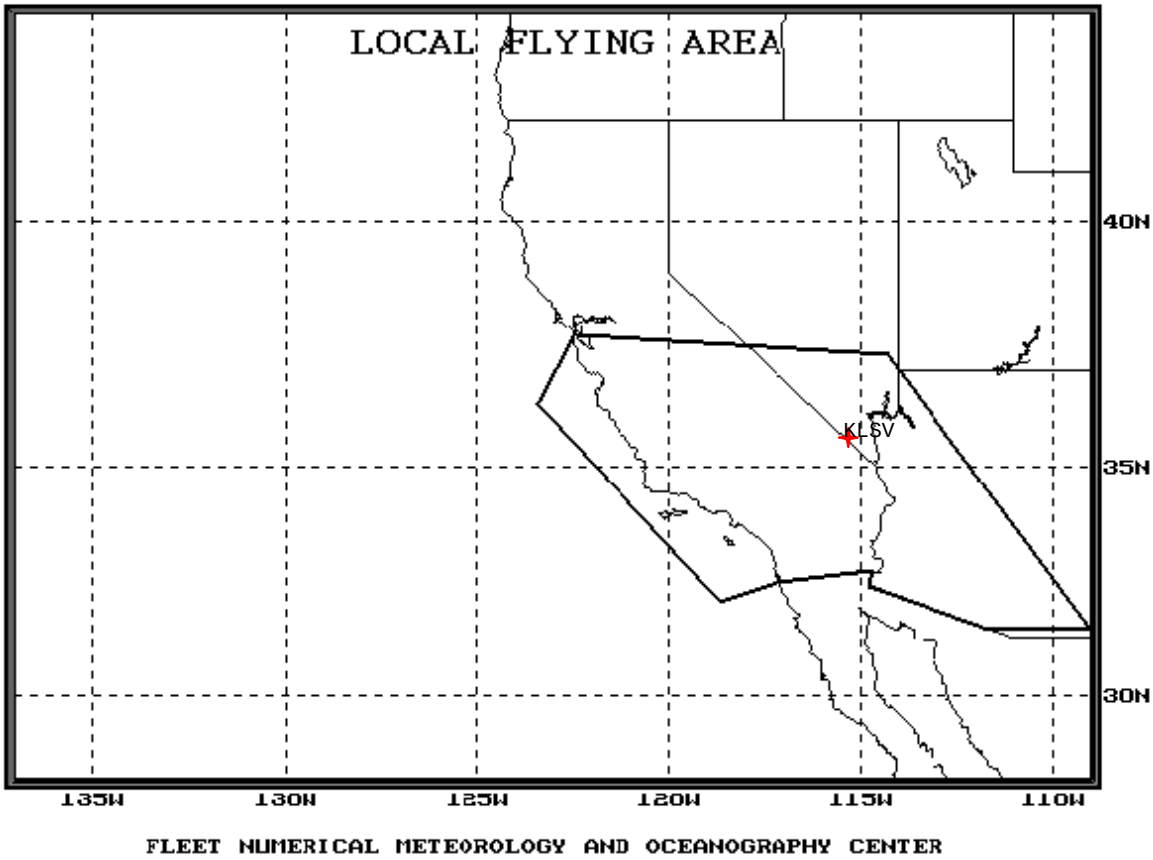


FIG 3.2

b. Local Area. Is defined as the geographical area within 25 nautical miles of MCAS Camp Pendleton

c. Local Advisory. Advisories are issued by the MCAS Camp Pendleton weather office for destructive weather occurring or forecast to occur at general location(s) within the local flying area during a specified time.

d. Watches/Warning. Weather watches/warnings are more specific and require action of a greater urgency than weather advisories and are issued by the MCAS Camp Pendleton weather office for the local area only.

e. Types of Weather Warnings/Watches and Advisories

(1) Thunderstorm Condition 1. Thunderstorms are occurring or imminent within 10 nautical miles of the Air Station during the specified time.

(2) Thunderstorm Condition 2. Thunderstorms are occurring or imminent within the local area during the specified time.

(3) Thunderstorm Advisory. Thunderstorms are forecast to occur at general locations within the local flying area during the specified time.

f. Wind

(1) Wind Warning. Sustained wind of 20 - 33 knots and/or frequent gust in excess of 30 knots are occurring or are forecast to occur in the local area during the time specified. Under these conditions, higher or lower sustained wind and gust are possible due to terrain effects as wind is funneled in and around obstructions.

(2) Wind Advisory. Hazardous wind as specified under wind warning are forecast to occur at general locations within the local flying area during the specified time.

g. Flood Watches/Warnings

(1) Flash Flood Watch. This watch is issued when heavy or significant amounts of rainfall may indicate a potential for flash floods to occur.

(2) Flash Flood Warning. Flooding is imminent or forecasted to occur in low lying areas, to include MCAS Camp Pendleton.

h. Flood Conditions of Readiness

(1) Flood Alert Condition III. This condition will be issued when rainfall is observed or reported in Riverside or San Diego counties of 1 to 2 inches on wet or saturated ground, 4 inches plus on dry ground, or local/National Weather Service forecasts predicting thunderstorms and possible flash flood conditions. When extended periods of precipitation are forecast to occur, the duty forecaster will remain in frequent contact with the Fire Department located in the communities of Murrietta, and Temecula which are located to the north of Camp Pendleton. The purpose of this is to gain insight on the accumulation totals of precipitation upstream to better inform local commanders on the potential for flooding aboard MCB Camp Pendleton.

(2) Flood Alert Condition II. Will be set when one of the following conditions are met: When rainfall amounts equal or exceed conditions in Alert Condition III; visible flooding is detected upstream and/or rainfall that exceeds one or more inches within a six hour period, and/or local or National Weather Service forecast predicts heavy thunderstorms, Flash Flood Watches, and/or Flash Flood Warnings.

(3) Flood Alert Condition I. Will be set when one of the following conditions are met: When rainfall amounts equal or exceed conditions in Alert Condition II; bridges, roads and culverts are overflowing with water. Upstream fire departments are reporting local flooding.

i. Hurricane/Storm Condition. Conditions are set by the National Weather Service whenever sustained wind of 34 knots or greater are anticipated. Hurricane/Storm conditions are set as follows:

(1) Hurricane/Storm Condition 4. Destructive wind is possible within 72 hours.

(2) Hurricane/Storm Condition 3. Destructive wind is anticipated within 48 hours.

(3) Hurricane/Storm Condition 2. Destructive wind is anticipated within 24 hours.

(4) Hurricane/Storm Condition 1. Destructive wind is presently occurring or anticipated within 12 hours.

j. National Weather Service Warnings

(1) Tornado Watch. Conditions are favorable for tornadoes and severe thunderstorms within and close to the watch area.

(2) Tornado Warning. A tornado/waterspout has actually been sighted or indicated by weather radar.

(3) Severe Thunderstorm Watch. Severe thunderstorm (wind gust to 50 knots or greater and/or hail of 3/4 inch diameter or greater at the surface) development is possible within or adjacent to the watch area.

(4) Severe Thunderstorm Warning. The occurrence of a severe thunderstorm has been confirmed by observation or weather radar.

(5) Hurricane Watch. A hurricane poses a possible threat to a specified coastal area within 36 hours.

(6) Hurricane Warning. Hurricane force wind is expected at a specified coastal area within 24 hours.

(7) Tropical Storm Watch. A tropical storm poses a threat to a specified coastal area within 36 hours.

(8) Tropical Storm Warning. Tropical storm force wind is expected at a specified coastal area within 24 hours.

(9) Flash Flood Watch/Warning. Heavy rainfall may result in, or has produced flash

(10) Winter Storm Advisory/Watch/Warning. Issued for a variety of winter storm phenomena, including: blizzards, freezing rain, freezing drizzle, heavy snow and ice.

CHAPTER 4

SPECIALIZED FORECASTS

1. **Introduction**. There are a number of different products requested by customers on both the aviation and ground side of Marine Corps Commands. These products vary according to mission tasking. The following types of forecasts are provided by this section in response to specific requests:

a. Radiological Fallout (RADFO). The patterns of deposit of contaminated particles varies greatly with the upper winds, vertical currents, clouds and precipitation. Prediction of fallout areas depend upon the weapon yield, burst type, surface type and features, and the weather. All of these factors are estimated. NBC and Intelligence sections may assist in determination of these factors. Planners and commanders must at least have an approximate warning of the areas of serious contamination.

Reference: Include ATP-25, NAVOCEANCOMINST 3140.1 and NAVOCEANCOMINST 3441.1_.

b. Earthquake Observation and Reporting Program. This reporting program is used to support the National Earthquake Information Center (SEISMO), Denver, Colorado. Within 24 hours of a detected earthquake, an Earthquake Report (kept in the forecaster's desk) will be completed and mailed to the address on the form via the NCOIC/OIC. Additionally, a message will be sent immediately to the SEISMO if the earthquake has an intensity of IV or greater on the Modified Mercalli Scale.

Reference: NAVOCEANCOMINST 3141.1

c. Electro-Optical Tactical Decision Aids (EOTDA). EOTDA's predict the performance of air-to-ground weapon systems and night vision goggles based on environmental and tactical information. This program supports three types of systems: Infrared (IR), Visible (TV), and Laser, and can be used in two modes: Execution and Planning. In the below listed modes, the following is provided:

(1) IR Planning TDA
Narrow Field of View (NFOV) Detection Range
Wide Field of View (WFOV) Detection Range
Medium Field of View (MFOV) Detection Range
Lock-on Ranges
Temperature Contrast
4-Km Transmittance

Absolute Humidity
Solar/Lunar Position

(2) IR TDA
Narrow Field of View (NFOV) Detection Range
Wide Field of View (WFOV) Detection Range
Medium Field of View (MFOV) Detection Range
Lock-on Range

(3) TV Planning TDA
Narrow Field of View (NFOV) Detection Range
Wide Field of View (WFOV) Detection Range
Medium Field of View (MFOV) Detection Range
Lock-on Range
Solar/Lunar Position

(4) TV Execution TDA
Narrow Field of View (NFOV) Detection Range
Wide Field of View (WFOV) Detection Range
Medium Field of View (MFOV) Detection Range
Lock-on Range

(5) Laser Planning TDA
Receiver Range
Designator Range
Collocated Range
Ranging Range

The products most frequently requested by aviators assigned to the squadrons of Marine Aircraft Group 39, home based at MCAS Camp Pendleton are the ANVIS-6, NTS FLIR Wide, Narrow and Medium Fields of View and the Hellfire. These products are prepared daily and presented in the WEAX. For uniformity purposes the OPS records have been standardized using UL Def: Yes, Aerosol: 5-Desert, View Dir: 270 deg, Sensor Height: 2.0 hft, Target Elevation: 1000 ft, Target: T72, Target Heading: 90 deg, Albedo: Desert, Background: 1-Vegetation with Intermediate Growing State, Coverage, and Soil Moisture. In addition the forecaster will, in conjunction with the requester, prepare an EOTDA ops worksheet for the types of sensors that will be utilized and for the specified time frame.

d. GFMPL Products. This program is utilized on the computer located within the Secondary Control Point. The type of data compiled in the following format depends upon the user request.

(1) SOCUS (Sound Focus). This product is prepared daily and distributed via the WEAX for a Blast Position of

33°29'N 117°19'W. The Sound Focus program provides the user with the following products:

· 360° Plan View of areas expected to receive complaints, minor damage, and possible caustics.
· Plot of nose level (dB) versus range of the Plan View information along a user selected azimuth.
· Sound speed profile with respect to height.
· Maximum and minimum aircraft ground speeds versus height.

(2) COVER. Cover provides the capability to determine how a EM system will perform under atmospheric conditions in detecting or communicating with a target or receiver. It also provides the information necessary to plan flight profiles for airborne systems to achieve maximum probability of detecting targets. The following are limitations of the program:

· Cover assumes horizontal homogeneity (horizontal changes in the refractivity structure of the atmosphere are not accounted for).
· Cover is valid only for EM systems with frequencies between 100 MHz and 20 GHz.
· Cover does not include any effects produced by sea or land clutter in the calculation of detection or communication ranges.

(3) LOSS. The LOSS program is used to assess the performance of a user specified EM system under given atmospheric conditions. Path loss versus range is displayed with the system's path-loss thresholds. The following are limitations of the program:

· LOSS assumes horizontal homogeneity.
· LOSS is valid only for EM systems with frequencies between 100 MHz and 20 GHz.
· LOSS does not include any effects produced by sea or land clutter in the calculation of detection or communication ranges.

(4) SLAP. The Solar/Lunar Almanac Program (SLAP) produces monthly or daily summaries of ephemeral data for the sun and moon and a light level planning calendar for the evening sky. Including times for sunrise/set, moonrise/set and illumination, and beginning and end of civil/nautical twilight's.

(5) TIDES. The tidal predictions module calculates hourly tidal heights from local harmonically analyzed constituents, or from non local constituents, by means of

corrections applied to the times and heights of extreme predicted for a non local station.

e. Chemical Downwind Message (CDM). The chemical downwind message contains all the weather information needed to calculate a chemical downwind hazard. The CDM provides the local wind speed, wind direction, stability category, and relative humidity in a short concise statement. This message is issued every six hours and is valid for three consecutive two hour periods. It contains the following information.

· Date-time group of the observation.
· Date-time group for basic data is the time the first forecast is effective.
· Area of validity is the area affected by the CDM. It could be a map sheet number or an area, such as division or corps.

f. Surf and Sea Conditions. Due to a significant amount of amphibious operations in the littoral, MCAS Camp Pendleton forecasters provide (on a daily basis) the surf and sea states for the inner operating areas adjacent to Camp Pendleton. These forecasts and conditions may be derived from several sources. One and most importantly is the FOPN KNZY bulletin received via the CMW. The other source the forecaster may utilize is GFMPL for tidal information and NODDS for sea swells/height and direction and temperatures. This information is available in the MCAS Camp Pendleton WEAX.

g. Forecasting Pressure Altitude. Daily, along with the maximum temperature TAF dissemination, the forecaster may derive the forecast pressure altitude from the below listed information as part of the formula. See Figures 4.1 and 4.2.

LOCATION STA ELEV

CRQ	+ 328	KNKT	+29	KNZJ	+383
KDMA	+ 2705	KNLC	+234	KNZY	+26
KHIF	+ 4789	KNRC	+165	KOAR	+135
KIPL	- 56	KNRS	+24	KPSP	+448
KLSV	+ 1868	KNSI	+504	KRIV	+1548
KNFG	+ 78	KNTD	+12	KSLI	+33
KNFL	+ 3934	KNTK	+54	KTCM	+323
KNGZ	+ 14	KNUC	+ 182	TRM	+117
KNID	+ 2283	KNXP	+ 2055	KVBG	+367
KNJK	-43	KNYL	+ 213	KVCV	+2875

FIGURE 4.1

(Heights in feet above/below MSL) * -- Not listed in FLIP.
Reference: IFR-Supplement, {FLIP}, effective 20 JUL 1995;
Example: KNFG forecasts the ALSTG at 0500Z to be 29.85. Convert inches to feet using the chart in figure 4.1. 29.85 inches = +66 feet. Add +66 feet to the station elevation (+78 feet)

EX. KNFG station elevation +78
Conversion (inches to feet) + +66
Pressure Altitude for KNFG at 0500Z = +144

PRESSURE ALTITUDE TABLE (inches to feet)

Inches	**0.00**	**0.01**	**0.02**	**0.03**	**0.04** (FEET)	**0.05**	**0.06**	**0.07**	**0.08**	**O.09**
28.0	1824	1814	1805	1795	1785	1776	1766	1756	1746	1737
28.1	1727	1717	1707	1698	1688	1678	1668	1659	1649	1639
28.2	1630	1620	1610	1601	1591	1581	1572	1562	1552	1542
28.3	1533	1523	1513	1504	1494	1484	1475	1465	1456	1446
28.4	1436	1427	1417	1407	1398	1388	1378	1369	1359	1350
28.5	1340	1330	1321	1311	1302	1292	1282	1273	1263	1254
28.6	1244	1234	1225	1215	1206	1196	1186	1177	1167	1138
28.7	1148	1139	1129	1120	1110	1100	1091	1081	1072	1062
28.8	1053	1043	1034	1024	1015	1005	995	986	976	967
28.9	957	948	938	929	919	910	900	891	881	872
29.0	863	853	844	834	825	815	806	796	787	777
29.1	768	758	749	739	730	721	711	702	692	683
29.2	673	664	655	645	636	626	617	607	598	589
29.3	579	570	560	551	542	532	523	514	504	495
29.4	485	476	467	457	448	439	429	420	410	401
29.5	392	382	373	364	354	345	336	326	318	308
29.6	298	289	280	270	261	252	242	233	224	215
29.7	205	196	187	177	168	159	149	140	131	122
29.8	112	103	94	85	75	66	57	47	36	29
29.9	20	10	1	8	-17	-26	-36	-45	-54	-63
30.0	-73	-62	-91	-100	-110	-119	-126	-137	-146	-156
30.1	-165	-174	-183	-182	-202	211	-220	-229	-238	-248
30.2	-257	-266	·275	-284	-293	-303	-312	321	-330	-339
30.3	-348	-358	-367	376	-385	-394	-403	-412	-421	-431
30.4	.440	-449	458	-467	-476	-485	-494	-504	513	-522
30.5	.531	-540	-549	-558	-567	-576	-585	-594	-607	-613
30.6	-622	-631	-640	-649	658	-667	-676	-685	-694	-703
30.7	-712	-721	-730	-740	-749	-758	·767	-776	-785	-794
30.8	-803	-812	-821	.830	-839	-848	-857	-866	-875	-884
30.9	.893	-902	-911	-920	-929	-938	-947	-956	-965	974
31.0	·983	-992	-1001	.1010	-1019	1028	-1037	-1046	-1055	-1064

FIGURE 4.2

NOTE: See Appendix C for Monthly and Annual Altimeter and Pressure Altitude Variations.

Reference: Meteorological Tables

CHAPTER 5
ENVIRONMENTAL EFFECTS

1. **Introduction**. The effects of natural phenomena on personnel as well as aircraft are a primary concern when planning any event. Alerting commanders in a timely manner of the occurrence or probability of occurrence, is paramount for the Weather Service (METOC) mission. Camp Pendleton's weather largely consists of late evening/early morning stratiform clouds and fog. We refer to this as the "marine layer". This phenomena is indigenous to coastal areas and can extend as far inland as one hundred miles. Its effects on weapons systems and sensors can be quite dramatic.

2. **Field Minima and Weather Affecting Weapons System and Sensors**

a. Field Minima

(1) Special Instrument Rating. No takeoff ceiling or visibility apply. Takeoff shall depend on the judgment of the pilot and urgency of flight.

(2) Standard Instrument Rating

(a.) When GCA (Ground Control Approach) is operating, the PAR (Precision Approach Radar) minima is 425 ft ceiling and 1 statute mile visibility. The ASR (Airport Surveillance Radar) minima is 520 ft ceiling and 1 statute mile visibility. The take-off minima is a 400 ft ceiling and one statute mile visibility.

(b.) When GCA is not operating, the TACAN minima is 1,000 ft ceiling and 1 statute mile visibility.

b. Weather Effects on EO/IR Sensors

(1) Visibility is a phenomena caused by small particles in the atmosphere that scatter radiation in a manner that strongly impacts the short visible wavelengths. It has an impact on IR wavelengths and almost none on MMW wavelengths. Haze is a good example of this phenomena.

(2) Rain drops are a phenomena that scatters radiation in a manner that impacts the visible and IR bands about the same and starts to have less of an impact as the MMW wavelengths are approached.

(3) Absolute humidity of water vapor in the air is a phenomenon that absorbs radiation in predominantly the IR bands and the high frequency MMW band (220 GHz).

(4) Fog and clouds, which are characterized by the liquid water content, are cases of very low visibility in which the suspended water droplets are scattering the radiation. The impact on the spectral bands is between that of visibility and rain.

3. **Phenomena and Operating Constraints**

a. Flood Condition 3 (Ref 7)

(1) Direct all tenant commands and station personnel to prepare for flash flooding.

(2) Coordinate with tenants to prepare for aircraft evacuation or movement to higher ground.

(3) Review requirements pertaining to Flood Alert condition 2 and initiate actions to attain required readiness.

b. Flood Condition 2 (Ref 7)

(1) In coordination with tenant and transient aircraft custodians/aircrews, evacuation of aircraft as appropriate.

(2) Ensure inbound aircraft are informed of both the current and forecast environmental conditions.

c. Flood Condition 1 (Ref 7). After all responsibilities in the StaO have been adhered to, ensure all weather personnel evacuate the Air Station.

d. Other Requirements when in a Flood Condition. Refer to StaO 3145.1_

e. Thunderstorm Condition 2 (Ref 7). Ordnance, Fuels, and Amphibious Assault Craft Units prepare for Thunderstorm Condition 1.

(1) Ordnance begins to secure its ordnance.

(2) Fuels continue normal operations.

(3) Amphibious Assault Craft Units alert craft that are in a working status.

f. Thunderstorm Condition 1 (Ref 7)

(1) Ordnance suspends all operations. (Ref 3)

(2) Fuels suspend all operations. (Ref 4)

(3) Amphibious Assault Craft will suspend operations. The concern is not just lightning, but winds and seas as well. (Ref 5)

g. Wind Conditions

(1) Wind will be a factor involving the safety in the operation of amphibious assault craft when it is determined by the craft commander that safety may be compromised. No other criteria regarding wind exists. (Ref 5)

(2) Wind in excess of 65 knots is criteria to hanger aircraft. (Ref 6)

(3) Launch and recovery should be made into a relative wind of less than 45 knots. In an emergency, the helicopter may be launched in 60 knot wind.

h. X-Wind factors for Aircraft

Aircraft	Crosswinds	Cannot Take Off
A-6 Intruder	15 Kts at 090	20 Kts at 090
F/A-18 Hornet	20 Kts at 090	30 Kts at 090
KC-130 Hercules	10 Kts at 090	15-20 Kts at 090
UC-12B Beachcraft	15 Kts at 090	25 Kts at 090
CT-39G Sabreliner	20 Kts at 090	30 Kts at 090 (dry) 25 Kts at 090 (wet)
C-141B Starlifter	25 Kts at 090	25 Kts at 090 (dry) 15 Kts at 090 (wet)
F-5	20 Kts at 090 (Chute) (dry) 35 Kts at 090 (w/o chute) (dry) 10 Kts at 090 (chute) (wet) 20 Kts at 090 (w/o chute) (wet)	
UH-1 Huey	45 Kts relative wind/60 Kts in emergency	
AH-1 Cobra	45 Kts relative wind/60 Kts in emergency	
CH-46 Sea Knight		
CH-53 Sea Stallion		

(Ref 13)

i. Turbulence/Icing factors for Aircraft

(1) H-l/AH-lJ+W/CH-53+46&C-12 are not allowed to file into areas of known extreme turbulence.

(2) Icing capabilities of different aircraft

Type	De-ice	Anti-ice	Max icing	Wx Radar
A-6	X		Light	150 NM
F/A18	X	X	Moderate	Yes
KC-130	X		Severe	240 NM
UC-12B	X	X	Light	200 NM
CT-39G	X		Light	300 NM

CHAPTER 6

References

1. General

a. Sailing Directions (Planning Guide), Pub 152, Third Edition, Defense Mapping Agency Hydrographic/Topographic Center Bethesda, MD, 1989

b. Local Area Forecasters Handbook for NAS North Island, San Diego, CA. Naval Oceanography Command Facility San Diego, 1989

c. Defense Mapping Agency Chart 2549: San Diego, 2nd Edition, 1991

d. Defense Mapping Agency Chart 18766: San Diego to Islas de Todos Santos, 7th Edition, November 1983

e. Defense Mapping, Agency Chart 18772: Approaches To San Diego Bay, 45th Edition, January 1994

f. Defense Mapping Agency Chart 18773: San Diego Bay,35th Edition, March 1995

g. National Oceanic and Atmospheric Administration Chart 18774: Gulf of Santa Catalina, 8th Edition, February 1994

h. National Oceanic and Atmospheric Administration Chart 18776: San Pedro Channel, 31st Edition, May 1995

i. Marine Studies of San Pedro Bay. California. Part 10: Physical Water Quality in the Long Beach Harbor Area. Alan Hancock Foundation, January 1976

j. Oceanside Harbor. California Design for Harbor Improvements, Technical Report CERC-92-14, U. S. Army Corps of Engineers

k. Report on Climate Change and the California Current Ecosystem. Report Number 7, U. S. Global Ocean Ecosystems Dynamics, September 1992

l. Mine Warfare Pilot: San Diego and Approaches,Naval Oceanographic Office Special Publication SP-1006, Bay St. Louis, MS, 1985

m. Mueller, J. L., Biooptical Provinces of the Northeast Pacific Ocean, San Diego State University, 1993

n. Longshore Current Observations in Southern California, Technical Memorandum No. 13, Beach Erosion Board, Corps of Engineers, 1950

o. Larson, Magnus and Kraus, Nicholas C., Analysis of Cross-shore Movement of Natural Longshore Bars and Material Placed to Create Longshore Bars, Final Report, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, 1992

p. Tide Tables 1996. West Coast of North and South America. National Oceanic and Atmospheric Administration, 1995

q. United States Coast Pilot, Pacific Coast: California, Oregon, Washington and Hawaii, Pub 7, National Oceanic and Atmospheric Administration. 1993

r. Lee, Arthur C. and Osborne, Robert H., Relative Fluxes of Sand for Southern California Beaches: Fourier Grain Shape Analysis, Shore & beach, July 1995

s. The Distribution and Characteristics of Surface Bioluminescence in the Oceans, Technical Report TR-184. Naval Oceanographic Office, March 1966

t. Mine Warfare Pilot: Point Conception - San Diego. Naval Oceanographic Office Special Publication SP-821, Bay St. Louis, MS, January 1971

u. Low Altitude flight information Publication Vol 2.

v. US Army Material Command Smart Weapons Management Office.

w. MCAS El Toro Forecaster Handbook

x. 29 Palms AGSE Forecasters Handbook

y. MOSS Users Manual

z. OPARS Users Manual

aa. NODDS Users Manual

1. Directives

a. NAVSEA Op 5

b. NAVAIR 06-5-502

c. SEAOPS S9LCA-AA-SSM-010

d. OPNAVINST 3710.7_

e. Station Order 3145.1_

f. StaO P3710.7_

g. NAVMETOCCOMINST 3140.2_

h. OPNAVINST 3140.24_

i. NAVOCEANOCOMINST 3140.1_

j. NAVOCEANOCOMINST 3441.1_

k. NAVOCEANOCOMINST 3141.1_

l. FM 3-3

APPENDIX A

HISTORICAL CLIMATOLOGICAL DATA

IMPORTANT NOTICE

All climatology contained in this appendix was derived from observations recorded at MCAS Camp Pendleton, California (33^{0} 17' 54" North, 117^{0} 21' 06" West) as contained in International Station Meteorological Climate Summary v3.0. All times have been converted to Local Standard Time. Dates and times are indicated for Daylight Savings Time (U) and Pacific Standard Time (T). Climatological data should be used as a guideline and not as an exact forecast.

ANNUAL HISTORICAL CLIMATOLOGICAL DATA

TEMPERATURE (F) RELATIVE HUMIDITY (%)

AVERAGE 630400 (L) 82

ABSOLUTE MAX 112 (JUL 1985)1300 (L)58
ABSOLUTE MIN 24 (FEB/DEC 1990)
FIELD CONDITION (%)
PRECIPITATION (INCHES)
IMC8.6
ANNUAL MEAN11.80VMC91.4
ANNUAL MAX34.44 (1978)
24HR MAX 3.00 (MAR 1978)CEILING/VISIBILITY (%)

MEAN # OF DAYS WITH>=1000 AND >=3 91.4
<1000 AND OR <38.6
PRECIP >.01"41.0
THUNDERSTORMS3.0

SURFACE WINDS (ALL HOURS)PREDOMINANT

PREVAILING DIRECTIONSW
ASSOC AVG SPEED (KT)7.1
MAX MONTHLY WIND SPEED (KT)49 (JAN/FEB 1988)

HISTORICAL CLIMATOLOGICAL DATA FOR JANUARY

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 550400(L)83
AVERAGE MAX 681300(L)55
AVERAGE MIN 41
ABSOLUTE MAX 91 (1986)FIELD CONDITION (%)
ABSOLUTE MIN 25 (1987)IMC 11.3

VMC89.7
PRECIPITATION (INCHES)
MAX MONTHLY 12.28 (1978)SURFACE WINDS (ALL HOURS) PREDOMINANT
MEAN MONTHLY 2.10PREVAILING DIRECTION SSW
24HR MAX 2.34 (1993)ASSOC AVG SPEED (KT) 7.0
MAX MONTHLY WIND SPEED (KT) 49 (1988)
MEAN # OF DAYS WITH
PRECIP >.01" 6.45
THUNDERSTORMS <1

CEILING/VISIBILITY (%)
>=1000 AND >=389.7
<1000 AND/OR <311.3

HISTORICAL CLIMATOLOGICAL DATA FOR FEBRUARY

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 560400 (L) 82
AVERAGE MAX 681300 (L)59
AVERAGE MIN 43
ABSOLUTE MAX 90 (1986/1990)FIELD CONDITIONS (%)
ABSOLUTE MIN 24 (1990)IMC 9.4
VMC91.6
PRECIPITATION (INCHES)
MAX MONTHLY 8.73 (1969)SURFACE WINDS (ALL HOURS) PREDOMINANT
MEAN MONTHLY 3.10 PREVAILING DIRECTION SSW
24HR MAX 2.45 (1990)ASSOC AVG SPEED (KT) 7.0
MAX MONTHLY WIND SPEED (KT) 49 (1988)
MEAN # OF DAYS WITH
PRECIP >.01" 6.4
THUNDERSTORMS <1

CEILING/VISIBILITY (%)
>=1000 AND >=391.6
<1000 AND/OR <3 9.4

HISTORICAL CLIMATOLOGICAL DATA FOR MARCH

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 570400 (L)87
AVERAGE MAX 691300 (L)61
AVERAGE MIN 46
ABSOLUTE MAX 98 (1988)FIELD CONDITIONS (%)
ABSOLUTE MIN 31 (1971)IMC 7.3
VMC92.7
PRECIPITATION (INCHES)
MAX MONTHLY 7.50 (1983)SURFACE WINDS (ALL HOURS)PREDOMINANT

MEAN MONTHLY 2.30PREVAILING DIRECTIONSW
24HR MAX 3.00 (1978)ASSOC AVG SPEED (KT) 7.0
MAX MONTHLY WIND SPEED (KT)45 (1991)
MEAN # OF DAYS WITH
PRECIP >.01"7.0
THUNDERSTORMS1

CEILING/VISIBILITY (%)
>=1000 AND >=392.7
<1000 AND/OR <345 (1991)

HISTORICAL CLIMATOLOGICAL DATA FOR APRIL

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 610400 (L)86
AVERAGE MAX 731300 (L)57
AVERAGE MIN 46
ABSOLUTE MAX 106 (1989) FIELD CONDITION (%)
ABSOLUTE MIN 32 (1969)IMC 8.6
VMC91.4
PRECIPITATION (INCHES)
MAX MONTHLY 3.05 (1983)SURFACE WINDS (ALL HOURS)PREDOMINANT
MEAN MONTHLY .70 PREVAILING DIRECTIONSW
24HR MAX 1.21 (1983)ASSOC AVG SPEED (KT)7.0
MAX MONTHLY WIND SPEED (KT)4
MEAN # OF DAYS WITH
PRECIP >.01" 4.0
THUNDERSTORMS0

CEILING/VISIBILITY (%)
>=1000 AND >=391.4
<1000 AND/OR <3 8.6

HISTORICAL CLIMATOLOGICAL DATA FOR MAY

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 640400 (L)79
AVERAGE MAX 731300 (L) 62
AVERAGE 54
ABSOLUTE MAX 102 (1990)FIELD CONDITION (%)
ABSOLUTE MIN 40 (1968)IMC 7.1
VMC92.9
PRECIPITATION (INCHES)
MAX MONTHLY 1.20 (1990)SURFACE WINDS (ALL HOURS)PREDOMINANT
MEAN MONTHLY .20PREVAILING DIRECTIONSW
24HR MAX 1.16 (1990)ASSOC AVG SPEED (KT)8.0
MAX MONTHLY WIND SPEED (KT)43 (1984)
MEAN # OF DAYS WITH
PRECIP >.01"1.0

THUNDERSTORMS<.5

CEILING/VISIBILITY (%)
>=1000 AND >=392.9
<1000 AND/OR <3 7.1

HISTORICAL CLIMATOLOGICAL DATA FOR JUNE

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 670400 (L)80
AVERAGE MAX 761300 (L)62
AVERAGE MIN 57
ABSOLUTE MAX 109 (1990)FIELD CONDITION (%)
ABSOLUTE MIN 43 (1988)IMC 11.0
VMC89.0
PRECIPITATION (INCHES)
MAX MONTHLY .96 (1990)SURFACE WINDS (ALL HOURS)PREDOMINANT
MEAN MONTHLY .06PREVAILING DIRECTIONSW
24HR MAX .76 (1993)ASSOC AVG SPEED (KT)8.0
MAX MONTHLY WIND SPEED (KT26 (1991)
MEAN # OF DAYS WITH
PRECIP >.01"1.0
THUNDERSTORMS<.5

CEILING/VISIBILITY (%)
>=1000 AND >=389.0
<1000 AND/OR <311.0

HISTORICAL CLIMATOLOGICAL DATA FOR JULY

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 710400 (L)76
AVERAGE MAX 801300 (L)60
AVERAGE MIN 61
ABSOLUTE MAX 112 (1985)FIELD CONDITION (%)
ABSOLUTE MIN 46 (1969)IMC 9.3
VMC90.7
PRECIPITATION (INCHES)
MAX MONTHLY .18 (1987)SURFACE WINDS (ALL HOURS) PREDOMINANT
MEAN MONTHLY .01PREVAILING DIRECTIONSW
24HR MAX .18 (1987)ASSOC AVG SPEED (KT)8.0
MAX MONTHLY WIND SPEED (KT)26 (1991)
MEAN # OF DAYS WITH
PRECIP >.01" 1.0
THUNDERSTORMS<.5

CEILING/VISIBILITY (%)
>=1000 AND >=390.7
<1000 AND/OR <3 9.3

HISTORICAL CLIMATOLOGICAL DATA FOR AUGUST

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 720400 (L)80
AVERAGE MAX 821300 (L)60
AVERAGE MIN 62
ABSOLUTE MAX 105 (1991)FIELD CONDITION (%)
ABSOLUTE MIN 44 (1969)IMC 9.6
VMC90.4
PRECIPITATION (INCHES)
MAX MONTHLY 2.32 (1977)SURFACE WINDS (ALL HOURS)PREDOMINANT
MEAN MONTHLY TPREVAILING DIRECTIONSWW
24HR MAX 1.54 (1977)ASSOC AVG SPEED (KT)8.0
MAX MONTHLY WIND SPEED (KT)29 (1991)
MEAN # OF DAYS WITH
PRECIP >.01"1.0
THUNDERSTORMS <1.0

CEILING/VISIBILITY (%)
>=1000 AND >=390.4
<1000 AND/OR <3 9.6

HISTORICAL CLIMATOLOGICAL DATA FOR SEPTEMBER

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 710400 (L)79
AVERAGE MAX 821300 (L)58
AVERAGE MAX 110 (1988)
AVERAGE MIN 46 (1971)FIELD CONDITION (%)
IMC9.8
PRECIPITATION (INCHES)VMC 90.2
MAX MONTHLY 1.45
MEAN MONTHLY .13SURFACE WINDS (ALL HOURS)PREDOMINANT
24HR MAX .91 (1978)PREVAILING DIRECTIONSSW
ASSOC AVG SPEED (KT)7.0
MEAN # OF DAYS WITHMAX MONTHLY WIND SPEED (KT)29 (1947/1968)
PRECIP >.01" 1.0
THUNDERSTORMS<.5

CEILING/VISIBILITY (%)
>1000 AND/OR >=390.2
<1000 AND/OR <3 9.8

HISTORICAL CLIMATOLOGICAL DATA FOR OCTOBER

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 660400(L)82
AVERAGE MAX 781300 (L)53
AVERAGE MIN 54
ABSOLUTE MAX 110 (1991)FIELD CONDITION (%)
ABSOLUTE MIN 35 (1987)IMC10.7
VMC89.3

PRECIPITATION (INCHES)SURFACE WINDS (ALL HOURS)PREDOMINANT
MAX MONTHLY 3.32 (1987)PREVAILING DIRECTIONSW
MEAN MONTHLY .50ASSOC AVG SPEED (KT)7.7
24HR MAX 1.49 (1987)MAX MONTHLY WIND SPEED (KT)47 (1988)

MEAN # OF DAYS WITH
PRECIP >.01"3.0
THUNDERSTORMS<.5

CEILING/VISIBILITY (%)
>=1000 AND >=389.3
<1000 AND/OR <310.7

HISTORICAL CLIMATOLOGICAL DATA FOR NOVEMBER

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 600400 (L)84
AVERAGE MAX 751300 (L)52
AVERAGE MIN 45
ABSOLUTE MAX 98 (1990)FIELD CONDITION (%)
ABSOLUTE MIN 30 (1974)IMC 7.3
VMC92.9
PRECIPITATION (INCHES)
MAX MONTHLY 8.86 (1981)SURFACE WINDS (ALL HOURS)PREDOMINANT
MEAN MONTHLY .80PREVAILING DIRECTIONSSW
24HR MAX 1.90 (1972)ASSOC AVG SPEED (KT)6.0
MAX MONTHLY WIND SPEED (KT)47 (1991)
MEAN # OF DAYS WITH
PRECIP >.01"4.4
THUNDERSTORMS<1

CEILING/VISIBILITY (%)
>=1000 AND >=392.9
<1000 AND/OR <3 7.3

HISTORICAL CLIMATOLOGICAL DATA FOR DECEMBER

TEMPERATURE (F)RELATIVE HUMIDITY (%)
AVERAGE 550400 (L)78
AVERAGE MAX 691300 (L)52
AVERAGE MIN 40
ABSOLUTE MAX 91 (1989/1990)FIELD CONDITION (%)
ABSOLUTE MIN 24 (1990)IMC 7.5
VMC92.5
PRECIPITATION (INCHES)
MAX MONTHLY 4.71 (1984)SURFACE WINDS (ALL HOURS)PREDOMINANT
MEAN MONTHLY 1.80PREVAILING DIRECTIONNNE
24HR MAX 1.61 (1988)ASSOC AVG SPEED (KT)6.0
SNOWFALL TMAX MONTHLY WIND SPEED47 (1987)

MEAN # OF DAYS WITH
PRECIP >.01"6.0
THUNDERSTORMS<.5

CEILING/VISIBILITY (%)
>=1000 AND >=392.5
<1000 AND/OR <3 7.5

APPENDIX B

SANTA ANA WORKSHEET

SANTA ANA WINDS WORKSHEET
MCAS CAMP PENDLETON

A. A yes answer to the following conditions should alert the forecaster to a potential Santa Ana condition.

l. Cold frontal (trough) passage.

2. Pressure Differential between Camp Pendleton and the Plateau (WMC,EKO,BAN,LOL,RNO) 12 MB and increasing.

3. A cold trough at 700 and 500 MB over Rocky Mountain States (between 100 and 110 degrees West).

4. 700 MB temperature at NTD > 0 C.

5. Average 700 MB height at 35N and 45N and between 125W and 135W is about 10400 feet. (3200 Meters).

B. Forecast to begin - Usually a Santa Ana will begin between 0300U and 0900U in the morning.

Frontal Orientation	**Time after frontal passage**
1. N-S _____	Immediately after frontal passage

2. SE-NW _____ 2-12 Hrs. (Usually soon after frontal passage)

3. NE-SW _____ 12-36 Hrs

4. E-W _____ 6-18 Hrs

C. Intensity at Camp Pendleton - Pressure differential between Camp Pendleton and the Plateau. (Gusts normally average 1.6 times the sustained winds).

1. 8-11 MB___ Possible 15 to 20 knots with gusts of 25 to 30 knots.

2. 12-15 MB___ 20 to 30 knots with gusts of 30 to 45 knots.

3. 16-24 MB_30 to 40 knots with gusts of 45 to 65 knots.

4. > 25 MB_40 to 50 knots with gusts of 65 to 80 knots.

D. Duration - Check the appropriate lines below.

1. Pressure differential between Camp Pendleton and the Plateau (WMC, RNO, LOL)

_____Weak (8 - 11 MB) =1
_____Moderate (12 - 15 MB) =2
_____Strong (16 - 24 MB) =3
_____Very Strong (25 or more) =4

2. Depth of Easterlies (NE - E) check one

_____Shallow (SFC to 12000 feet) = 1
_____Moderately Deep (SFC to 13000 - 20000 feet) = 2
_____Deep (SFC to 21000 - 30000 feet) = 3
_____Very Deep (SFC 31000 - 50000 feet) = 4

3. Temperature at Riverside (RIV) check one

_____Warm (45° F and above) =1
_____Cool (35° F to 44° F) =2
_____Cold (25° F to 34° F) =3
_____Very Cold (below 25° F) =3

Numerical Total of 1, 2, and 3 above ____+____+____=_____

Using this total, determine the appropriate condition below (check one)

_____Weak Condition (3 - 5)

_____Moderate Condition (6 - 8)

_____Strong Condition (9 - 12)

E. Morning and Afternoon Winds (Check one)

_____Weak Condition: Shifting to Westerly 15 - 25 knots between 1100U and continually diminishing during afternoon.

_____Moderate Condition:

Case 1. Shifting to west 15 - 25 knots between 1300U and 1500U and continually diminishing to calm by sunset.

Case 2. Northeast winds diminishing slowly after 1300U and becoming light and variable by 1500U - 1600U.

_____Strong Condition: Northeasterly winds diminishing slowly all day, becoming 15 - 29 knots by sunset.

F. Evening and Night Winds (Check one)

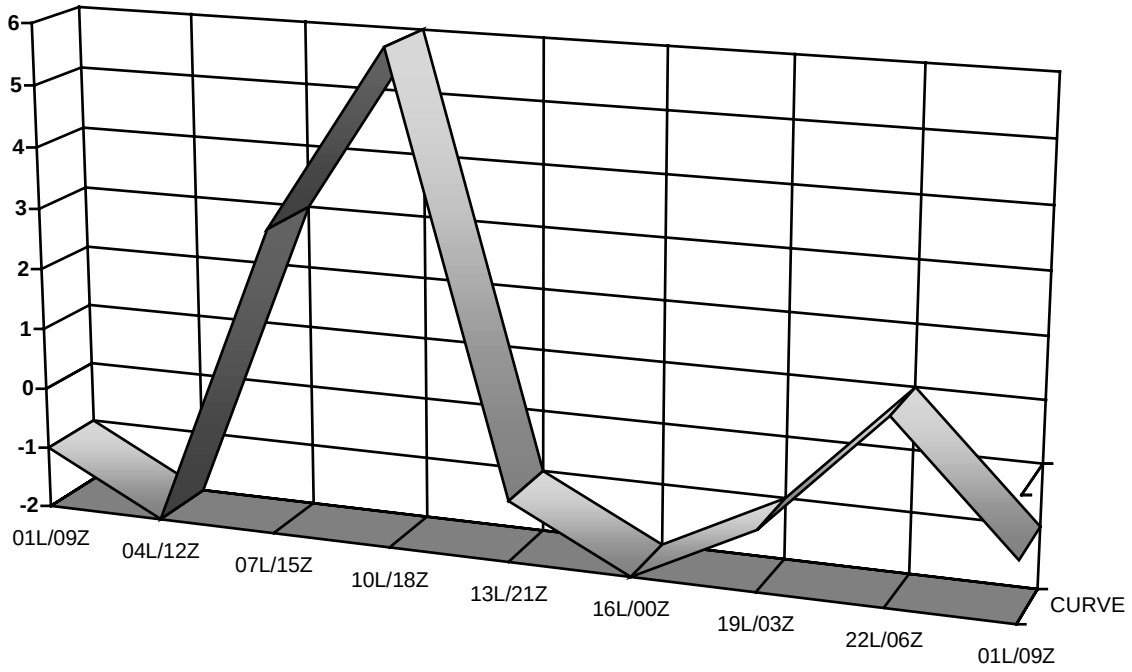
_____Weak Conditions: Light Northerly Winds
_____Moderate Conditions: Northerly 10 - 18 Knots
_____Strong Conditions: Northeasterly winds diminishing slowly all day becoming 15 -20 knots by sunset.

NOTE: Low Level wind shear is always a significant factor.

APPENDIX C

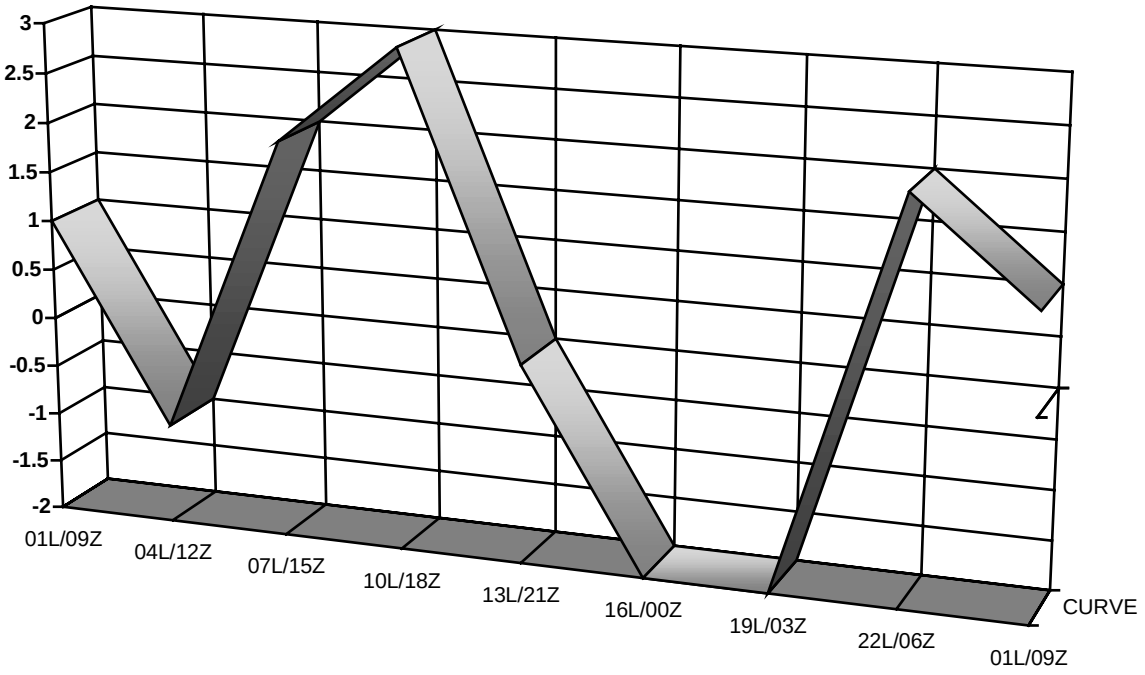
DIURNAL PRESSURE CHANGES

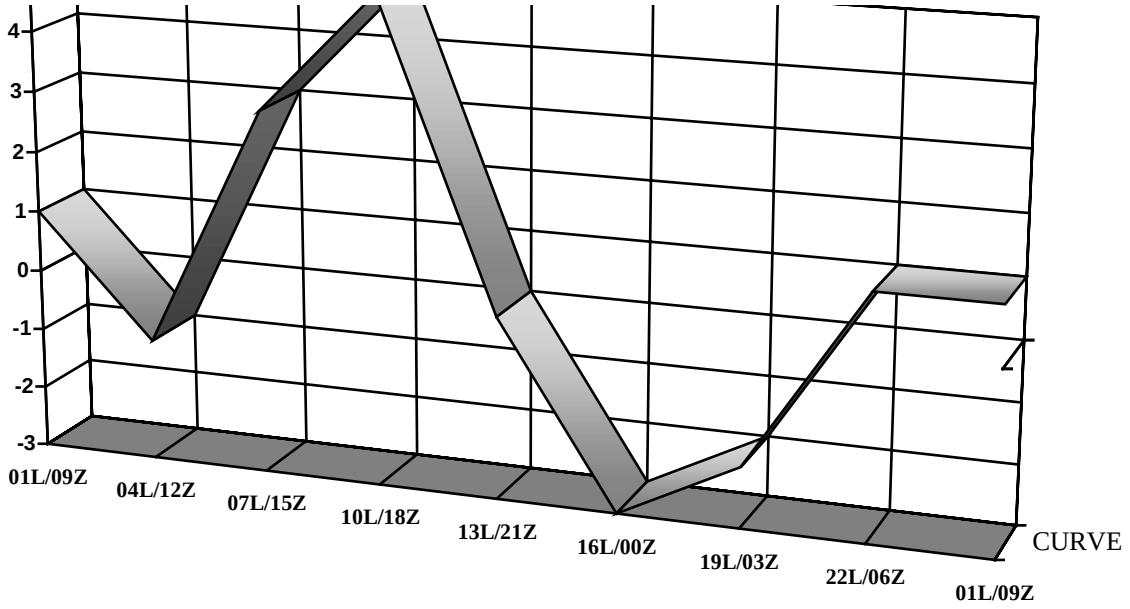
ALTIMETER CURVE
MONTH OF JANUARY



ALTIMETER CURVE
MONTH OF FEBRUARY

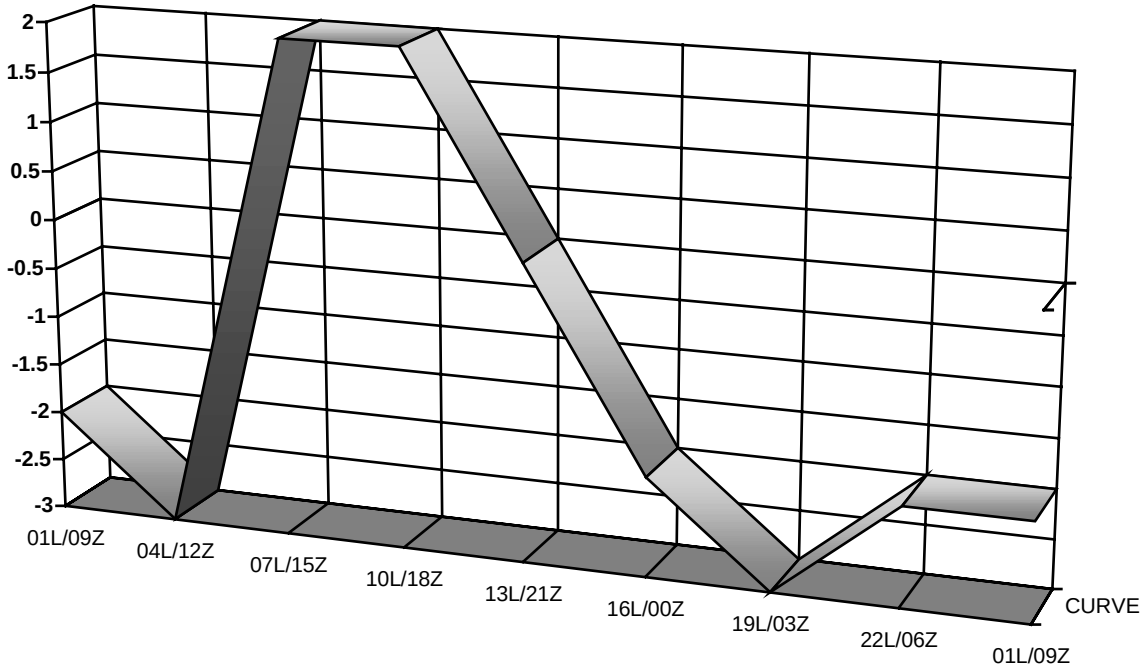
ALTIMETER CURVE
MONTH OF MARCH

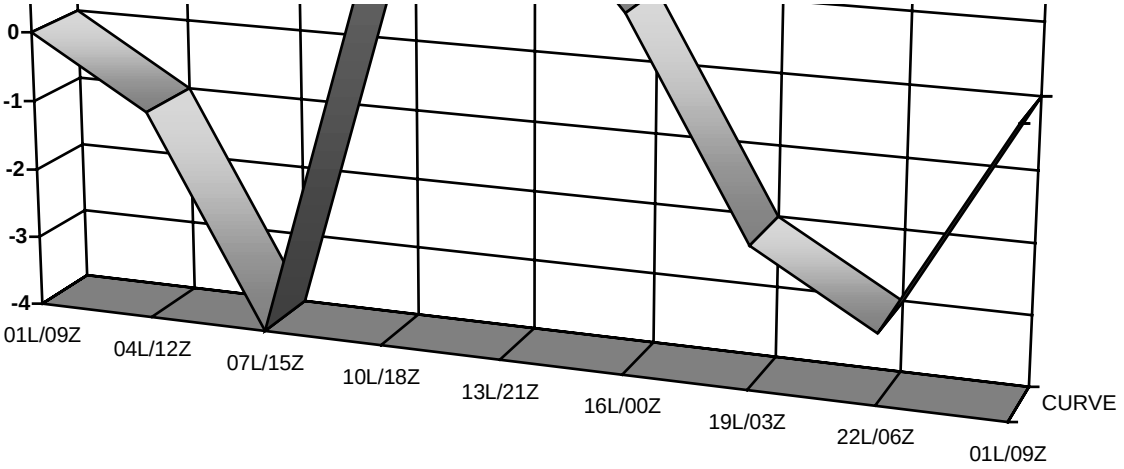




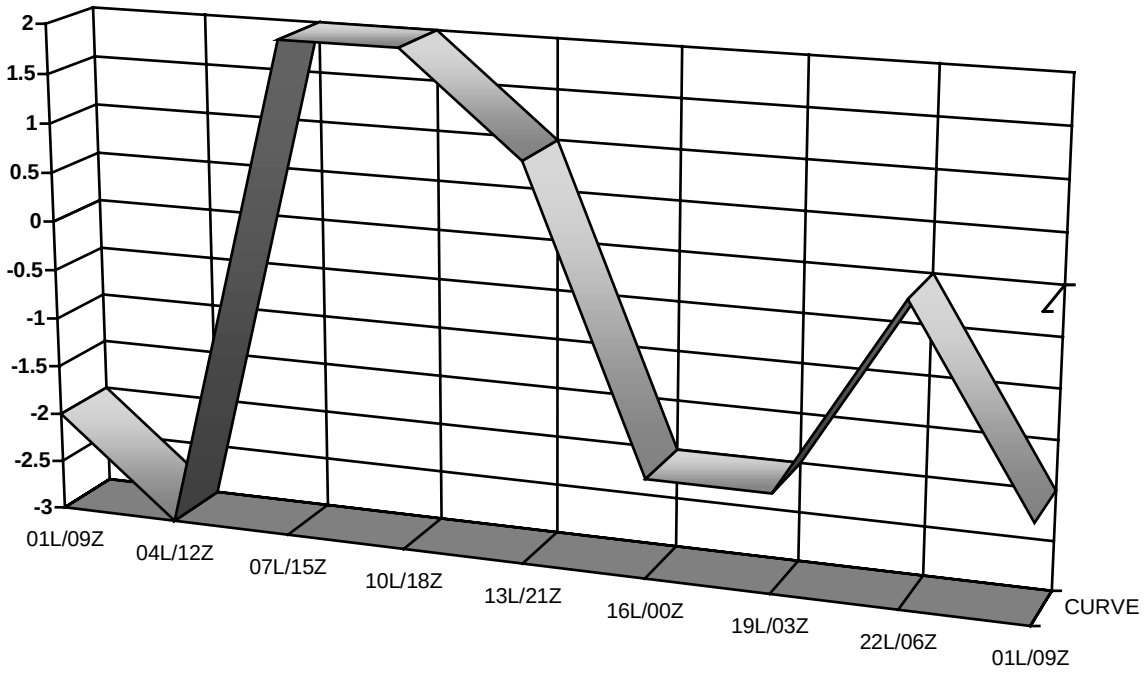
ALTIMETER CURVE
MONTH OF APRIL

ALTIMETER CURVE
MONTH OF MAY

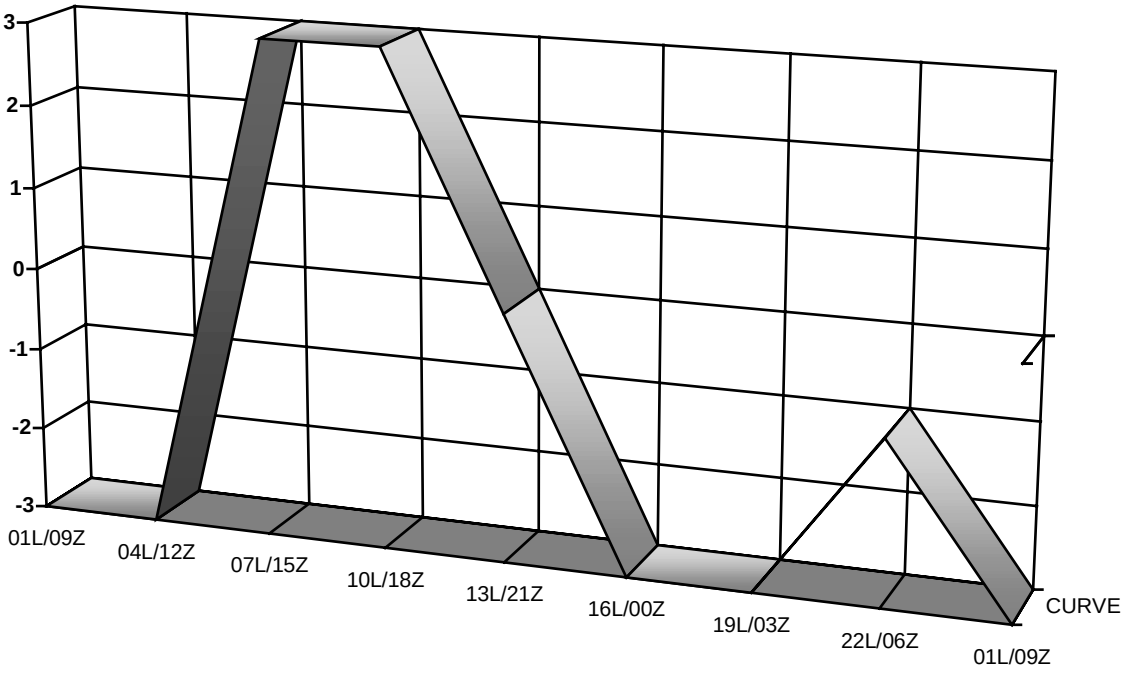




ALTIMETER CURVE
MONTH OF JUNE

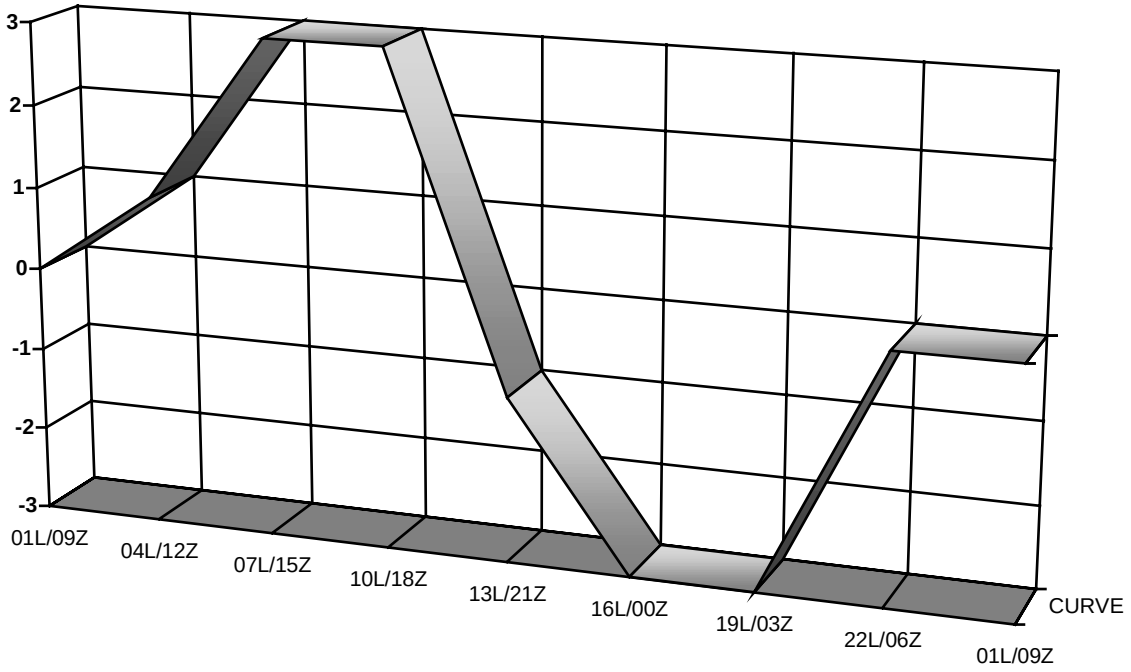


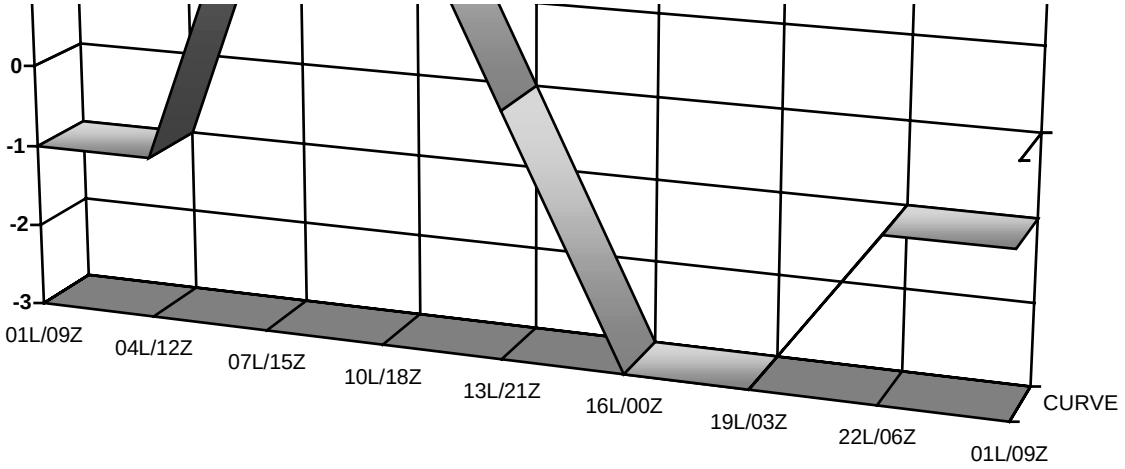
ALTIMETER CURVE
MONTH OF JULY



ALTIMETER CURVE
MONTH OF AUGUST

ALTIMETER CURVE
MONTH OF SEPTEMBER





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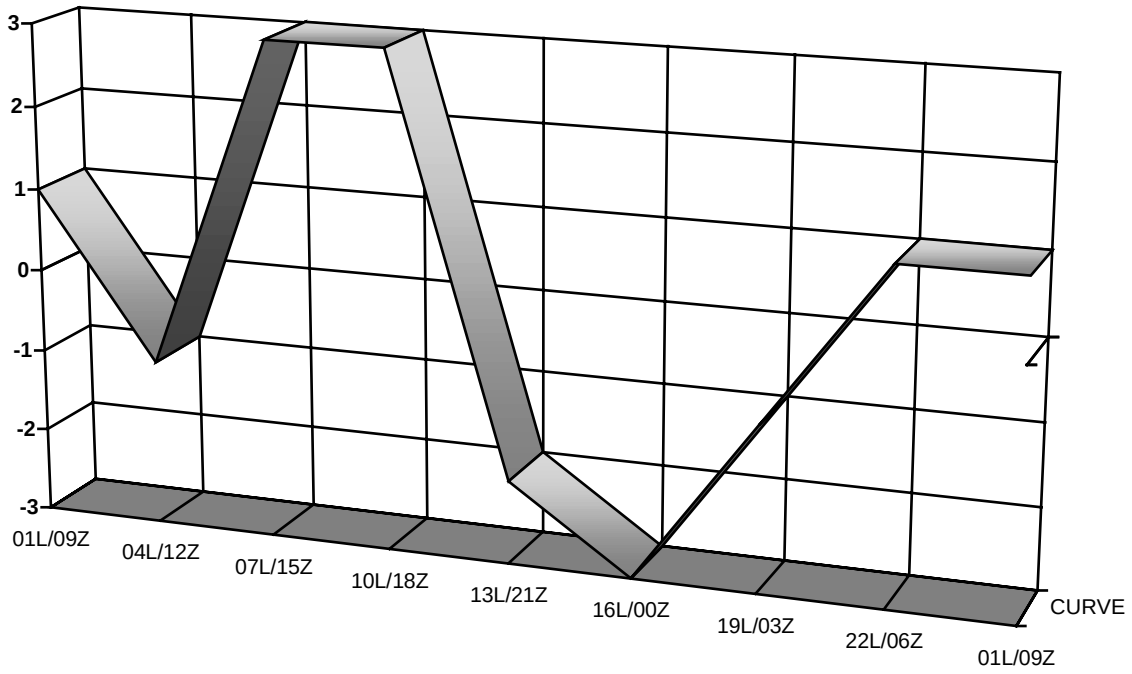
MONTH OF OCTOBER



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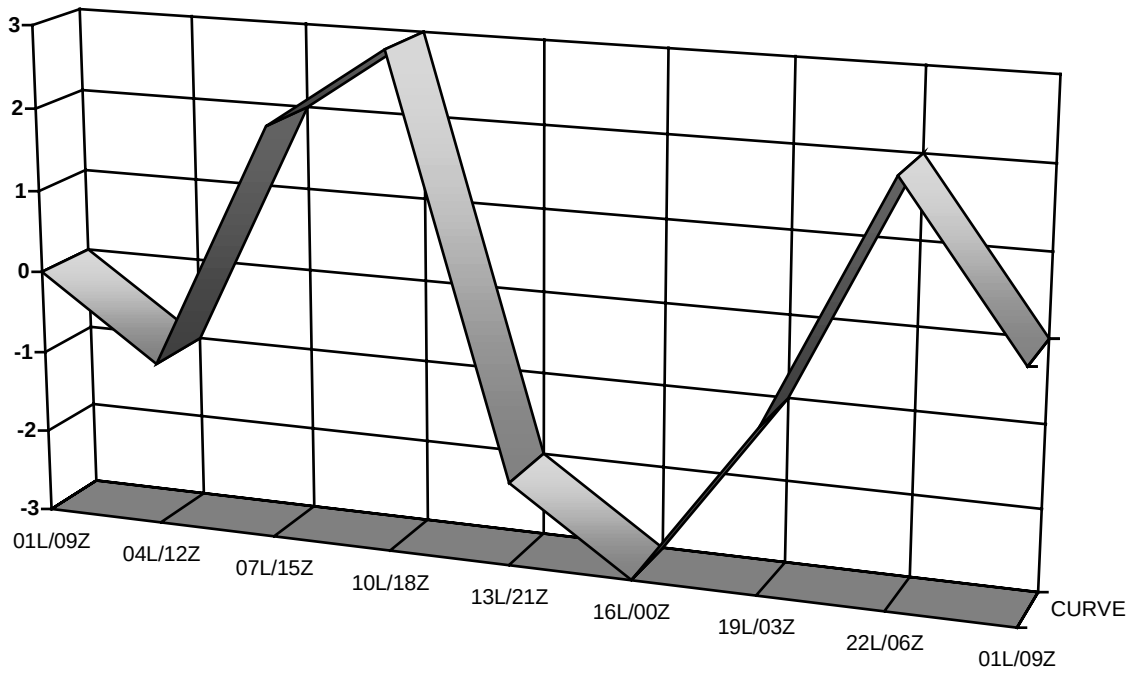
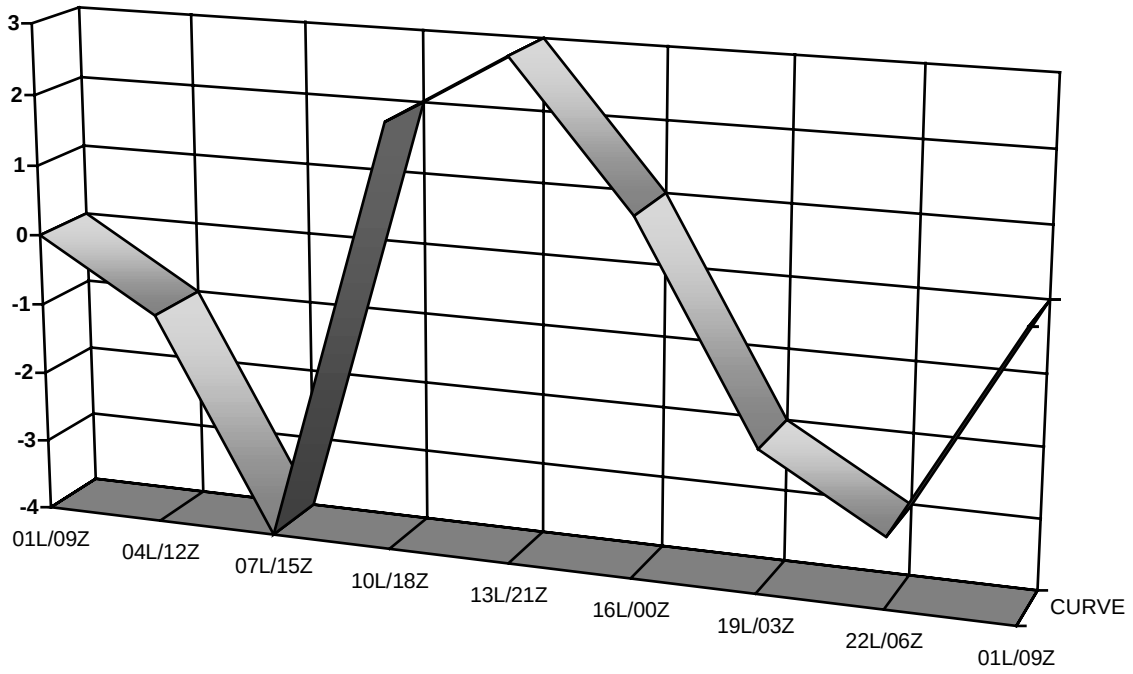
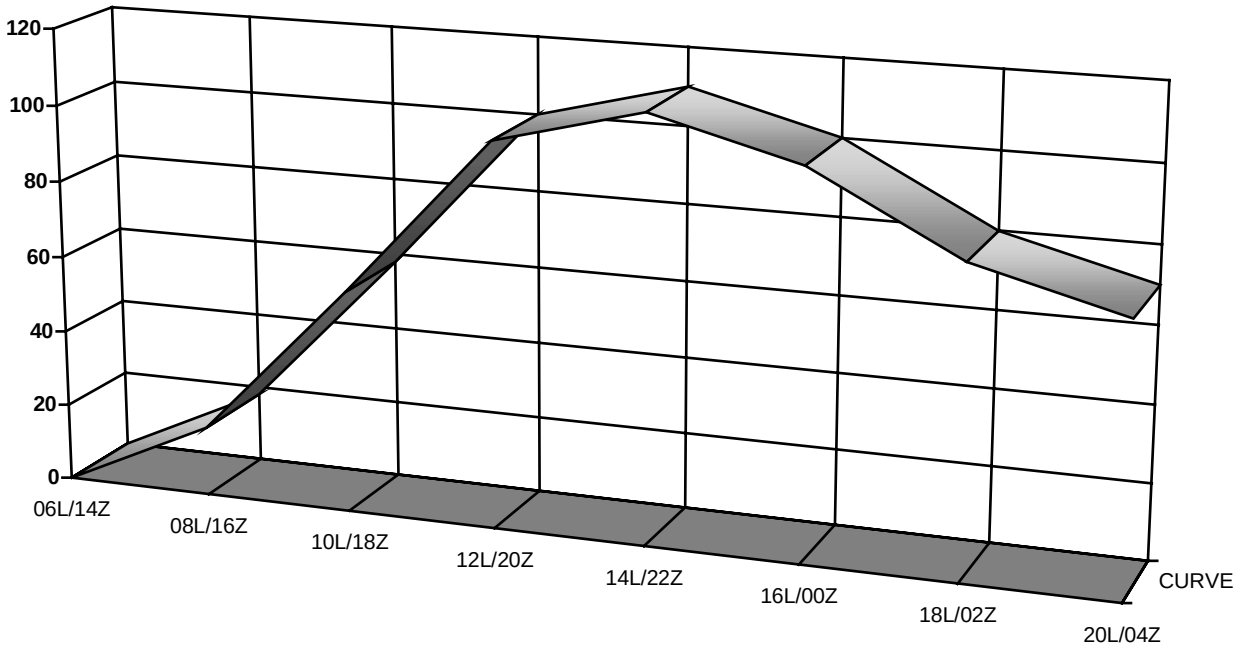
MONTH OF NOVEMBER



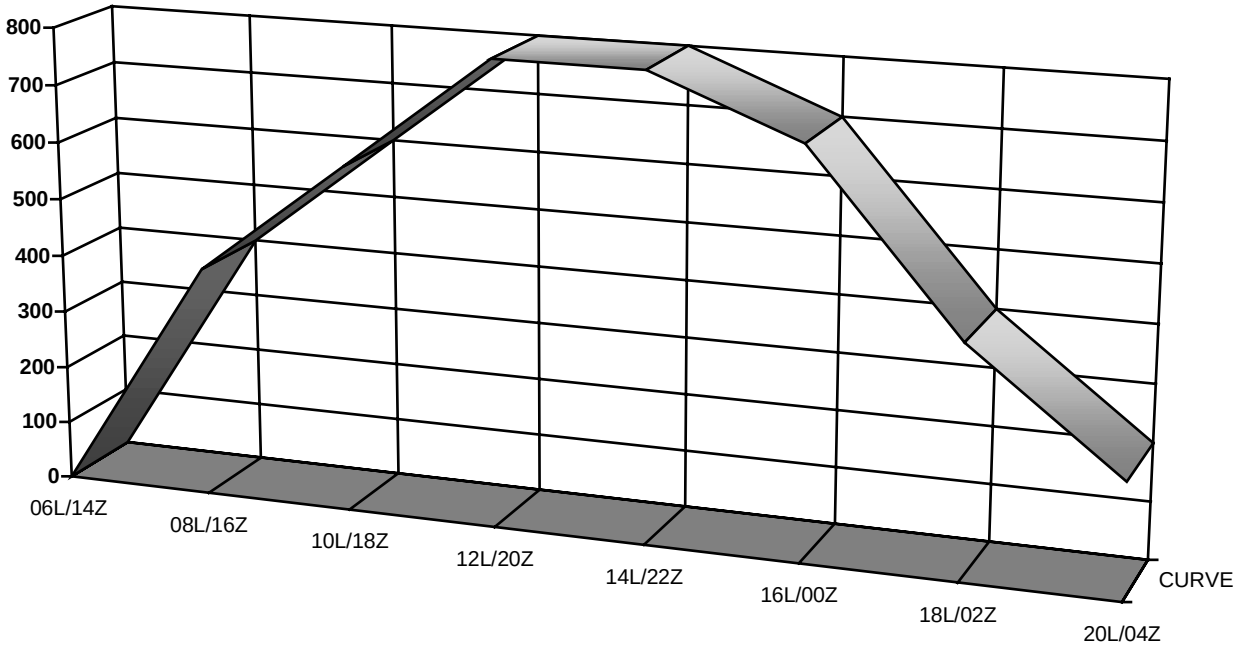
ALTIMETER CURVE
MONTH OF DECEMBER



PRESSURE ALTITUDE
MONTH OF JANUARY



DENSITY ALTITUDE
MONTH OF JANUARY



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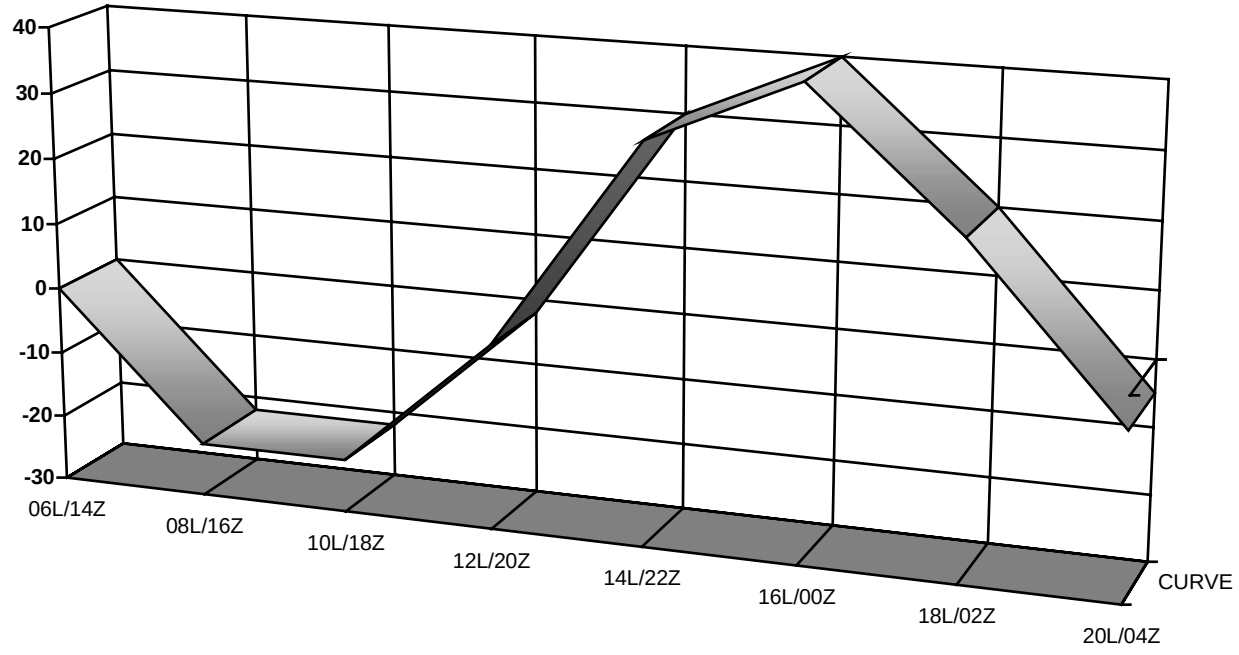
MONTH OF FEBRUARY



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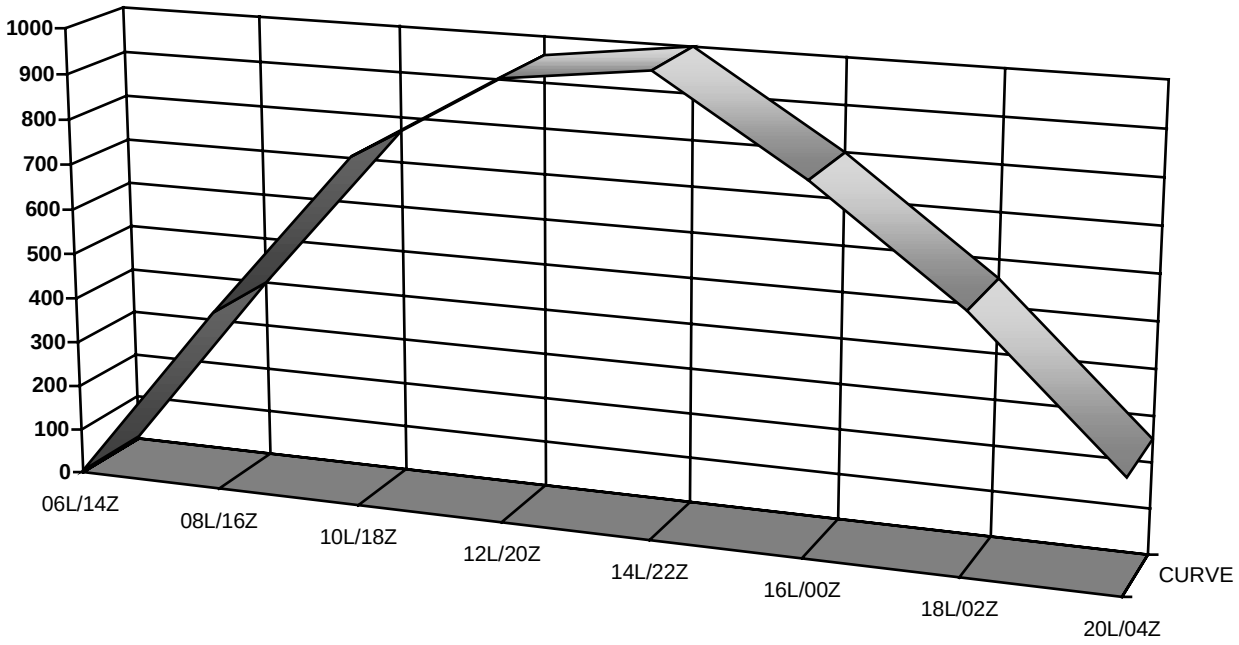
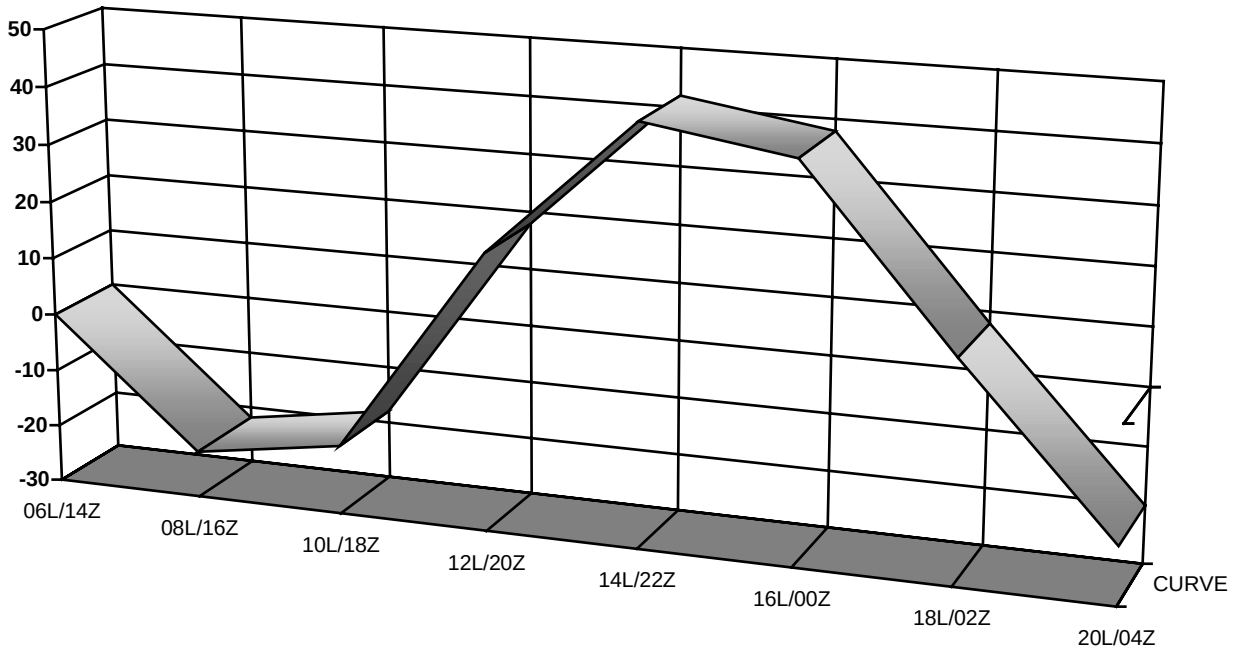


PRESSURE ALTITUDE
MONTH OF MARCH



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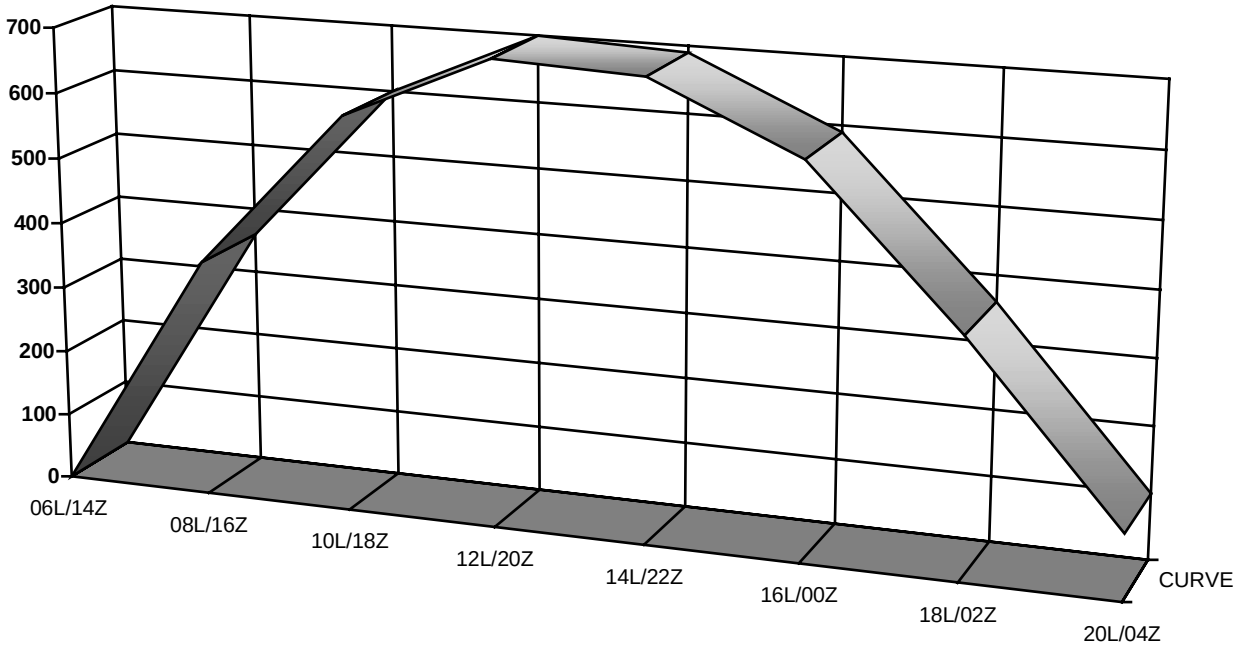
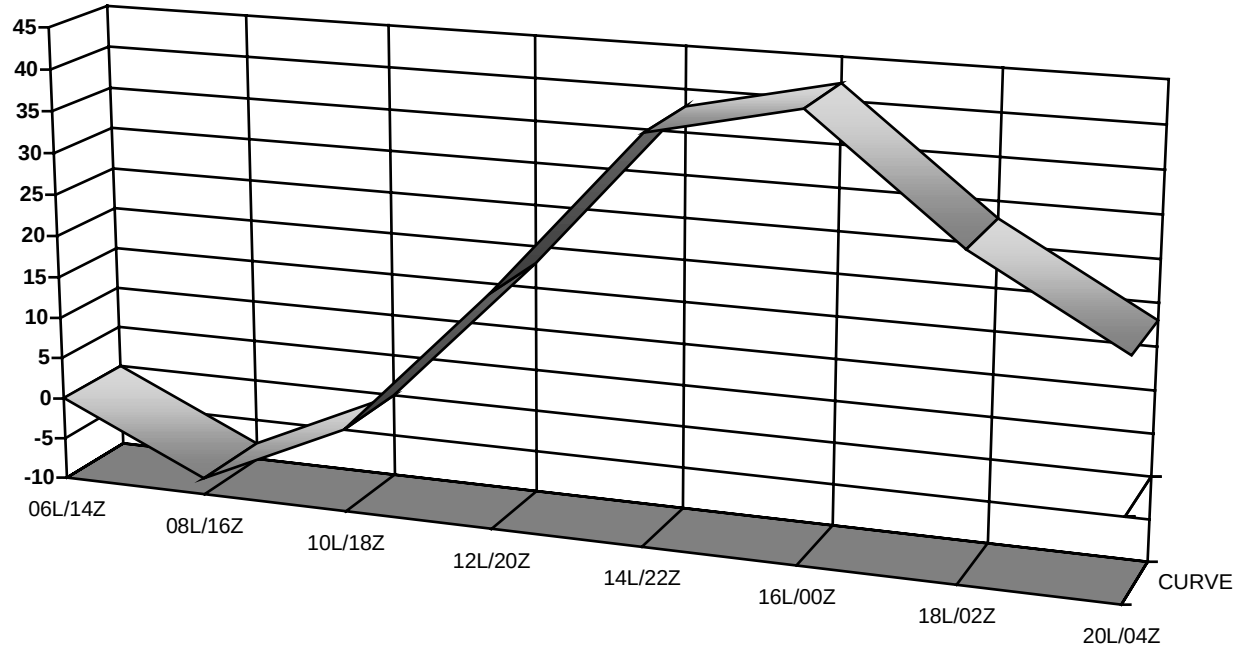
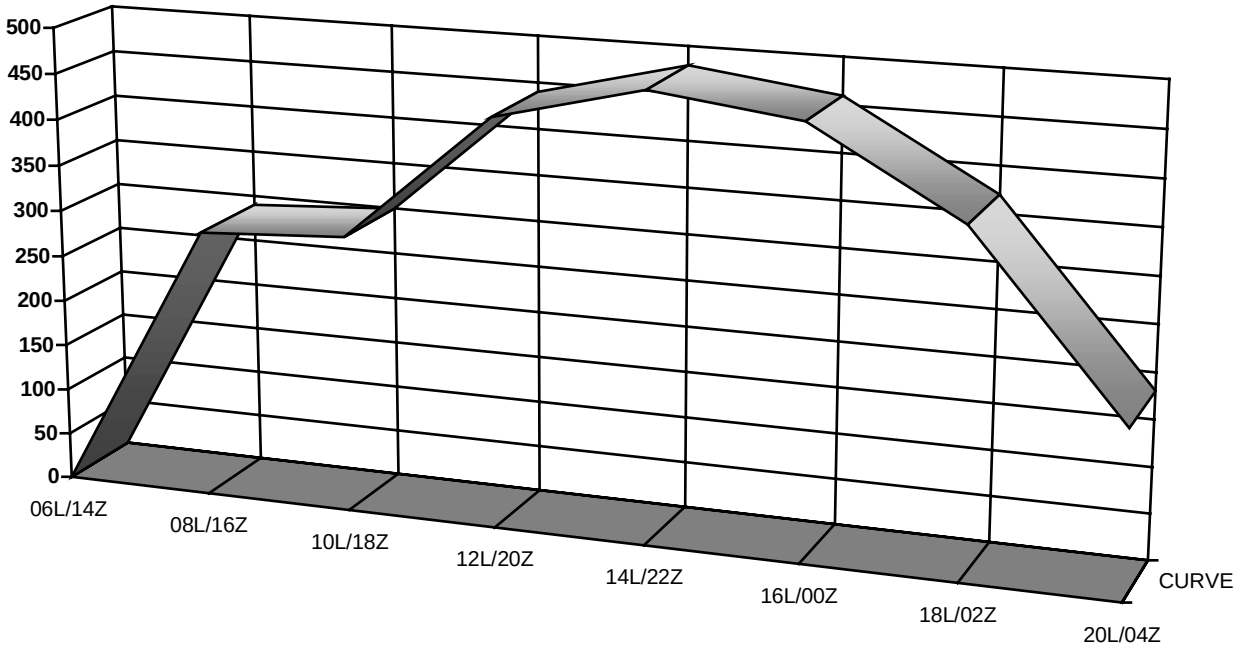
MONTH OF MARCH



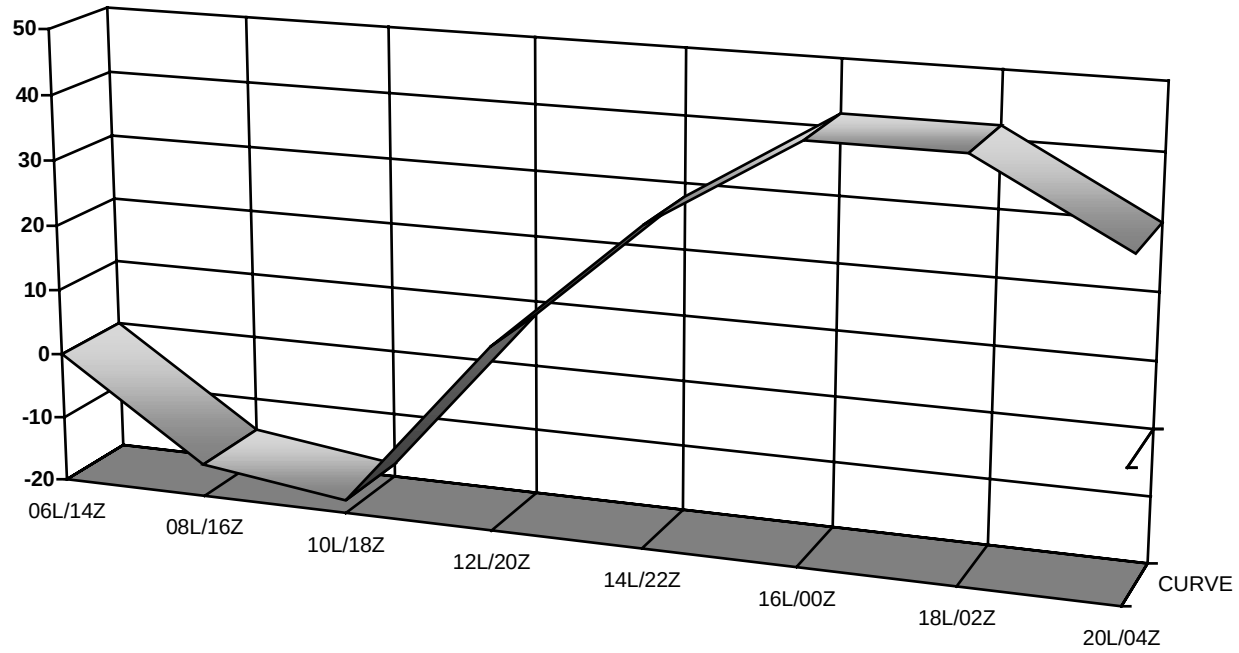
PRESSURE ALTITUDE
MONTH OF APRIL



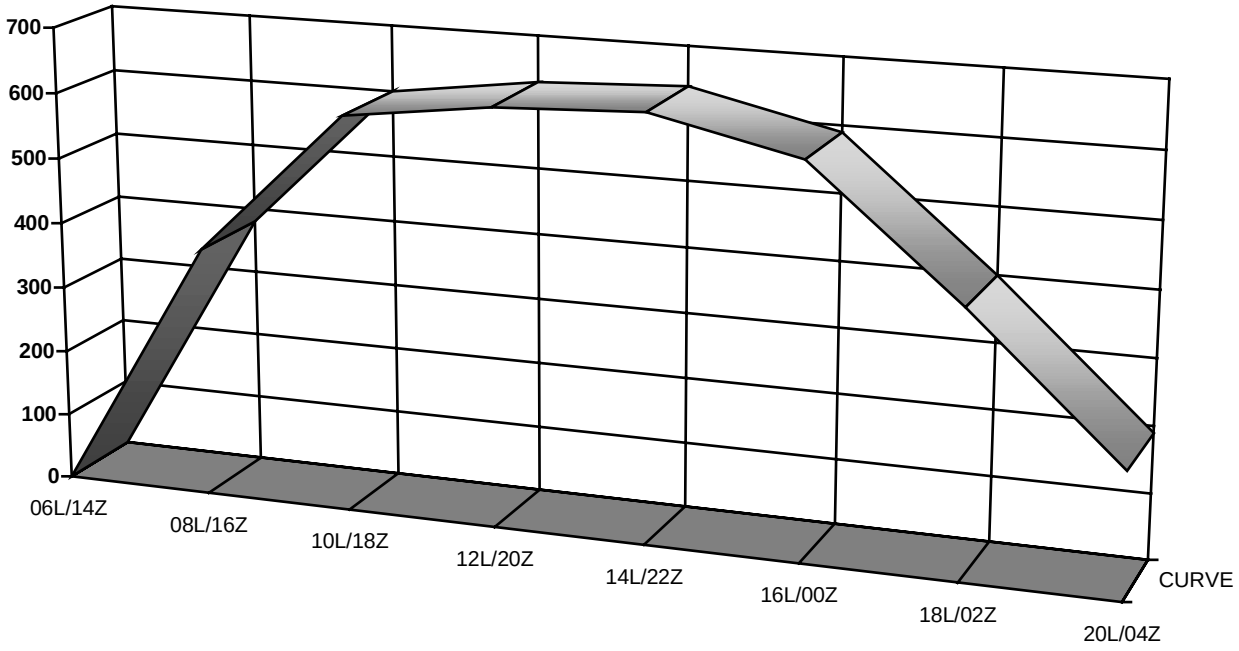
DENSITY ALTITUDE
MONTH OF APRIL



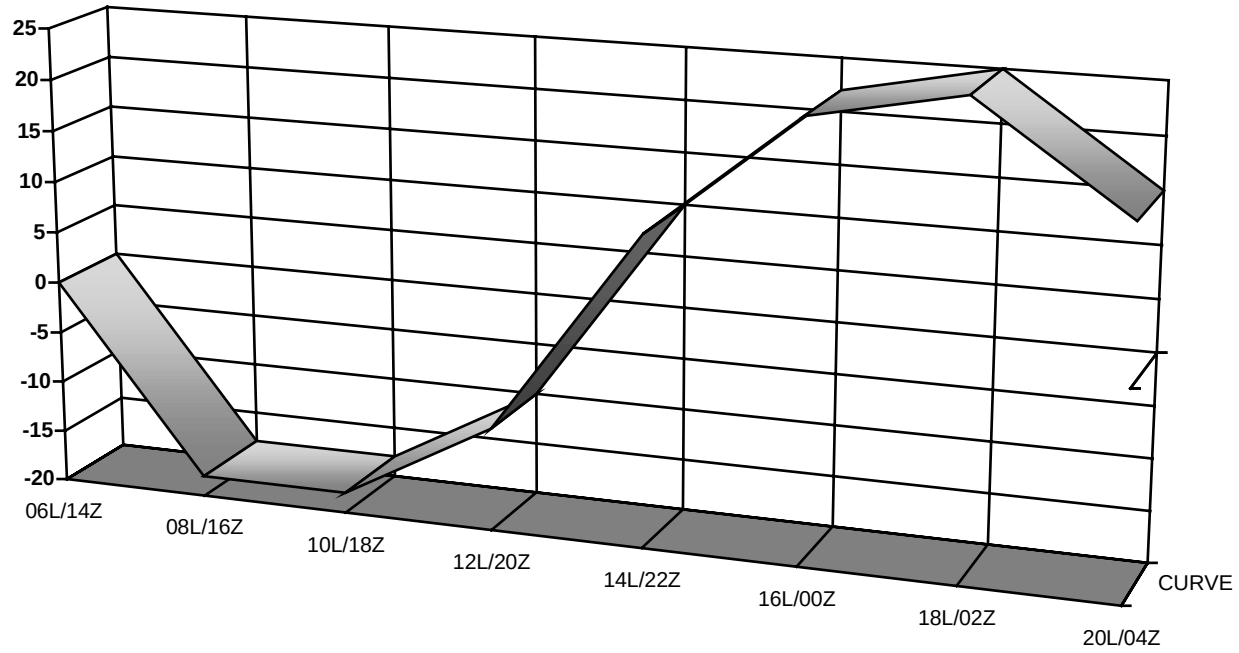
PRESSURE ALTITUDE
MONTH OF MAY



DENSITY ALTITUDE
MONTH OF MAY

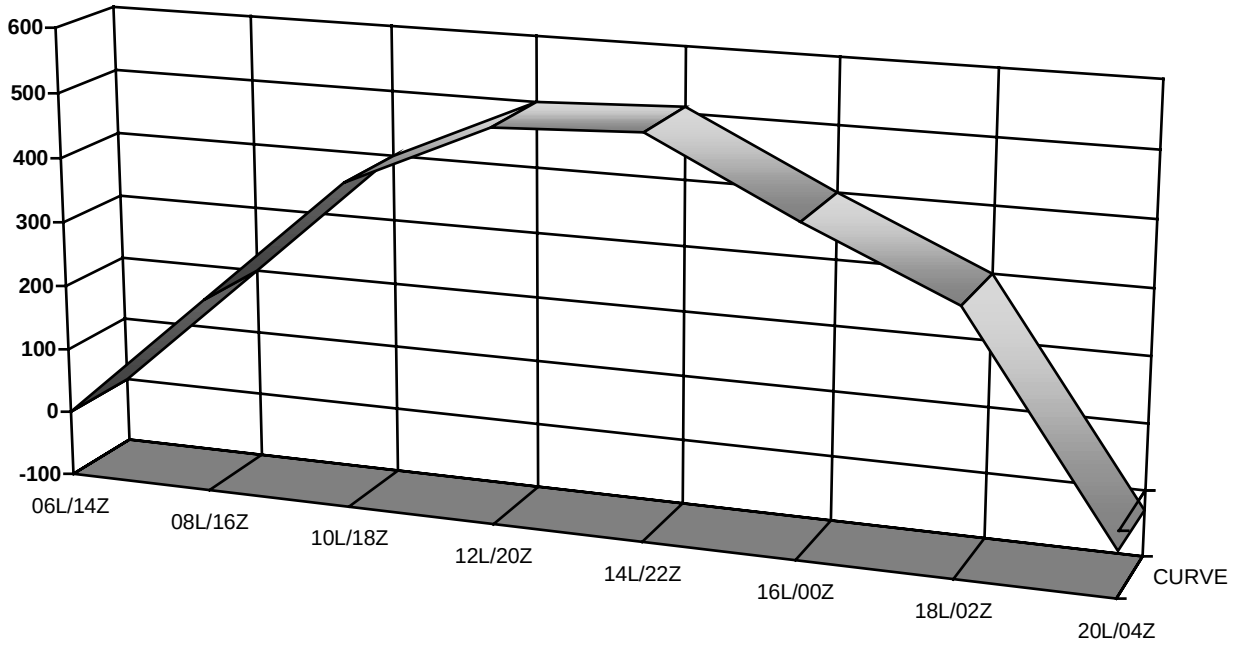


PRESSURE ALTITUDE
MONTH OF JUNE



DENSITY ALTITUDE

MONTH OF JUNE



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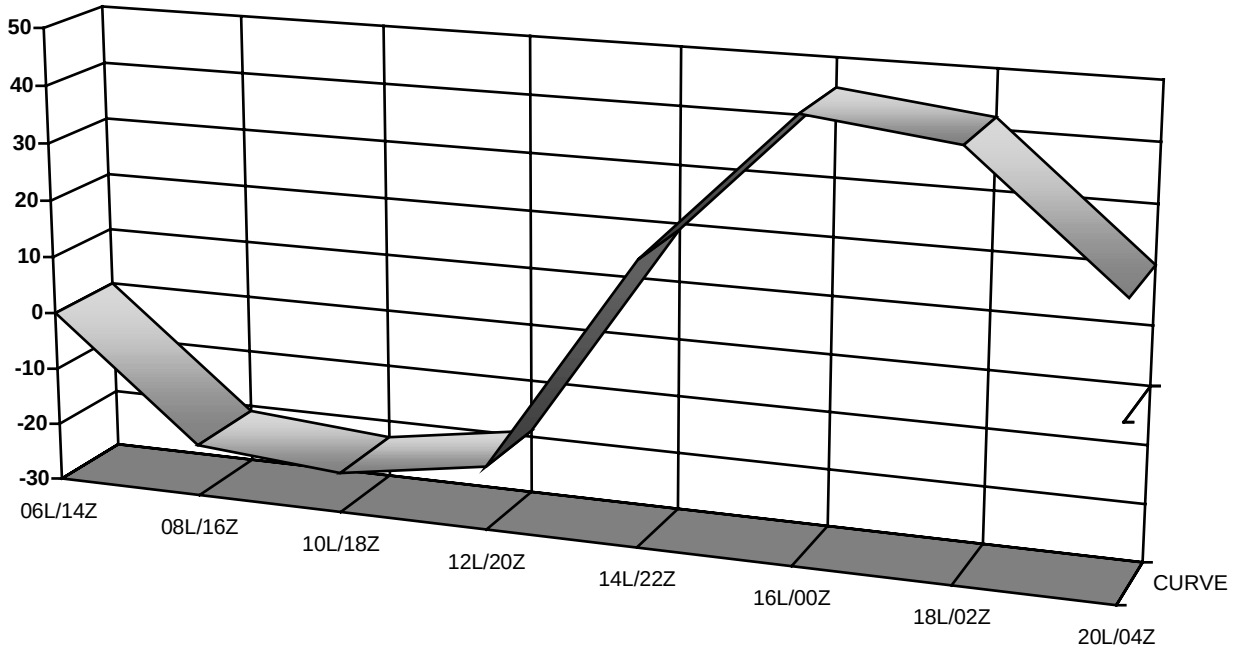
MONTH OF JULY



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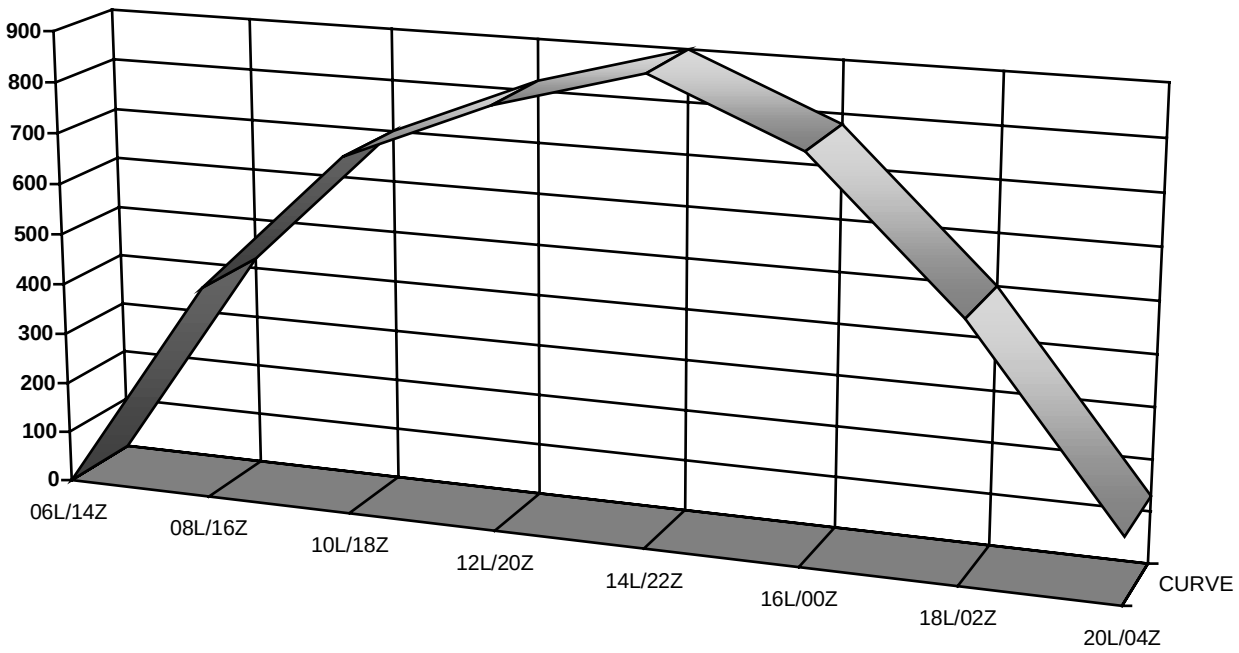
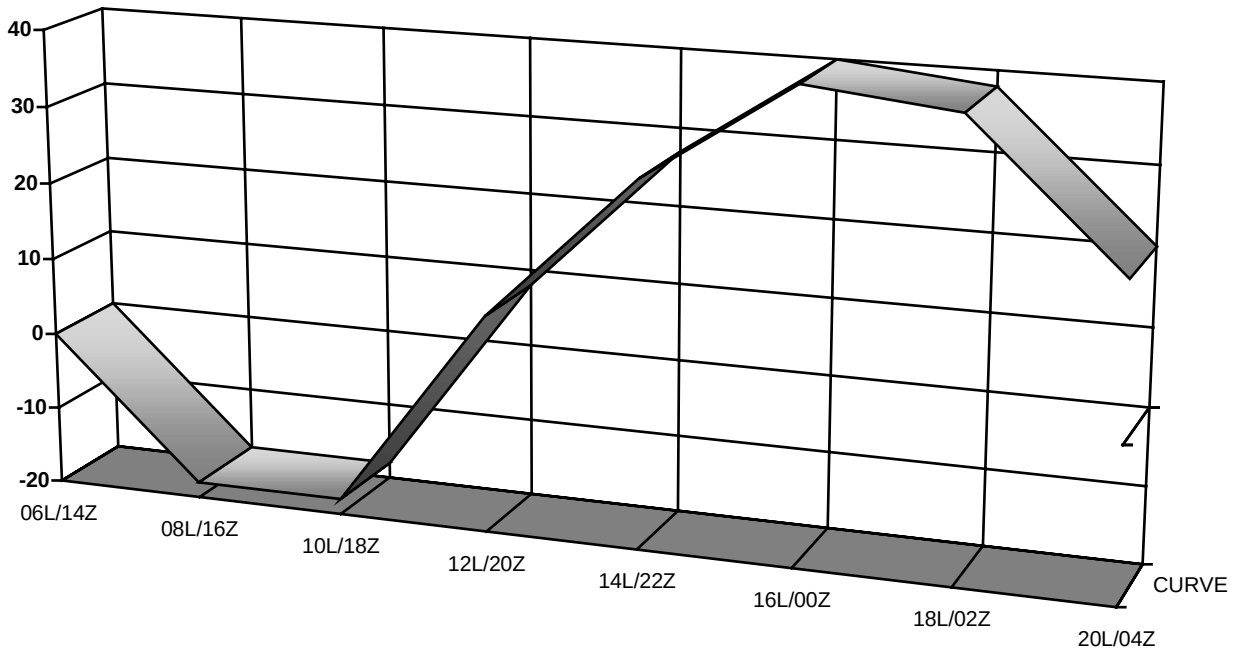
MONTH OF JULY



PRESSURE ALTITUDE
MONTH OF AUGUST



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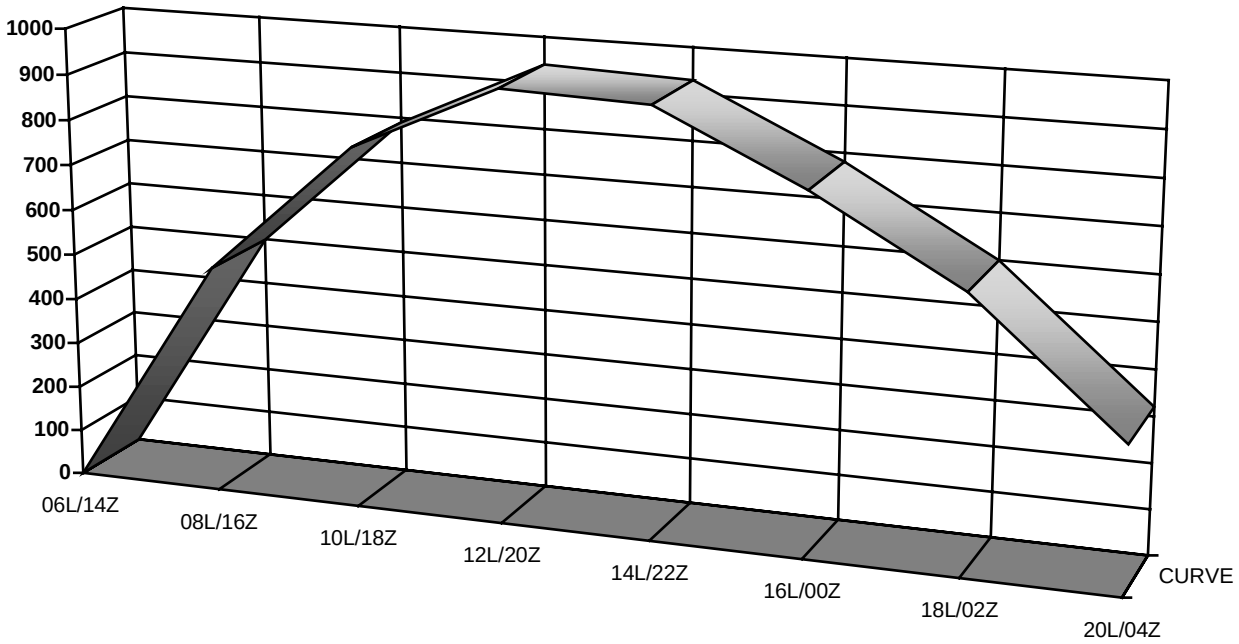
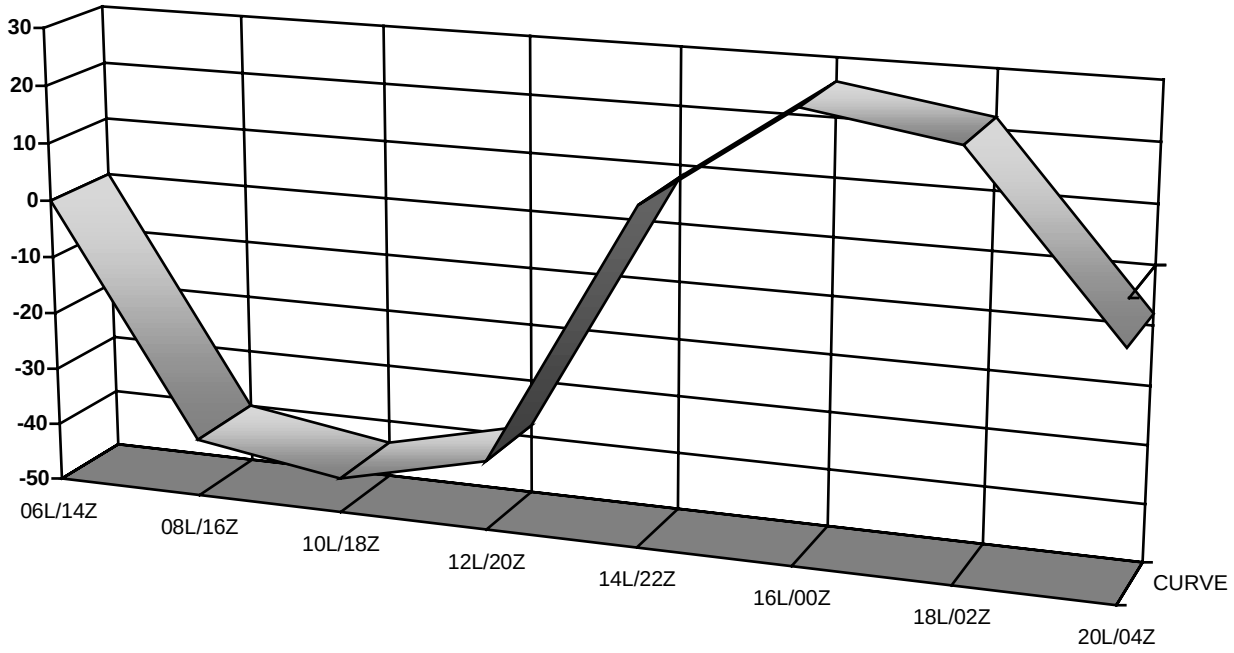
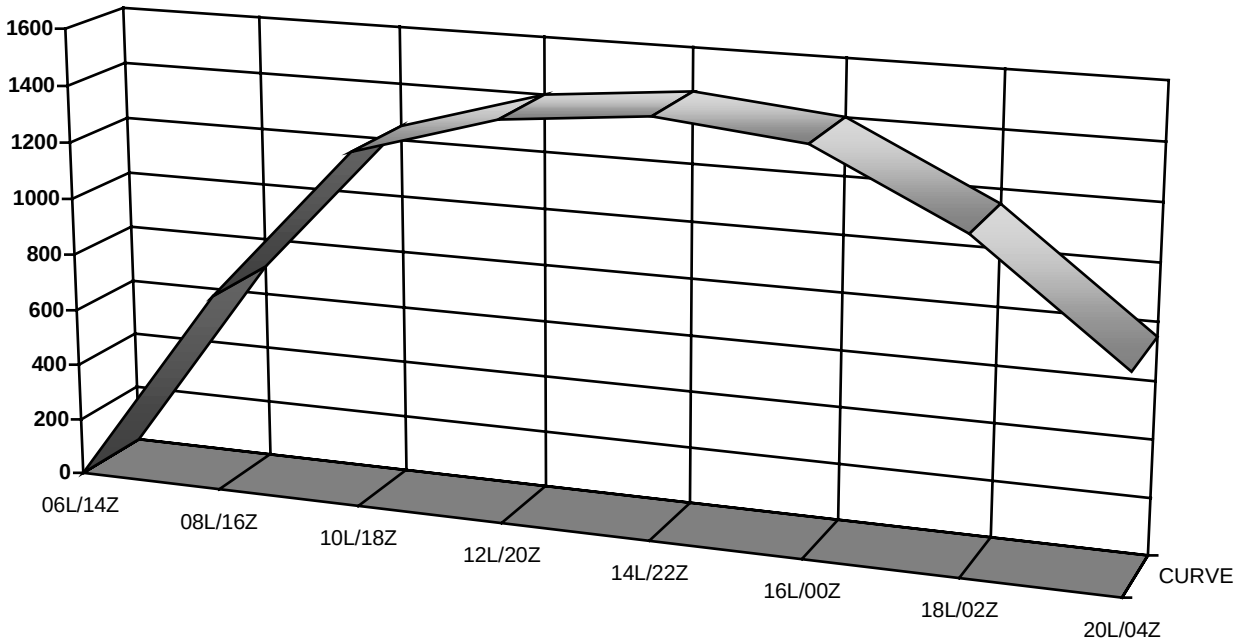
MONTH OF AUGUST



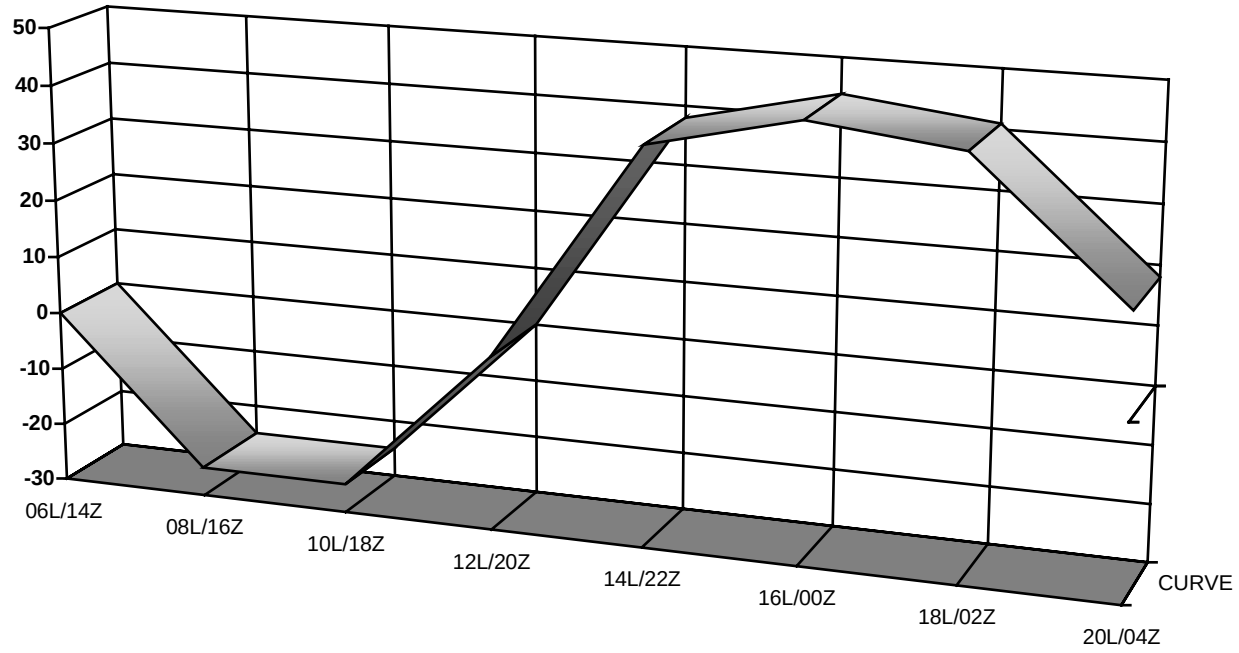
PRESSURE ALTITUDE
MONTH OF SEPTEMBER



DENSITY ALTITUDE
MONTH OF SEPTEMBER



PRESSURE ALTITUDE
MONTH OF OCTOBER



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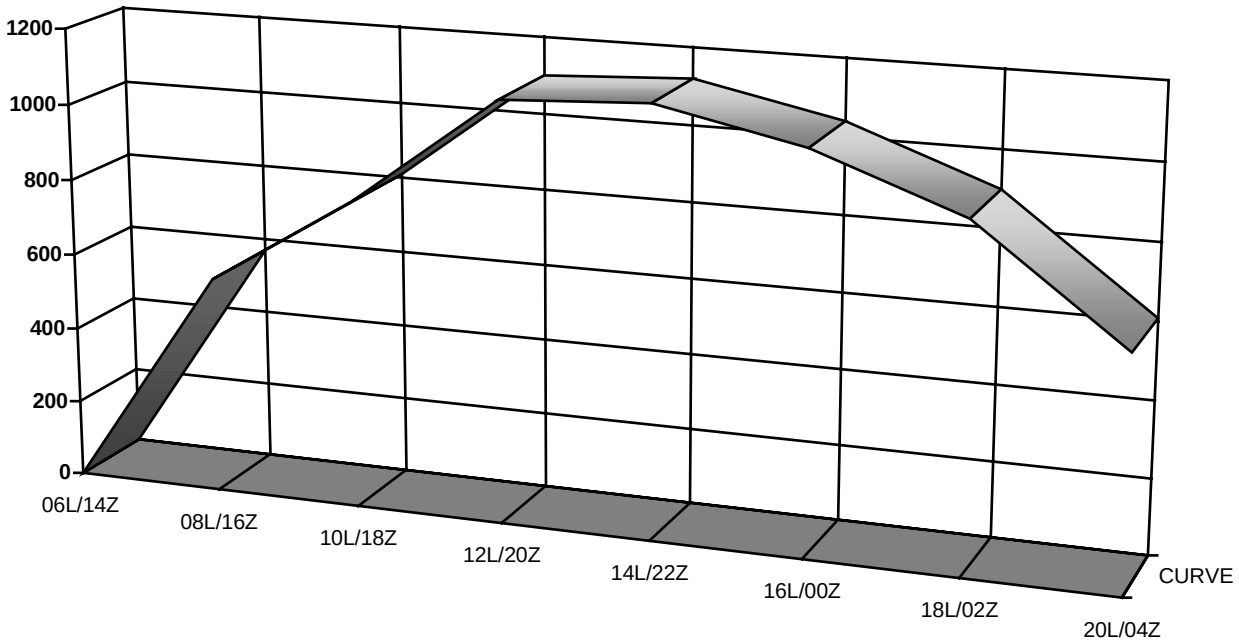
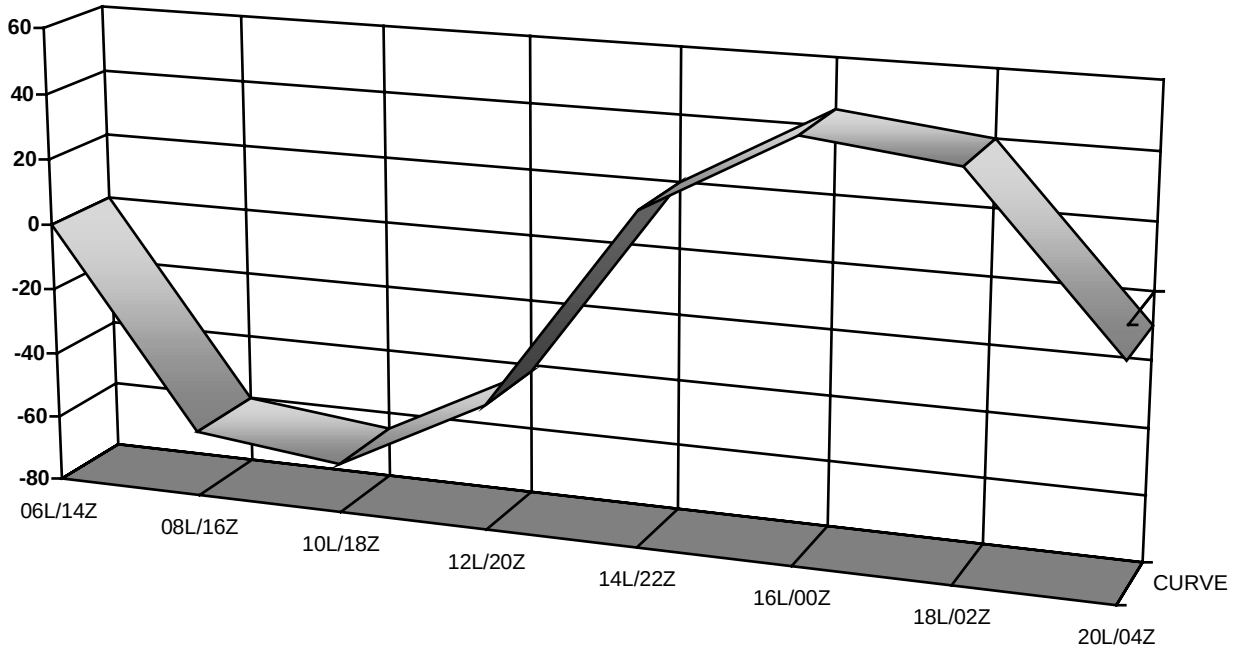


PRESSURE ALTITUDE
MONTH OF NOVEMBER



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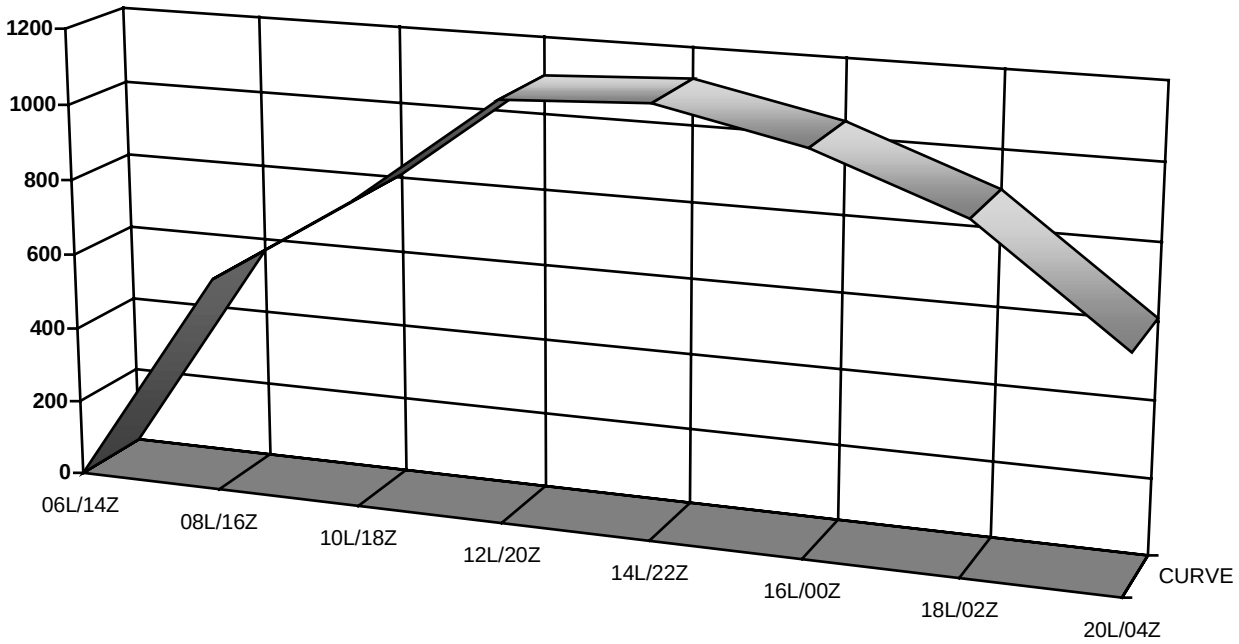
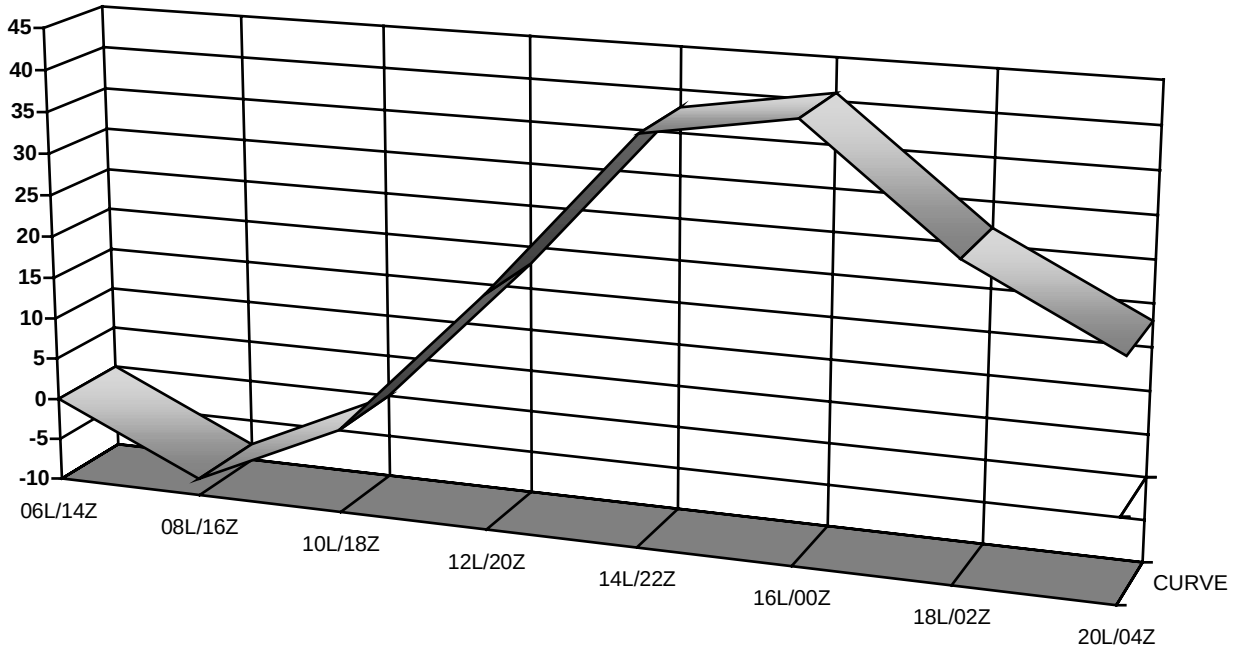
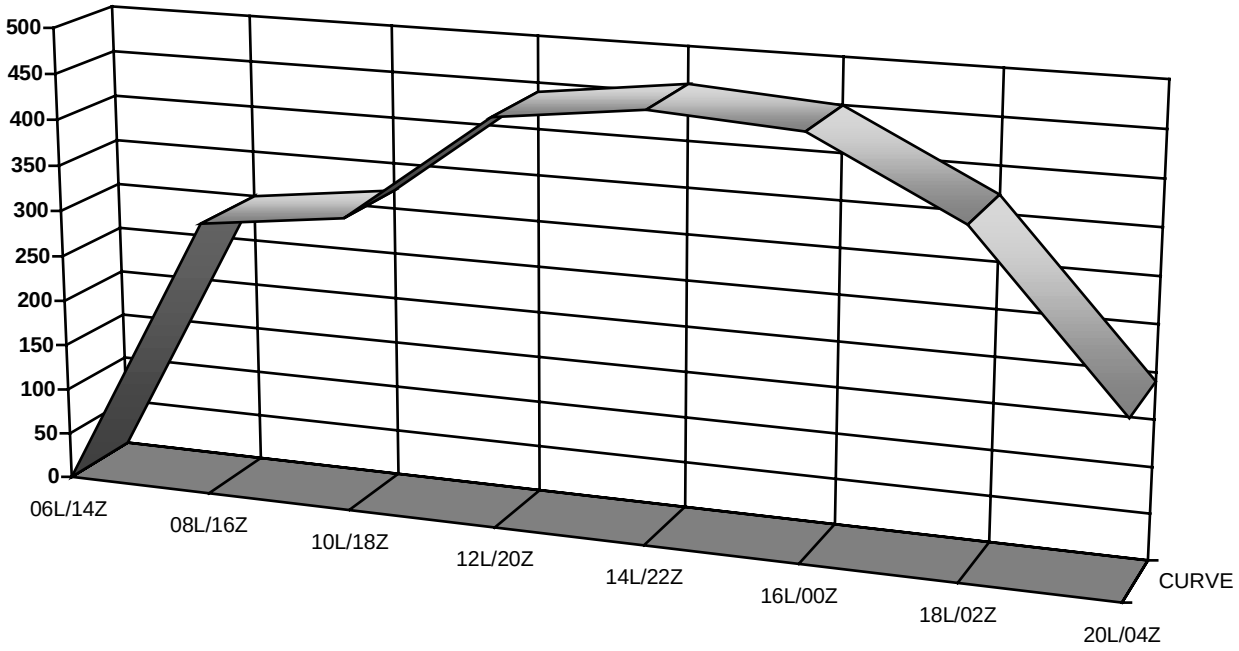


PRESSURE ALTITUDE
MONTH OF DECEMBER



DENSITY ALTITUDE
MONTH OF DECEMBER


500
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08L/16Z
10L/18Z
12L/20Z
14L/22Z
16L/00Z
18L/02Z
20L/04Z
CURVE

DEFINITIONS

ACOUSTICS. The total effect of sound.

ABSOLUTE MAX. Highest recorded value for an area.

ABSOLUTE MIN. Lowest recorded value for an area.

ANNUAL MEAN. Yearly average of historical data.

ANNUAL MAX. Highest recorded value for the year.

ANOMALIES. The deviation of (usually) temperature or precipitation in a given region over a specified period from the normal value for the same region.

AVERAGE. The mean of historical data.

AVG SPEED. Mean speed recorded in knots (1.15 statute miles per hour).

BATHYMETRY. The study of water depths.

BIOFOULING. Infestations.

BREAKWATER. A barrier that protects a harbor or shore from the full impact of waves.

BREAKER. A sea-surface wave, which is too steep to be stable.

BROACH. To veer or cause to veer broadside to the wind and waves.

CEILING. The height above the ground ascribed to the lowest broken or overcast layer; or the vertical visibility into an obscuring phenomena.

CLIMATOLOGY. The meteorological study of climate.

CIVIL TWILIGHT. The interval of incomplete darkness between sunrise or sunset and the time when the center of the sun's disc is 6 degrees below the sea-level horizon.

BCT - Beginning Civil Twilight
ECT - Ending Civil Twilight

DAYLIGHT SAVINGS TIME. Time which clocks are set one hour or more ahead of standard time to provide for more daylight at the end of the working day during late spring, summer, and early fall.

EDDY. A small volume of air (or any fluid) that behaves differently from the larger flow in which it exists.

EXTRA-TROPICAL CYCLONES. A cyclonic storm that most often forms along a front in middle and high latitudes. Also called a form of a middle latitude storm, a depression, and a low.

FETCH. The area in which ocean waves are generated by the wind.

FOG. A visible accumulation of minute water droplets, which are based at the Earth's surface

GALES. In the Beaufort wind scale, a wind whose speed is from 28-55 knots and categorized as follows: moderate, 28-33 kt; fresh gale, 34-40 kt; strong gale, 41-47 kt; and whole gale, 48-55 kt.

GRADIENT. The space rate of decrease of a function.

HEIGHT. Elevation.

IFR. Instrument flight rules. A flight conducted by use of navigational instruments that permits the flight crew to proceed without reference to visual landmarks or celestial fixes.

IMC. Instrument Meteorological Conditions, ceiling <1000 and/or visibility <3 miles.

KNOT. A unit of speed equal to 1 nautical mile per hour (1 knot equals 1.15 mi/hr).

LI%. Lunar Illumination Percentage.

LITTORAL. A shore or coastal region.

METOC. Meteorological and Oceanograpic.

MIXED LAYER (SONIC LAYER). The surface layer of virtually isothermal water.

MOONRISE (MR). The instant when the upper edge of the moon appears on the sea-level horizon.

MOONSET (MS). The instant when the upper edge of the moon disappears below the sea-level horizon.

NAUTICAL MILES. 1852 meters, 1.15 statute miles.

NAUTICAL TWIGLIGHT. The interval of incomplete darkness between sunrise or sunset and the time when the center of the sun's disc is 12 degrees below the sea-level horizon.

BNT - Beginning Nautical Twilight
ENT - Ending Nautical Twilight

OBSERVATIONS. An evaluation of one or more meteorological elements that describe the state of the atmospheric either at the Earth's surface or aloft.

PERIOD. The time interval between passages, at a fixed point.

PRECIPITATION. Any or all forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground.

RELATIVE HUMIDITY. The ratio of the amount of water vapor actually in the air compared to the amount of water vapor the air can hold at that particular temperature and pressure.

SALINITY. A measure of dissolved salts in sea water.

SEAS. The condition of the ocean's surface with regard to its course, flow, swell, or turbulence.

SEA SURFACE TEMPERATURE. A measure of translational molecular kinetic energy at the sea surface.

SEDIMENTS. Material carried in suspension by water; or deposits of waterborne materials.

SHOALING. A sandy elevation of the bottom of a body of water, constituting a hazard to navigation.

SUNSET (SS). The instant when the upper edge of the sun disappears below the sea-level horizon.

SUNRISE (SR). The instant when the upper edge of the sun appears on the sea-level horizon.

SURF. The sea-surface wave activity between the outermost line of breakers and the shores.

SURFACE WIND. Direction is given on a 16 point compass in relation to TRUE NORTH and speed is given in knots (KT).

SWELL PERIODS. A long wave which moves continuously without breaking.

TEMPERATURE. A measure of translational molecular kinetic energy (Degree of hotness or coldness). Listed in degrees Fahrenheit. To convert to Celsius: C = (f-32)/1.8.

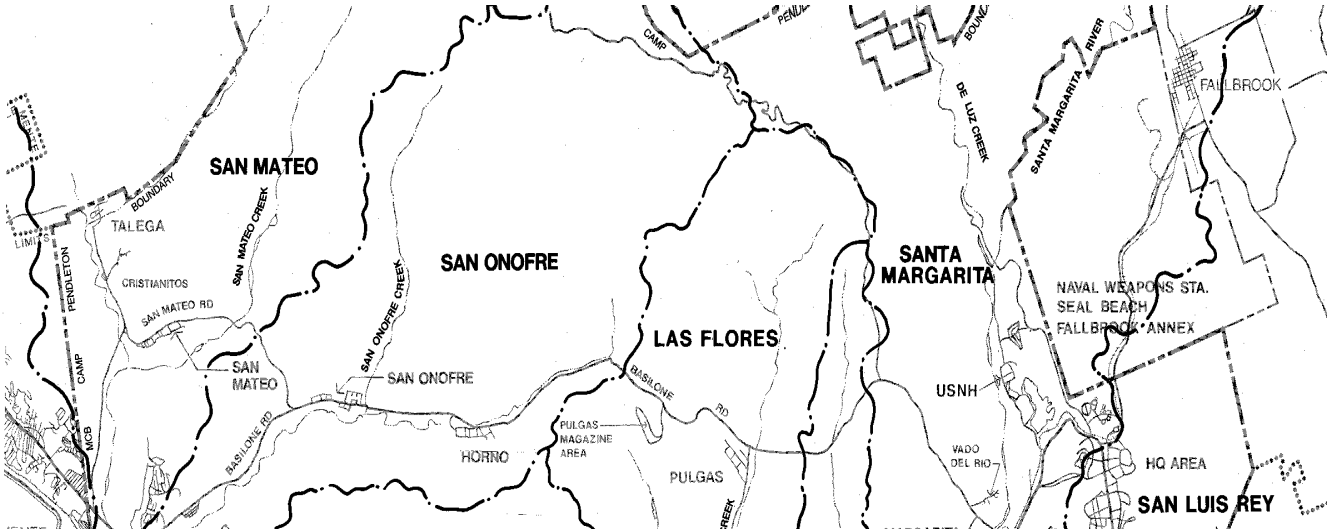
TIDES. The periodic rise and fall of the water resulting from gravitational interactions between the Sun, Moon, and Earth.

UPWELLING. The rising of water (usually cold) toward the surface from the deeper regions of a body of water.

VFR. Visual flight rules. A set of regulations set down by the U. S. Civil Aeronautics Board to govern the operational control of aircraft during visual flight.

VISIBILITY. A measure of the opacity of the atmosphere and is expressed in terms of the horizontal distance at which you are able to see and identify specified objects.

VMC. Visual Meteorological Conditions, ceiling $\geq$1000 and visibility $\geq$3 miles.

WAVES. Any pattern with some roughly identifiable periodicity in time and/or space.

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