FMFRP 0-59

The Environment and Its Effects on Materiel, Personnel, and Operations with Special Emphasis on the Middle East

U.S. Marine Corps

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DEPARTMENT OF THE NAVY
Headquarters United States Marine Corps
Washington, DC 20380-0001

19 October 1990

FOREWORD

1. PURPOSE

FMFRP 0-59, The Environment and its Effects on Materiel, Personnel and Operations with Special Emphasis on the Middle East, provides an overview of the problems encountered in desert warfare and some of their solutions.

2. BACKGROUND

a. Desert operations have much in common with operations in the other parts of the world. The unique aspects of desert operations stem primarily from deserts' heat and lack of moisture. While these two factors have significant consequences, most of the doctrine, tactics, techniques, and procedures used in operations in other parts of the world applies to desert operations. The challenge of desert operations is to adapt to a new environment.

b. FMFRP 0-59 was prepared by Mr. Paul Krause of the U.S. Army Engineer Topographic Laboratories to fill the need raised by Operation Desert Shield for a brief manual which orients commanders and soldiers on the problems associated with military operations in Saudi Arabia. FMFRP 0-59 was originally published in September 1990 as Operational Handbook 0-59.

c. Because the need for the information in this handbook arose suddenly and without warning, much of the material included in this handbook is drawn from draft documents and old documents. Consequently, while the general nature of the problems described is correct, specific solutions mentioned in the book may not in practice be adequate. This manual offers some well-founded theories which have given those operating in deserts the professional judgment to be effective.

3. SUPERSESSION

Operational Handbook 0-59, The Environment and its Effects on Materiel, Personnel and Operations with Special Emphasis on the Middle East; however, the texts of FMFRP 0-59 and OH 0-59 are identical and OH 0-59 will continue to be used until the stock is exhausted.

4. RECOMMENDATIONS

Users' comments are valuable to improving this manual. Submit comments to --

Commanding General
Marine Corps Combat Development Command (WF12)
Quantico, VA 22134-5001

5. CERTIFICATION

Reviewed and approved this date.

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS

M. P. CAULFIELD
Major General, U.S. Marine Corps
Deputy Commander for Warfighting
Marine Corps Combat Development Command
Quantico, Virginia

DIST: 1400059000

The Environment and its Effects on Materiel, Personnel and Operations With Special Emphasis on the Middle East

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SELECTED INFORMATION

THE ENVIRONMENT AND ITS EFFECTS ON MATERIEL, PERSONNEL AND OPERATIONS WITH SPECIAL EMPHASIS ON THE MIDDLE EAST

24 AUGUST 90

PART A. SUMMARIZED INFORMATION

GATHERED AND PREPARED
BY
ENVIRONMENTAL EFFECTS BRANCH
U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES
FORT BELVOIR, VA 22060-5546

PART A: TABLE OF CONTENTS

CAVEAT

THE INFORMATION CONTAINED HEREIN WAS EXTRACTED FROM THE FILES OF THE ENVIRONMENTAL EFFECTS BRANCH, U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES, FORT BELVOIR, VIRGINIA.

THIS INFORMATION IS INTENDED TO GIVE THE READER AN APPRECIATION OF THE MIDDLE-EAST ENVIRONMENT AND TO HIGHLIGHT SOME OF THE EFFECTS THAT THE DESERT ENVIRONMENT CAN HAVE ON EQUIPMENT, PERSONNEL AND OPERATIONS.

THIS INFORMATION SHOULD NOT BE CONSIDERED TOTALLY COMPLETE. ENVIRONMENTAL EFFECTS, OTHER THAN THOSE CITED HEREIN, MAY OCCUR.

THIS DOCUMENT IS NOT INTENDED TO SUPERSEDE OR REPLACE ANY CURRENT DOCTRINE OR TRAINING PRACTICES.

SECTION I. ENVIRONMENT -- GENERAL

SECTION I. ENVIRONMENT -- GENERAL

General Climate

In the Arabian desert a persistent wind called the shamal blows from May through August.

The deserts of the Middle east are very hot during the summer months, but lower delta area of Iraq and the coastal areas of the Persian Gulf and the gulf itself are some of the hottest and most oppressive parts of the world.

During August, the hottest month for Iraq, temperatures of 120°F have been recorded near Basra and Diwaniya.

Along the Arabian coast of the Persian Coast the summer wind (shamal) a hot desiccating wind brings normal activity to a halt for a few days almost every year.

Climatic Conditions

* The Persian Gulf area has the most severe combination of high temperatures and high humidities found anywhere in the world. The Red Sea area is only a little less severe. At prototype stations along the Persian Gulf such as Abadan, Iran, Kuwait City, Kuwait, and Bahrein Island one can encounter summer conditions with ambient air temperatures of 105° F (41° C), dewpoints of 88° F (31° C), relative humidities of 59 per cent, and noontime solar radiation intensities of 343 BTU's per sq ft per hr (1080 watts per sq meter). This combination of conditions makes prolonged work by humans nearly impossible. It also severely affects many types of military equipment. Environmental control (e.g., air conditioning) problems are much more severe under these extreme conditions than under more typical high temperature/high humidity conditions.

* The highest surface water temperature in the oceans was recorded in the Persian Gulf. An August temperature of 101° F (38° C) was meaured in the shallow waters of the Gulf. In August temperatures above 94° F occur 20 per cent of the time, temperatures above 95° F occur 5 per cent of the time, and temperatures above 96° F occur 1 per cent of the time.

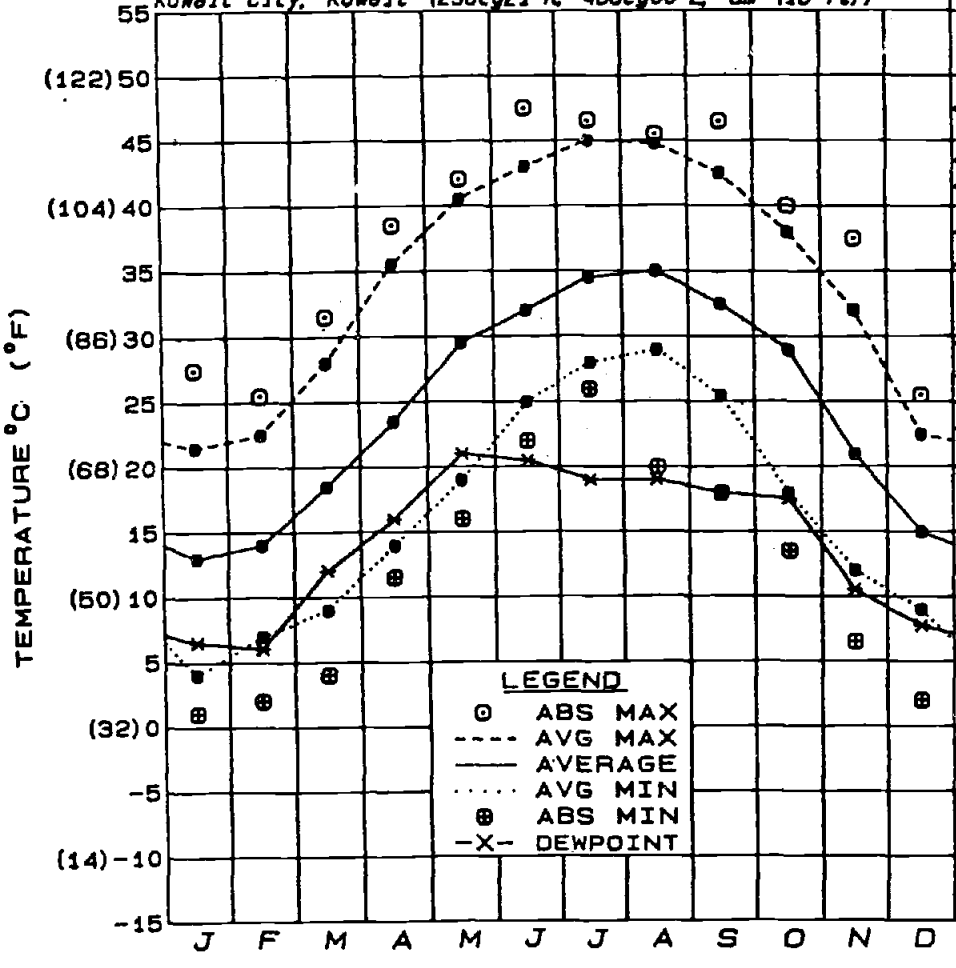
SECTION II. ENVIRONMENT -- SITE SPECIFIC

SECTION II. ENVIRONMENT -- SITE SPECIFIC

FIGURE 3

MONTHLY TEMPERATURE DISTRIBUTIONS
WITH
ASSOCIATED PROBABILITIES AND DURATIONS
FOR THE
HOT CLIMATIC DESIGN TYPE
HOT-HUMID CYCLE

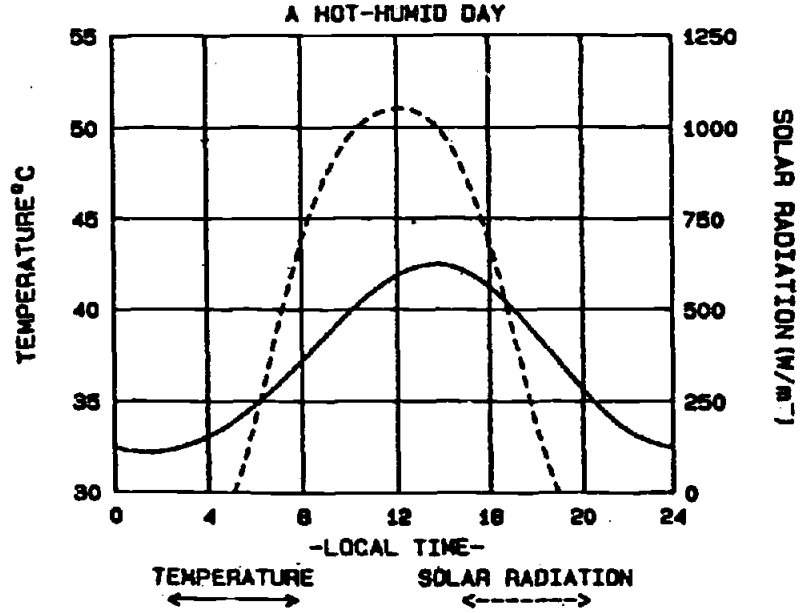
Kuwait City, Kuwait (29deg21'N, 48deg00'E, 3m (16 ft))



PROBABILITY OF BEING EQUAL TO OR HIGHER THAN INDICATED TEMPERATURES			TEMPERATURE DURATION #
HOT-HUMID		WORLDWIDE	HOT-HUMID
HOTTEST MONTH	ANNUAL	ANNUAL	HOTTEST MONTH
< .0001	< .0001	< .0001	< 1
< .001	< .001	< .001	< 9
< .01			< 7
			< 12
< .1	< .01	< .01	< 40
< .5			< 100
	< .1		< 225
< .9		< .1	
< .99			< 744
< .999			
< .9999	< .5		
	< .9	< .5	
	< .99		
	< .999		
	< .9999	< .75	
		< .9	

MAXIMUM NO. OF CONSECUTIVE HOURS AT OR HIGHER THAN INDICATED TEMPERATURES (91-DAY MONTH)

TYPICAL TEMPERATURE AND
SOLAR RADIATION CYCLES ON
A HOT-HUMID DAY



TEMPERATURE °C

PROBABILITY OF EQUALLING OR EXCEEDING

	J	F	M	A	M	J	J	A	S	O	N	D
.0001	26	24	30	37	41	48	45	44	44	38	35	25
.001	24	22	28	35	39	44	44	42	42	37	33	23
.01	21	20	26	33	37	42	42	40	40	35	30	21
.1	18	17	23	29	34	38	39	38	37	32	26	18
.5	13	14	19	24	30	32	35	35	33	29	21	15
.8	10	11	14	20	23	28	31	30	28	24	18	11
.99	7	8	11	16	19	27	30	28	25	21	13	8
.999	5	7	8	16	16	25	29	24	23	18	10	6
.9999	3	5	6	14	16	24	28	22	21	16	8	4

IRAQ
GENERAL INFORMATION

TIGRIS RIVER

Source: DMA Pub. 170

* Flows SSE past Baghdad then SE to its junction with the Euphrates at Al Qurnah (31 00'N 47 26'E).
* The tidal effect is felt for about 30 miles above Al Qurnah.
* Only shallow-draft vessels can navigate the river above Al Qurnah.
* Vessels with a 3Ft draft can reach 200 miles NNW of Baghdad.
* Rise in river by rain & snow begins the middle of November.
* The river is full by the end of December.
* The river begins to fall in May.
* The river reaches its lowest level in September.
* The river is narrow and is difficult to navigate with its many bends and strong current of 3 to 4 knots.

IRAQ
GENERAL INFORMATION

EUPHRATES RIVER

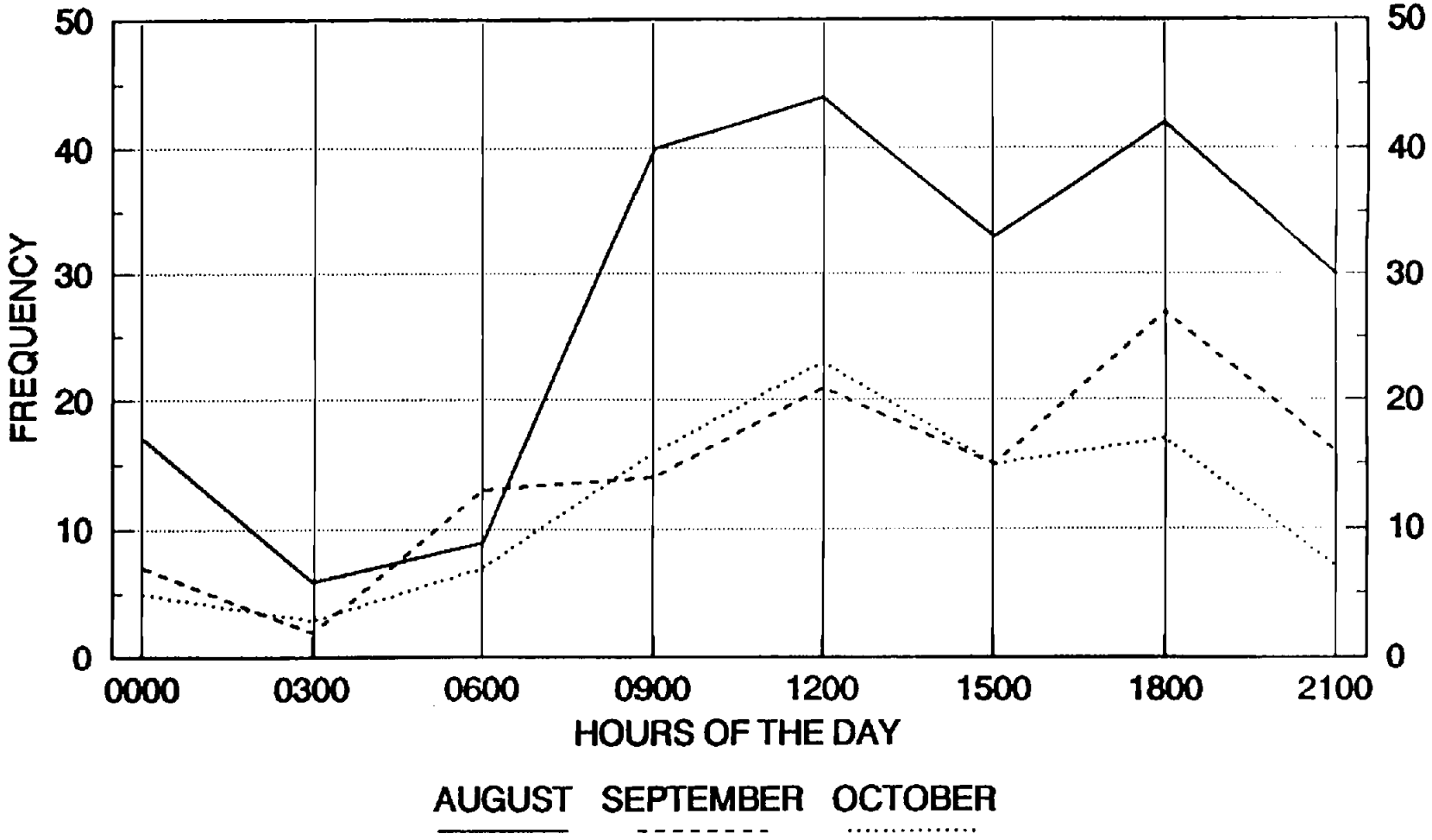
Source: DMA Pub. 170

* Flows from Syria to its junction with the Tigris river at Al Qurnah (31 00'N 47 26'E).
* There is little current.
* The bottom is composed of soft mud.
* From Al Qurnah the main channel leads WSW with depths to 12 Ft.
* Vessels with drafts of 12 Ft ascend the river for about 20 miles.
* Vessels with 4 Ft drafts can reach the entrance of Hawr al Hammar.
* The lake only has depths of 2 to 3 Ft.

CLIMATE (VISIBILITY: IRAQ & KUWAIT)

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

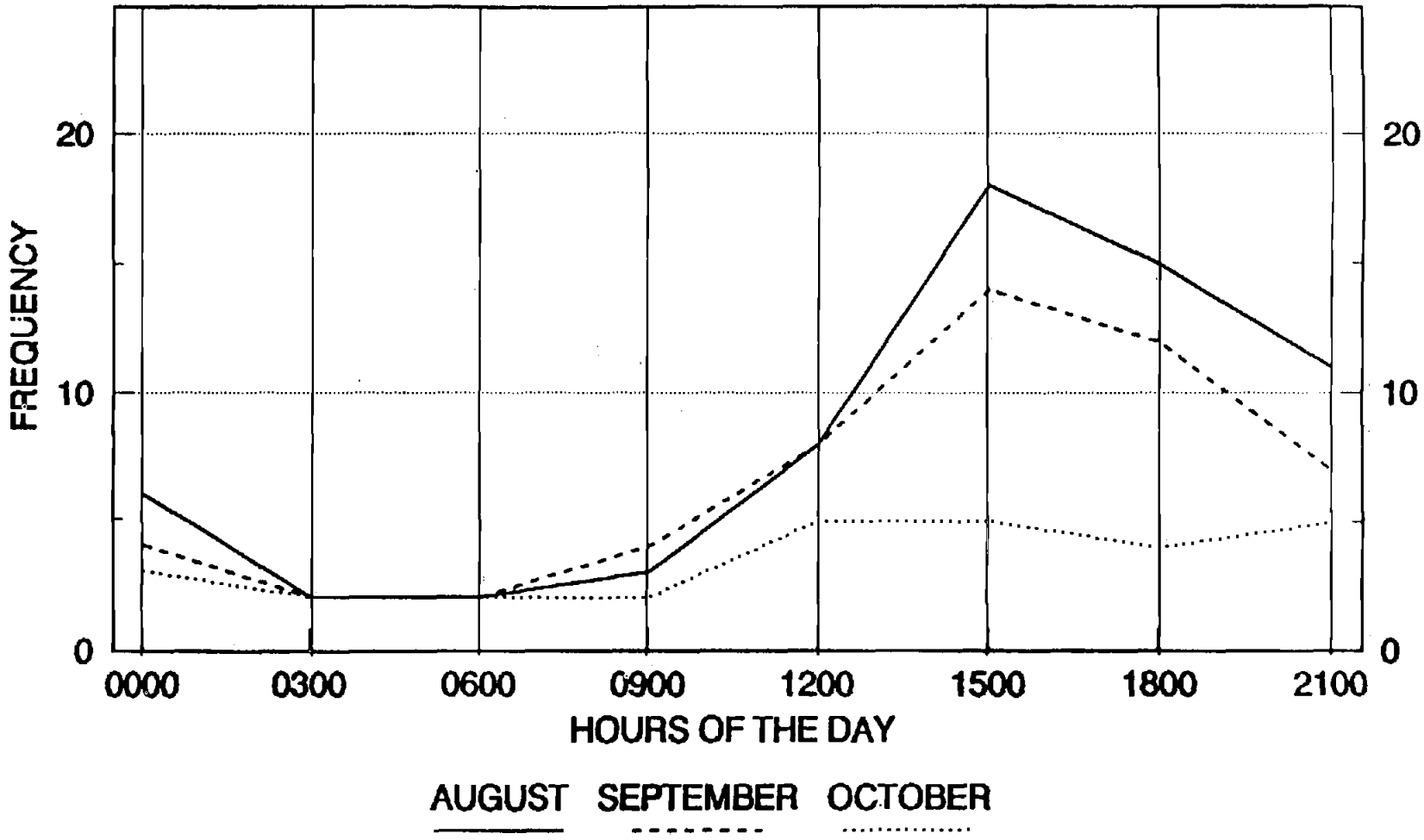
KUWAIT, KUWAIT



SOURCE: ECOM-DR-75-4
BASED ON 20 YEARS OF DATA

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

BASRA, IRAQ

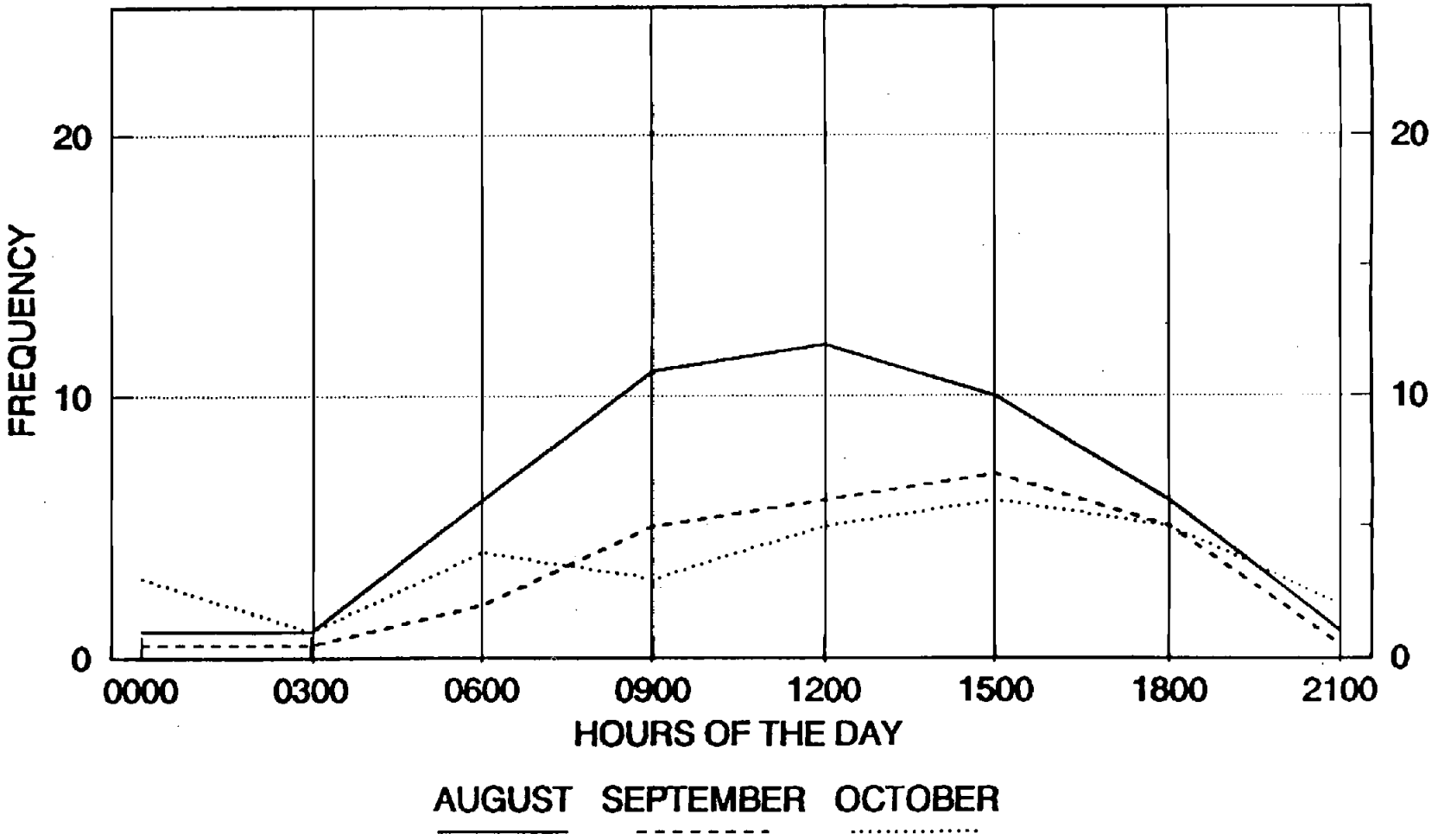


SOURCE: ECOM-DR-75-4
BASED ON 15 YEARS OF DATA

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS

WITH VISIBILITY < 7 MILES IN BLOWING DUST

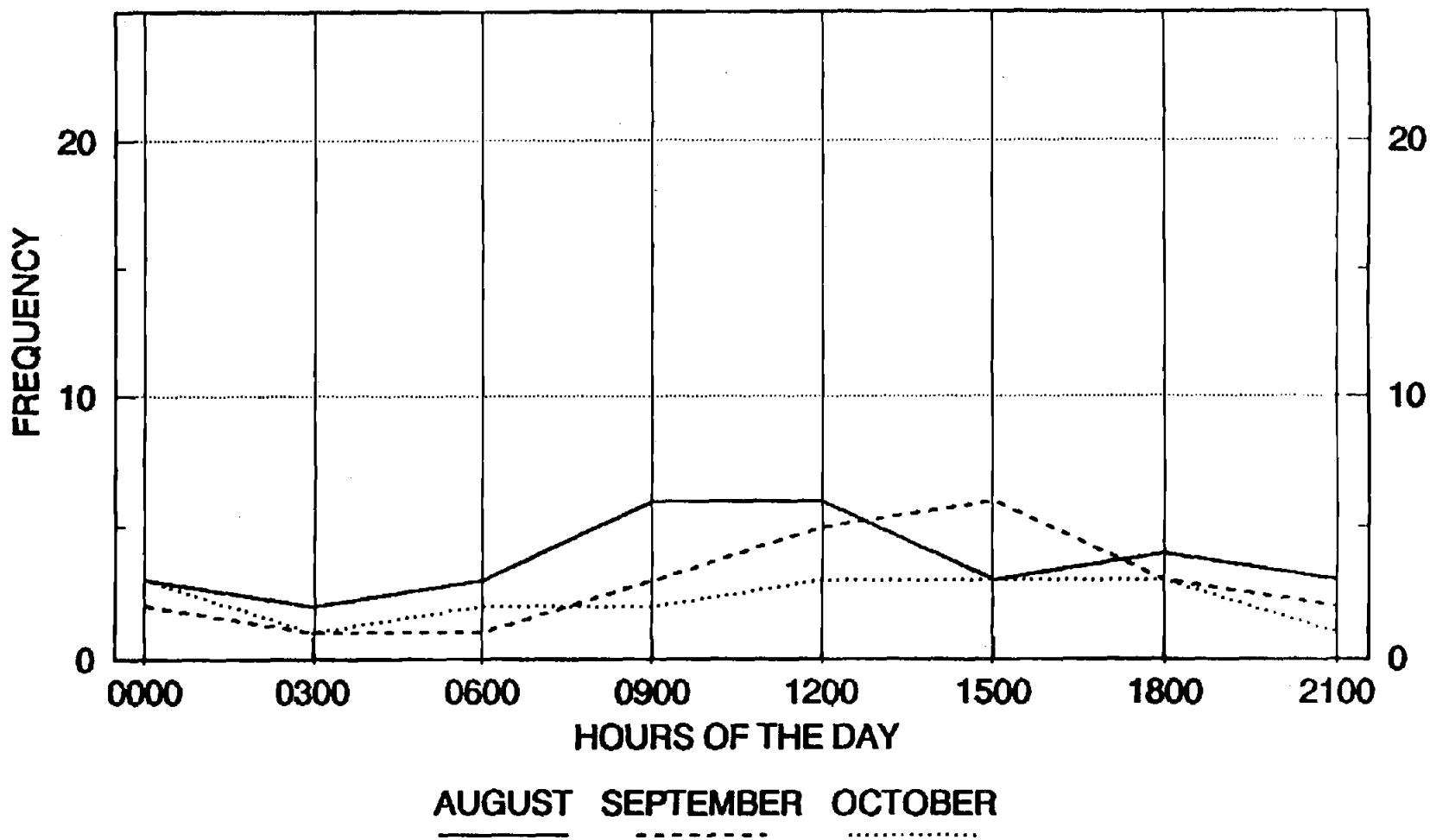
BAGHDAD, IRAQ



SOURCE: ECOM-DR-75-4
BASED ON 15 YEARS OF DATA

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

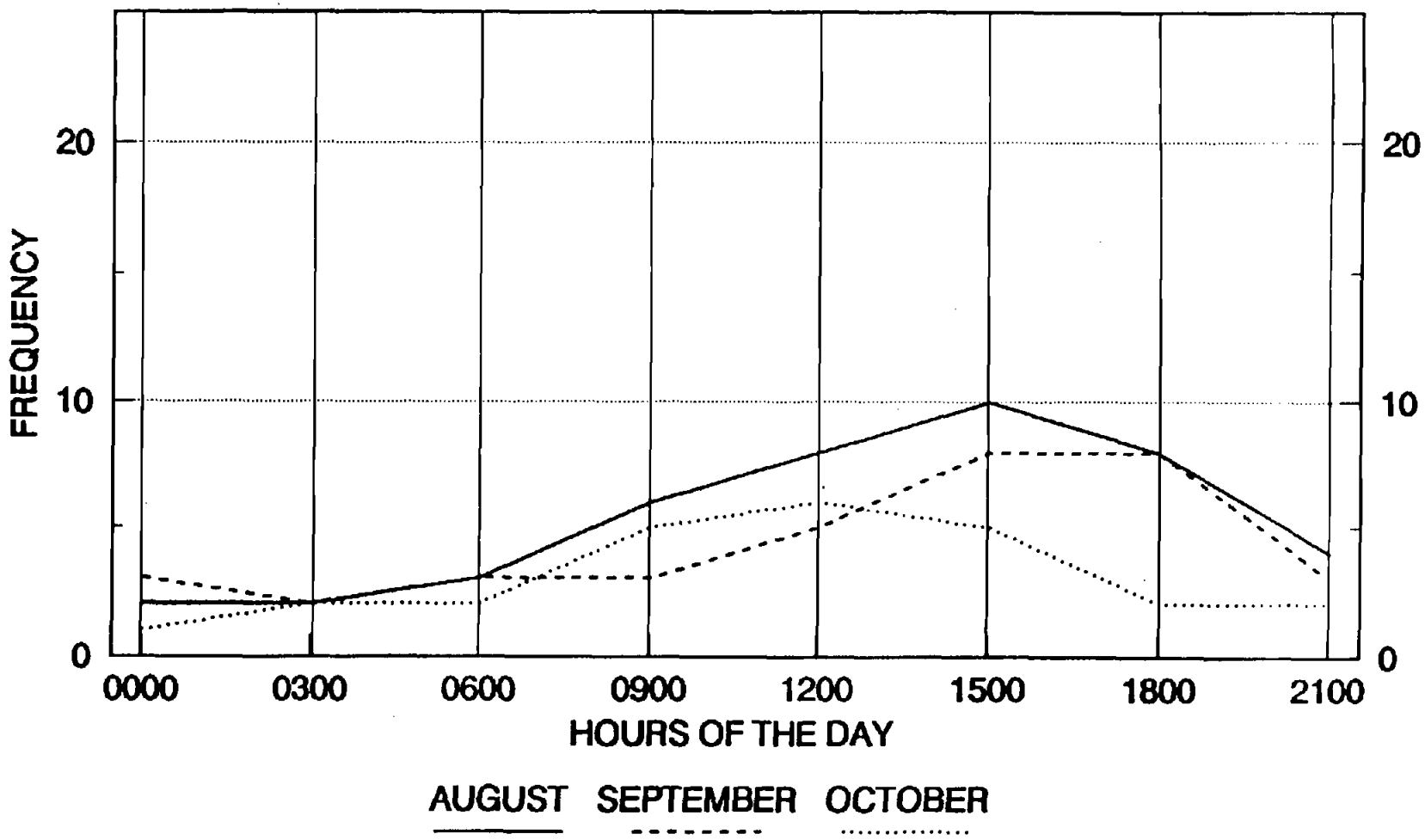
HABBANIYAH, IRAQ



SOURCE: ECOM-DR-75-4
BASED ON 13 YEARS OF DATA

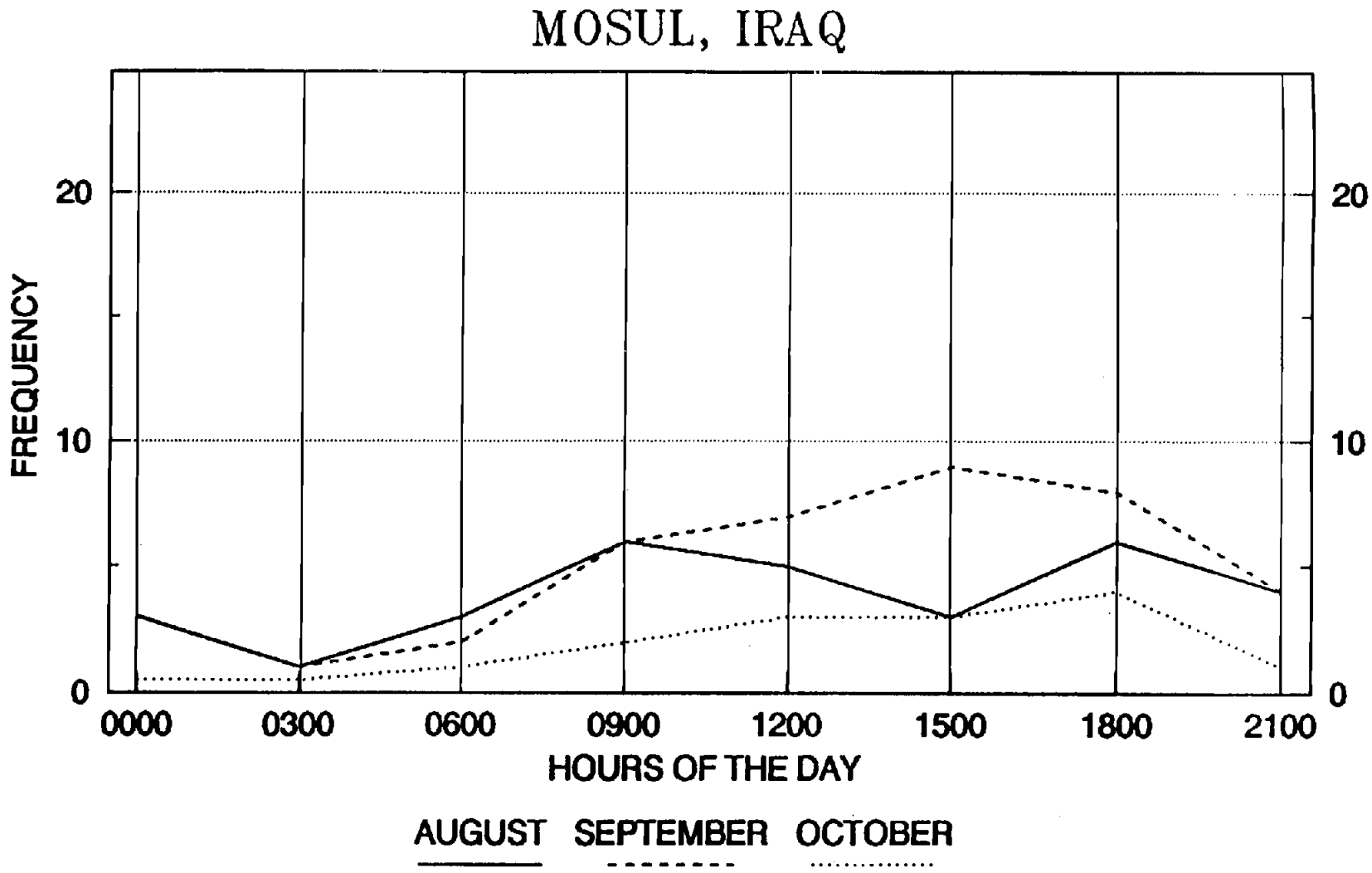
PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

KIRKUK, IRAQ



SOURCE: ECOM-DR-75-4
BASED ON 13 YEARS OF DATA

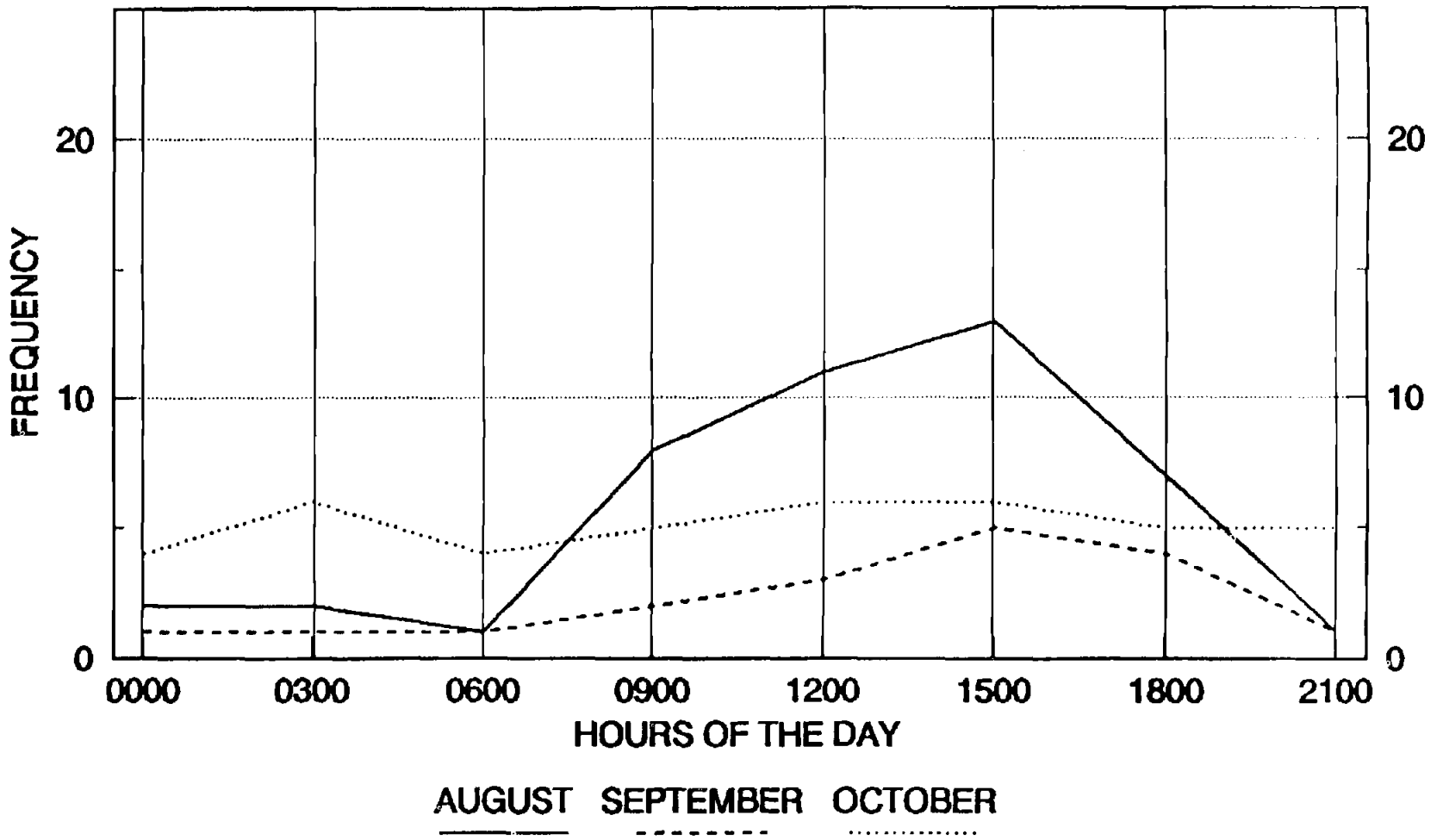
PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST



SOURCE: ECOM-DR-75-4
BASED ON 15 YEARS OF DATA

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

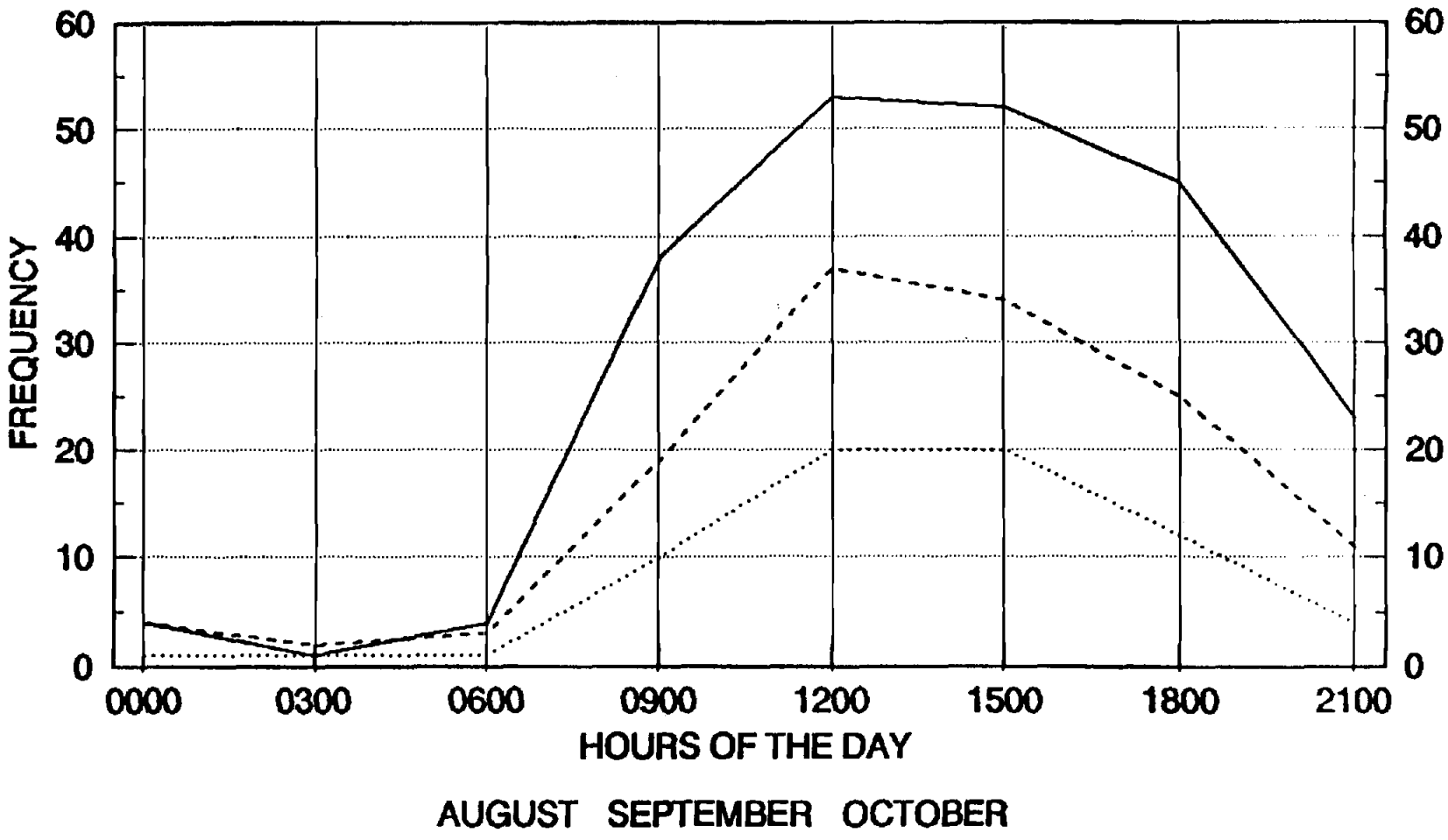
NAJAF, IRAQ



SOURCE: ECOM-DR-75-4
BASED ON 16 YEARS OF DATA

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

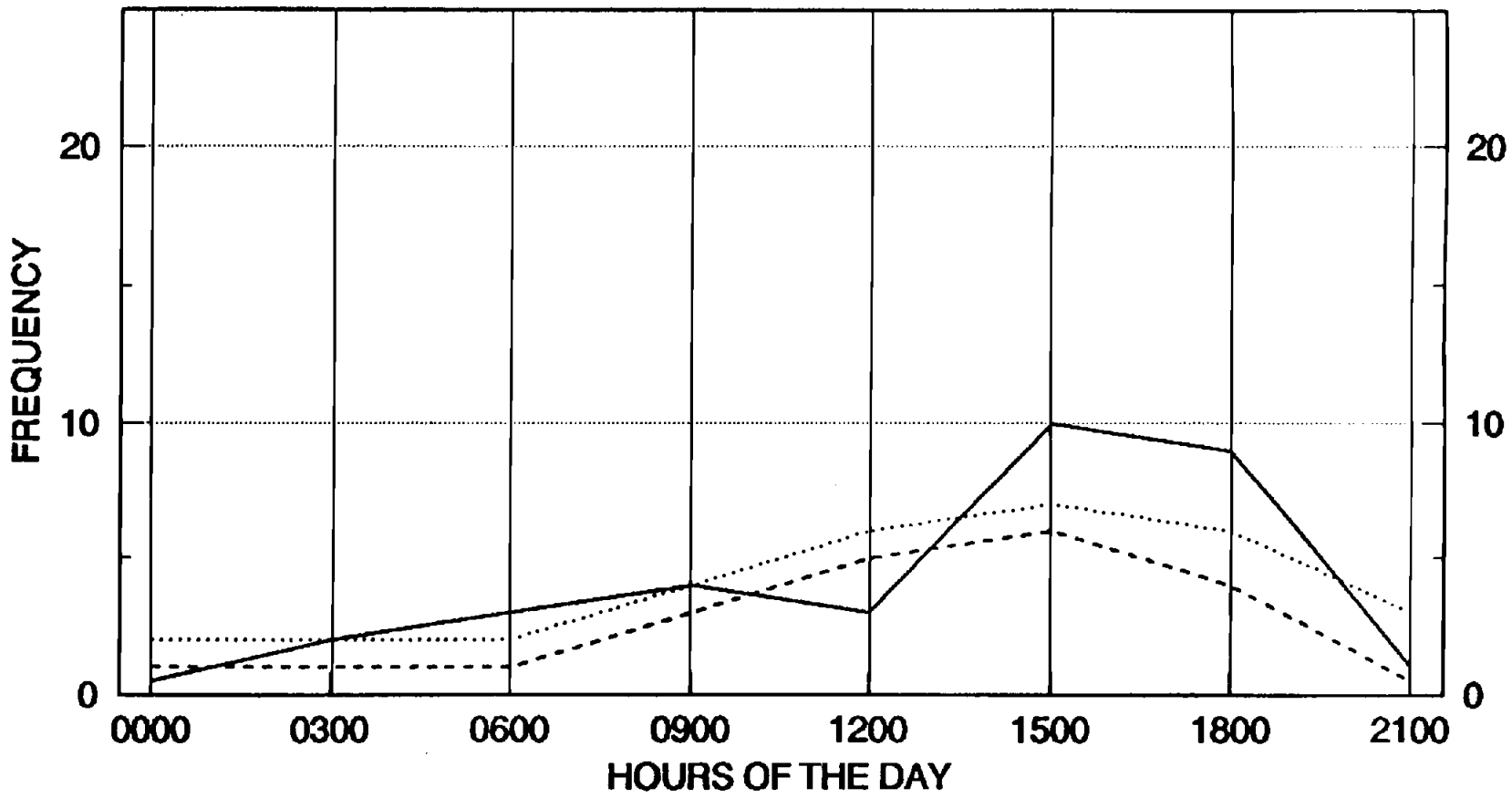
NASIRIYAH, IRAQ



SOURCE: ECOM-DR-75-4
BASED ON 15 YEARS OF DATA

PERCENT FREQUENCY OF OCCURRENCE OF HOURLY OBS
WITH VISIBILITY < 7 MILES IN BLOWING DUST

RUTBA, IRAQ



SOURCE: ECOM-DR-75-4
BASED ON 15 YEARS OF DATA

SECTION III. ENVIRONMENTAL EFFECTS: MATERIEL

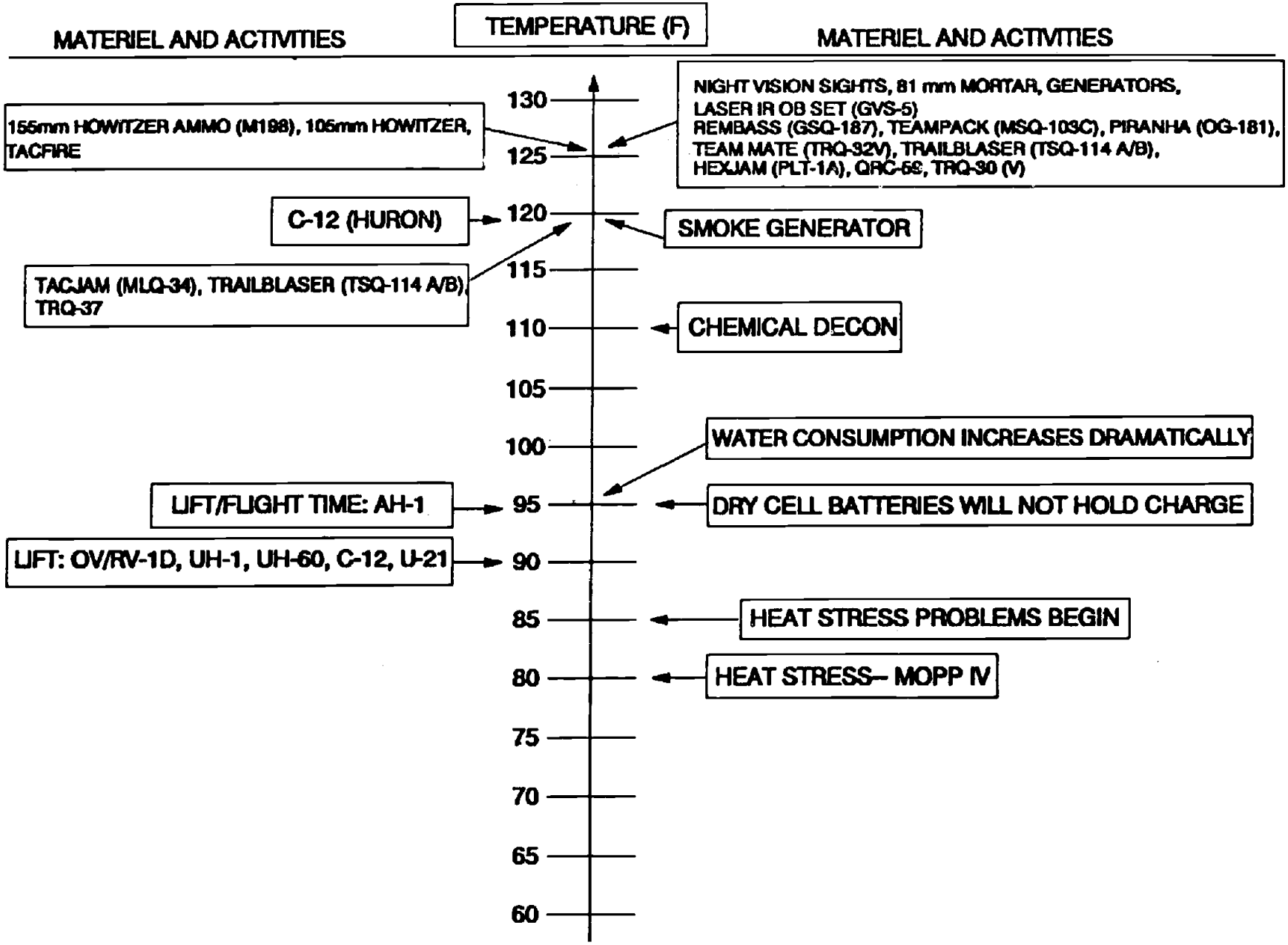
SECTION III. ENVIRONMENTAL EFFECTS: MATERIEL

Equipment Problems

* Tests have shown that a number of different types of vehicles develope operating problems when the air temperature rises above 100° F. Some of these problems are mechanical, such as vapor lock, engine overheating, and overheating of transmission oil. Other problems involve personnel discomfort and inefficiency, due to excessive inside temperatures in tanks and truck cabs, where temperatures may be as high as 35-40 °F above ambient air temperatures.

* Unless constantly maintained, arms and weapons of all sorts, from the pistol to the artillery piece wear out faster in the dusty atmosphere of the desert than elsewhere. The barrels of guns and unprotected moving parts are especially affected. The weapons most vulnerable are those of the small arms, sub-machine, and machine gun classes which are normally operated close to the ground. Many expedients such as wrapping or covering the moving parts, capping of artillery pieces and rifles with muzzle protectors, and other temporary improvisions, can act as effective countermeasures.

ENVIRONMENTAL EFFECTS



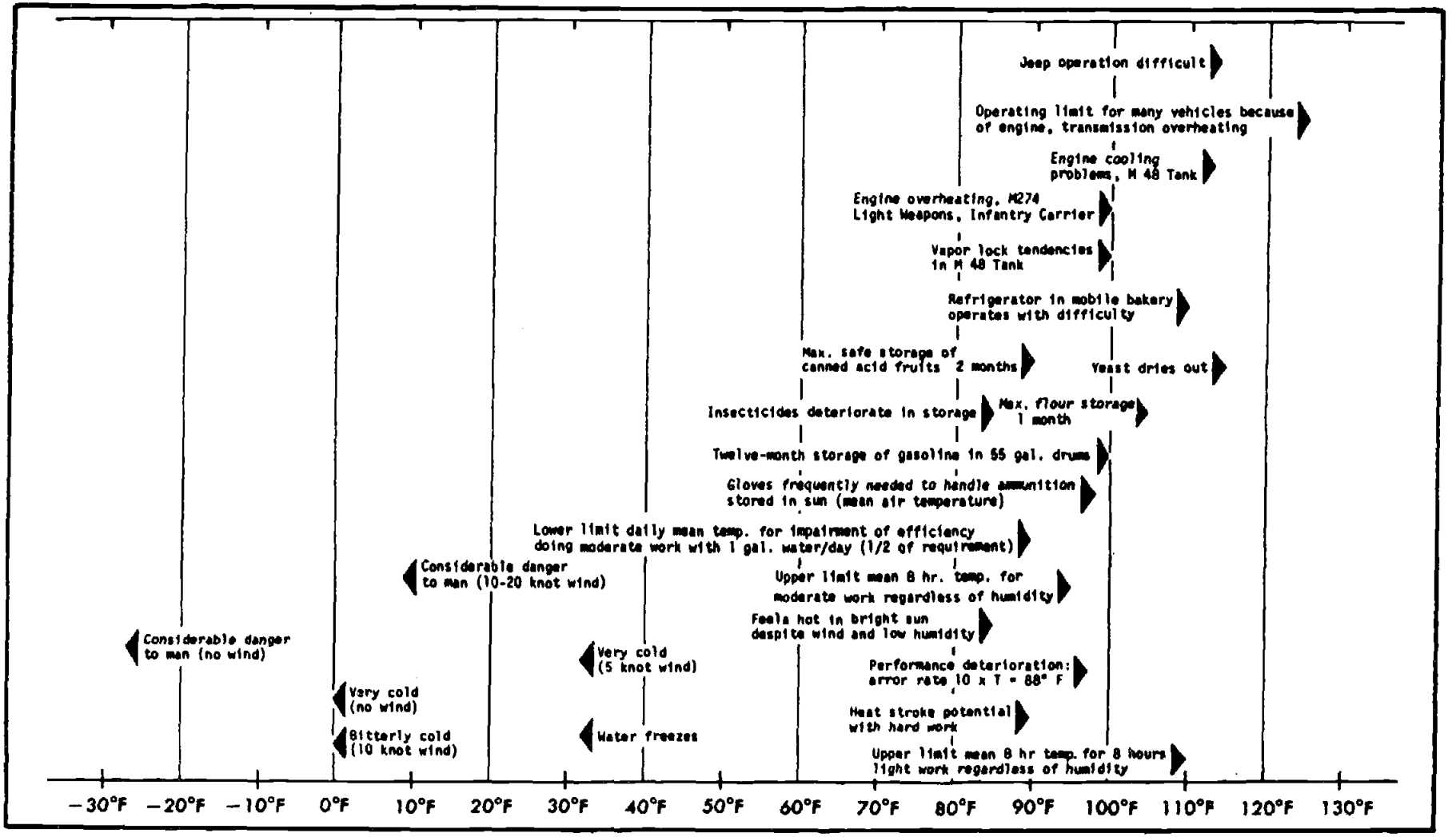


Figure 1. Temperature versus military factors.

ENVIRONMENTAL EFFECTS CHARTS

SURFACE WIND

TABLE A-13. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
LT 25			INCENDIARIES	
GT 7			GROUND SURVEILLANCE RADARS	INCREASED NOISE
GT 15			ACOUSTIC SENSORS	LESS EFFECT.
GT 15 CROSS WIND			TOW	IMPACTS TRACKING
GT 20	GROUND SURVEILLANCE RADARS	INCREASED NOISE	COMM ANTENNAS NOE OPERATIONS	
GT 25			PERSONNEL	
GT 30	HELICOPTERS	MAY CANCEL MISSION (SEE AVN FOR DETAILS)		
GT 40	PERSONNEL			
GT 45	ACOUSTIC SENSORS	LESS EFFECT.		
GT 50	COMM ANTENNAS			

LIGHT INF

TABLE A-18. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
LT 25			INCENDIARIES	
GT 7			GROUND SURVEILLANCE RADARS	INCREASED NOISE
GT 15 CROSS WIND			TOW	IMPACTS TRACKING
GT 15			ACOUSTIC SENSORS	LESS EFFECT.
GT 20	GROUND SURVEILLANCE RADARS	INCREASED NOISE	COMM ANTENNAS NOE OPERATIONS	
GT 25			COBRA (AH-1) ROCKET LAUNCHER PERSONNEL	ROCKET SYS. DEGRADED
GT 30	HELICOPTERS	MAY CANCEL MISSION (SEE AVN FOR DETAILS)		
GT 40	PERSONNEL			
GT 45	ACOUSTIC SENSORS	LESS EFFECT.		
GT 50	COMM ANTENNAS			
GT 60	FIXED WING AIRCRAFT	MAY CANCEL MISSION (SEE AVN FOR DETAILS)		

TABLE A-23. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
LT 25			INCENDIARIES	
GT 7			GROUND SURVEILLANCE RADARS	INCREASED NOISE
GT 10			PARACHUTE JUMPS	
GT 13	PARACHUTE JUMPS			
GT 15			ACOUSTIC SENSORS	LESS EFFECT.
GT 15 CROSS WIND			TOW	IMPACTS TRACKING
GT 20	GROUND SURVEILLANCE RADARS	INCREASED NOISE	COMM ANTENNAS NOE OPERATIONS	
GT 25			PERSONNEL	
GT 30	HELICOPTERS	MAY CANCEL MISSION (SEE AVN FOR DETAILS)		
GT 30 AT JUMP ALT.			PARACHUTE JUMPS	
GT 40	PERSONNEL			
GT 45	ACOUSTIC SENSORS	LESS EFFECT.		
GT 50	COMM ANTENNAS			
GT 60	FIXED WING AIRCRAFT	MAY CANCEL MISSION		

AIRBORNE

TABLE A-28. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
GT 15			ACOUSTIC SENSORS	LESS EFFECT.
GT 15 CROSS WIND COMPON.	OV/RV-1D	GROUNDED MAX FOR TAKE-OFF OR LANDING	TOW	IMPACTS TRACKING
GT 15 GUST SPREAD	2 BLADED HELICOPTER			
GT 20			COMM ANTENNAS NOE OPERATIONS FORWARD AREA REFUELING POINT 2 BLADED HELICOPTER	
GT 25			COBRA (AH-1) ROCKET LAUNCHER PERSONNEL	2.75 IN. ROCKET SYS. DEGRADED
GT 25 CROSS WIND COMPON.	U-21 C-12	GROUNDED. MAX FOR TAKE-OFF OR LANDING		
GT 30	2 BLADED HELICOPTER COBRA (AH-1) CHINOOK (CH-47) IROQUOIS (UH-1)		4 BLADED HELICOPTER	
GT 40	COBRA (AH-1S) CAYUSE (OH-6) SEMINOLE (U-8) PERSONNEL			
GT 45	ACOUSTIC SENSORS 4 BLADED HELICOPTER KIOWA (OH-58) BLACK HAWK (UH-60) APACHE (AH-64)	LESS EFFECT.		
GT 50	COMM ANTENNAS SKY CRANE (CH-54)			
GT 60	MOHAWK (OV-1) HURON (C-12) UTE (U-21)			

TABLE A-33. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
GT 7			GROUND SURVEILLANCE RADARS	INCREASED NOISE
GT 20	GROUND SURVEILLANCE RADARS	INCREASED NOISE	COMM ANTENNAS	
GT 25			PERSONNEL	
GT 30	MET PROCESSOR, GMD-1	INHIBITS BALLOON LAUNCH		
GT 35	ARTILLERY DETECTION RADAR (TPQ-37)	STOW ANTENNA	155mm HOWITZER	
GT 40	PERSONNEL			
GT 45	ARTILLERY DETECTION RADAR (TPQ-36)	STOW ANTENNA		
GT 50	COMM ANTENNAS			

TABLE A-8. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
LT 25			INCENDIARIES	
GT 7			GROUND SURVEILLANCE RADARS	INCREASED NOISE
GT 15			ACOUSTIC SENSORS	LESS EFFECT.
GT 15 CROSS WIND			TOW	IMPACTS TRACKING
GT 20	GROUND SURVEILLANCE RADARS	INCREASED NOISE	COMM ANTENNAS NOE OPERATIONS	
GT 25			PERSONNEL	
GT 30	HELICOPTERS	MAY CANCEL MISSION (SEE AVN FOR DETAILS)		
GT 40	PERSONNEL			
GT 45	ACOUSTIC SENSORS	LESS EFFECT.		
GT 50	COMM ANTENNAS			

TABLE A-3. WEATHER EFFECTS FROM SURFACE WIND

WEATHER VALUE (KNOTS)	SEVERE DEGRADATION		MODERATE DEGRADATION	
	SYSTEM/EVENT	REMARKS	SYSTEM/EVENT	REMARKS
LT 25			INCENDIARIES	
GT 7			GROUND SURVEILLANCE RADARS	INCREASED NOISE
GT 15			ACOUSTIC SENSORS	LESS EFFECT.
GT 15 CROSS WIND			TOW	IMPACTS TRACKING
GT 20	GROUND SURVEILLANCE RADARS	INCREASED NOISE	COMM ANTENNAS NOE OPERATIONS	
GT 25			PERSONNEL	
GT 30	HELICOPTERS	MAY CANCEL MISSION (SEE AVN FOR DETAILS)		
GT 40	PERSONNEL			
GT 45	ACOUSTIC SENSORS	LESS EFFECT.		
GT 50	COMM ANTENNAS			

SOME GENERAL RULES-OF-THUMB REGARDING:

OPTICAL PROBLEMS IN THE DESERT

- OVERALL EXCELLENT VISIBILITY IN DESERT MAY MEAN THE INABILITY TO AVOID DETECTION BY ENEMY
- HIGH SURFACE TEMPERATURES CREATE STRONG CONVECTION AND CAUSE HEAT SHIMMER AND HAZE AT THE SURFACE
- EARLY MORNING MAY BE BEST TIME FOR PHOTO RECONNAISSANCE
- SURFACE SHIMMER REDUCES TARGET RESOLUTION AND STABILITY OF SMALL OBJECTS. DIFFICULT TO PRECISELY FOCUS OR ALIGN OPTICAL DEVICES.
- SURFACE GLARE MAY CAUSE THE EQUIVALENT OF 'SNOW BLINDNESS' AND HAMPER USE OF OPTICAL DEVICES
- BATTLE ACTIVITY INCREASES AMOUNTS OF DUST IN THE ATMOSPHERE AND MAKES ALL OF THE ABOVE PROBLEMS MORE SEVERE.
- BLOWING SAND AND DUST ALSO ABRADES AND SCRATCHES OPTICAL DEVICES RAPIDLY. KEEP LENSES COVERED WHEN NOT IN USE.

SOME GENERAL RULES-OF-THUMB REGARDING:

MOBILITY/VEHICLE OPERATION PROBLEMS IN THE DESERT

- MAJOR PROBLEM IS SAND AND DUST CONTAMINATION OF VEHICLES
  FILTERS MAY REQUIRE CHANGING EVERY FEW HOURS UNDER SEVERE CONDITIONS
- REDUCED POWER, INCREASED FUEL CONSUMPTION, OVERHEATING AND PREMATURE ENGINE FAILURE CAN RESULT FROM CLOGGED FILTERS
- HIGH OPERATING TEMPERATURES MAY ALSO RESULT FROM CLOGGED RADIATOR FINS
- HIGH TEMPERATURES CAUSE PREMATURE FAILURE OF COOLING AND LUBRICATION SYSTEMS
- OPERATING VEHICLES OVER ROUGH OR SANDY TERRAIN MAY MEAN USING LOWER GEARS AND HENCE INCREASING ENGINE OPERATING TEMPERATURE
- VEHICLE POWER DERATING IS CONSIDERED TO BE A ONE PERCENT LOSS PER 10 DEGREES F ABOVE 60F (PLUS 3 PERCENT PER 1000 FT RISE IN ELEVATION)
- MAINTENANCE PERSONNEL SHOULD BE WARNED ABOUT HIGH ENGINE AND VEHICLE SURFACE TEMPERATURES – TO AVOID BURNS

SOME GENERAL RULES-OF-THUMB REGARDING:

COMMO-ELECTRONICS PROBLEMS IN THE DESERT

- HIGH FREQUENCY OF THERMAL INVERSIONS SETS UP CONDITIONS THAT CAUSE 'DUCTING' OF ELECTROMAGNETIC SIGNALS
- RADIO WAVES ARE DUCTED UPWARD DURING THE DAY AND DOWNWARD AT NIGHT. CAUSES FADED, WEAKENED SIGNAL OR COMPLETE LOSS
- DURING THE DAY, COMMO EQUIPMENT MAY REQUIRE 4 TO 8 db MORE IN DESERT LOCATIONS THAN AT MORE TEMPERATE SITES
- AT NIGHT, DUCTING MAY INCREASE RADIO AND RADAR RANGE. MAY ALLOW ENEMY TO EXPLOIT COMMO AND ALSO MAY CAUSE COMMO CONGESTION
- MULTIPATH PROPAGATION A PROBLEM FOR THE 'C' AND 'S' BAND RADARS. MAY CAUSE FREQUENT TARGET LOSS IN EARLY WARNING AND GCI RADARS.
- ELECTROMAGNETIC ATTENUATION (.2db/KM) IN THE X BAND AND AT HIGHER FREQS IS PRONOUNCED DURING DUST CLOUD PRESENCE
- RADIO STATIC, CAUSED BY ELECTRIFICATION OF DUST PARTICLES AND CORONA DISCHARGES FROM ANTENNAS A PROBLEM. STATIC INCREASES AS DUST CLOUD DENSITY AND WIND VELOCITY INCREASE.

*****DESERT MAINTENANCE*****

MEASURE OIL AND WATER LEVELS

THOROUGHLY CHECK COOLING SYSTEM HOSES

DRAIN FUEL FILTERS OFTEN

FREQUENTLY CLEAN AIR FILTERS

WATCH GAGES FOR WARNING SIGNS

EYEBALL BATTERIES FOR CRACKED CASES AND LOW FLUID LEVELS

KEEP EQUIPMENT CLEAN

COVER UNUSED GLASS SURFACES

REPORT FAULTS TO MAINENANCE PERSONNEL

NEVER TOUCH SUN-BAKED METAL WITH BARE HANDS

USE PROPER LUBRICANTS IN PROPER AMOUNTS

SOME GENERAL RULES-OF-THUMB REGARDING:

AIRCRAFT MAINTENANCE IN THE DESERT

- LOCATE MAINTENANCE AREAS ON HARDEST GROUND POSSIBLE TO THE WINDWARD SIDE OF OPERATIONAL (TAKEOFF/LANDING) AREAS
- POSTPONE REPAIRS IF SAND AND DUST STORMS ARE OCCURRING
- KEEP MAINTENANCE AREAS FREE OF SAND AND DUST
- CONSTRUCT SHELTERS TO COVER WORK AREAS AS WELL AS WINDBREAKS TO DECREASE BLOWING DUST IN MAINTENANCE AREAS
- CLEAN, INSPECT AND PROPERLY LUBRICATE FREQUENTLY. WHEN MIXED WITH OIL/GREASE, SAND BECOMES AN EFFECTIVE GRINDING AGENT.
- SEAL ALL OPENINGS WITH DUST-PROOF COVERS WHILE AIRCRAFT IS ON THE GROUND. AFTER SERVICING, REPLACE SEALS IMMEDIATELY.
- DO NOT LAY TOOLS ON THE DESERT GROUND. KEEP THEM CLEAN.
- SPARE PARTS MUST BE KEPT CLEAN AND STORED IN LOCKERS OR BINS AWAY FROM SAND AND DUST.
- THE SUN CAN RAISE THE TEMPERATURE OF AIRCRAFT SURFACES TO ABOVE 150 TO 160F – CAUSING BURNS TO MAINTENANCE PERSONNEL.

****** TIPS ON DESERT STORAGE ******

– KEEP ITEMS IN TRANSIT CONTAINERS TO PREVENT DUST INFILTRATION

– KEEP ITEMS OUT OF DIRECT EXPOSURE TO THE SUN IF POSSIBLE,
USE PROPER TECHNIQUES TO SHADE THE STORED ITEM.

– USE PROPER VENTILATION TO KEEP HIGH INDUCED AIR TEMPERATURES
FROM OCCURRING

– FOLLOW PROPER HANDLING PROCEDURES FOR PERISHABLE ITEMS

– USE CARE WHEN HANDLING DUMP STORED ITEMS THAT HAVE BEEN EXPOSED TO
DIRECT SOLAR RADIATION. SURFACE TEMPERATURES > 160F CAN CAUSE BURNS.

SECTION IV. ENVIRONMENTAL EFFECTS: PERSONNEL

SECTION IV. ENVIRONMENTAL EFFECTS: PERSONNEL

Acclimatization for Hot Conditions

Most people can get accustomed to working in high temperatures, whether in the stokehold of a ship, in the desert, or in a harvest field if adequate water is available and with periods of rest spaced through the work period.

Heat acclimatization possesses the following characteristics:

- It begins on the first day and is well developed by the fourth day.
- It is enhance by good physical condition.
- It is enhanced by exercise in the heat- mere exposure without exercise confers only slight acclimatization.
- Short daily exposures with work can result in appreciable acclimatization.
- The pattern of acclimatization is the same for short, severe exercise as for lesser work of longer duration.
- Acclimatization is well retained for one to two weeks after which it is lost at variable rates.
- Occasional exposures at intervals of up to one month suffice for retention of acclimatization.

Eighty percent of the total acclimatization attained in 23 days had occurred within the first seven days.

The acclimatization process is definitely impaired by low salt intake (5.8 grams daily), but that high intakes (over 15 grams), do not enhance the process.

Water Requirements and Other Human Factors

* A man's water requirement while doing strenuous work is about one quart per hour if the temperature is 120° F (49° C). This is about as high as water requirements would ever get (because prolonged work is not possible at such high temperatures and such conditions cannot persist for more than a few hours.) This is about 10 times as much water as is required to work at 60° F (15.6° C.)

* Survival time for men without water is only 2 or 3 days when the mean temperature exceeds 90° F (32° C.)

* While temperatures over 100° F (32° C) greatly increase man's need for water, average food intake has been found to diminish by as much as 10-15%

* Studies that were conducted on the volume of fluids drunk by ground crews during construction of Boulder Dam (now Hoover Dam) in the Mojave Desert of SW United States indicated that summer-time requirements ranged from three to seven quarts per man per day. The Boulder Dam area often has summer temperatures over 100° F, although it is not as hot as the Mid-east deserts. The average intake per man was 3 quarts during the work shift and 2.5 quarts during the remainder of the 24 hours. In a test conducted in the Boulder Dam area, a man evaporated 10 quarts of sweat during a walk of 7 hours.

* Water obtained from wells, springs, water holes, etc. in desert areas may not be safe without treatment. Liberal chlorination, or other suitable treatment, is required because:

a. Water-borne infections are common.

b. High temperatures increase the rate of disappearance of chlorine.

c. High temperatures incubate viable organisms.

d. The large water intake increases the number of organisms that reach the gastro-intestinal tract.

* Excessive heat may cause a reduction in the quality of performance of skilled tasks. While little difference in quality has been noted between work done with temperatures in the 80's (°F) as compared with the 70's, deterioration increases quickly as the temperature climbs from 90° F to over 100° F.

* The Germans in North Africa during World War II concluded that after a one to two week period of acclimatization men operated well in the desert for about one year.

HEAT DISABILITY: CLASSES, CAUSES AND SYMPTOMS

CLASS	CAUSES	SYMPTOMS	BODY TEMPERATURE
HEAT CRAMPS	LOSS OF BODY SALT THROUGH SWEATING	PAINFUL CONTRACTIONS OF VOLUNTARY MUSCLES, ESPECIALLY EXTREMITIES AND ABDOMINAL WALL	NORMAL OR SLIGHTLY SUBNORMAL
HEAT EXHAUSTION A. OCCURS IN HOTTEST MONTHS	SALT DEPLETION	GIDDINESS, ANOREXIA, HEADACHE, CRAMPS, VOMITING, SYNCOPE ON STANDING, EVIDENCE OF DEHYDRATION AND ALIGURIA	MAY BE NORMAL OR SUBNORMAL BUT USUALLY SLIGHTLY RAISED AND MAY REACH 101 F
B. OCCURS SECOND HALF OF SUMMER	BREAKDOWN OF DEFENSE MECHA-NISMS AGAINST HEAT. ESPECIALLY THE MECHANISM OF SWEATING	DIZZINESS, EXHAUSTION, ANOREXIA, INSOMNIA, DYSPNEA, DECREASED SWEATING, POLYURIA, AND FREQUENTLY PRICKLY HEAT	SAME AS ABOVE
HEAT STROKE		DEFECTIVE SWEATING, DELIRIUM OR COMA, CONVULSIVE SEIZURES, CIRCULATORY COLLAPSE. USUALLY COMES ON WITH DRAMATIC SUDDENNESS, BUT SOMETIMES USHERED IN BY WARNING SYMPTOMS.	106 F OR HIGHER

Signs and Symptoms of Dehydration in Man

(NOTE: This is Table 14D, p.240, in Physiology of Man in the Desert, by E.F. Adolph and Associates, New York: Interscience Publishers, 1947. Items arranged in approximate order of first appearance as dehydration in the heat progresses to exhaustion and beyond.)

At deficits of body water of

1-5% of body weight	6-10% of body weight	11-20% of body weight
Thirst	Dizziness	Delirium
Vague discomfort	Headache	Spasticity
Economy of movement	Dyspnea (labored breathing)	Swollen tongue
Anorexia (no appetite)	Tingling in limbs	Inability to swallow
Flushed skin	Decreased blood, volume	Deafness
Impatience	Increased blood concentration	Dim vision
Sleepiness	Absence of salivation	Shriveled skin
Increased pulse rate	Cyanosis (body blue)	Painful micturition
Increased rectal temp.	Indistinct speech	Numb skin
Nausea	Inability to walk	Anuria (defective micturition or none

A man who has lost 2 1/2% of his body weight (about 1 1/2 qts) of water loses 25% of his efficiency.

Working in 110°F cuts down a man's normal ability about 25%.

At temperatures up in the nineties and higher, 15% dehydration is probably fatal.

It is possible that man can survive 25% dehydration in air temperatures of 85% or cooler.

Efficiency lost by dehydration is quickly restored by drinking water.

Replacing water lost by sweating will in a few minutes restore a man who has collapsed from dehydration.

There is no permanent harm done to a man who dehydrates even up to 10 percent of his weight if enough water is drank to gain it back later.

You can drink brackish water - that is water with half as much salt as sea water-- and get a net gain of moisture for the body.

Clothing helps ration your sweat by not letting it evaporate so fast that you get only part of its cooling effect.

You may smoke, if you like; it will not change your need for water.

An increase in body temperature of six to eight degrees above normal (98.6°F for any extended period causes death.

The body absorbs heat from the air if the air is above 92° F.

A person who has lost 2 1/2 percent of their body weight by sweating (about 2 quarts for the average person) loses 25 percent of his efficiency.

Working in air temperatures of 110°F cuts down a person's normal ability about 25 percent.

A loss of 2 quarts of water by sweating and working in 110°F temperatures reduces the ability of the individual to around 50 percent.

Efficiency loss by dehydration is quickly restored by drinking water.

DAYS OF EXPECTED SURVIVAL IN THE DESERT

CONDITION: NO ACTIVITY (RESTING POSTURE)

AMBIENT AIR TEMPERATURE	AVAILABLE WATER PER MAN, U.S. QUARTS					
	0	1	2	4	10	20
	DAYS OF EXPECTED SURVIVAL					
120F	2	2	2	2.5	3	4.5
110F	3	3	3.5	4	5	7
100F	5	5.5	6	7	9.5	13.5
90F	7	8	9	10.5	15	23
80F	9	10	11	13	19	29
70F	10	11	12	14	20.5	32
60F	10	11	12	14	21	32
50F	10	11	12	14.5	21	32

SOURCE: PHYSIOLOGY OF MAN IN THE DESERT, 1947.

DAYS OF EXPECTED SURVIVAL IN THE DESERT

CONDITION: WALKING AT NIGHT UNTIL EXHAUSTED AND RESTING THEREAFTER

AMBIENT AIR TEMPERATURE	AVAILABLE WATER PER MAN, U.S. QUARTS					
	0	1	2	4	10	20
	DAYS OF EXPECTED SURVIVAL					
120F	1	2	2	2.5	3	
110F	2	2	2.5	3	3.5	
100F	3	3.5	3.5	4.5	5.5	
90F	5	5.5	5.5	6.5	8	
80F	7	7.5	8	9.5	11.5	
70F	7.5	8	9	10.5	13.5	
60F	8	8.5	9	11	14	
50F	8	8.5	9	11	14	

SOURCE: PHYSIOLOGY OF MAN IN THE DESERT, 1947.

DISEASES OF IRAQ

SOURCE: HEALTH DATA PUBLICATIONS
WALTER REED ARMY INSTITUTE OF RESEARCH
(DECEMBER 1960)

DISEASE	NOTES
Enteric Diseases	Bacillary and amebic dysentery, diarrhea. About 2,000 cases of typhoid fever reported annually. Constitutes greatest health hazard.
Malaria	Present in almost every section of Iraq. greatest prevalence in irrigated areas along the Shatt-al-Arab and lower Euphrates Rivers. Common along the Diyala River above Baghdad, and in mountain valleys of the north and northeast. Plasmodium vivax, P. malariae, and P. falciparum are all present. Seasonal incidence varies by locality. Southern Iraq - malaria occurs year round. Mesopotamian Valley - season from March to November with peak May to August. Mountainous north - season from May to October with peak July and August.
Tuberculosis	Most reported cases are pulmonary, but many extra pulmonary cases exist. Tuberculosis meningitis is fairly common in children.
Schistosomiasis	Occurs in the valleys of the Tigris and Euphrates Rivers and their tributaries. The fresh water snail is the intermediate host of this parasitic infection and lives in marshes, swamps, and poorly drained irrigation channels. Infection acquired when wading, swimming or drinking water. Avoid fresh water bathing and do not drink water unless treated or boiled. Swimmer's itch, a related condition is found in the southern part of Iraq.
Smallpox	Endemic in Iraq, and occasional epidemics occur.

Hookworm Disease	10-20% of the population in northern Iraq are infected. 40% of the population in the irrigated areas in the south.
Other Helminthic Infections	A large proportion of the population are infested with intestinal worms. common menatode infections are: pinworm whipworm roundworm eelworm Common tapeworms are: dwarf beef
Eye Diseases	Trachoma is widespread in Iraq due to uncleanliness and a lack of personal hygiene. Greater incidence of this occur in the central provinces due to frequent wind and dust storms. Leading cause of morbidity among workers in Kirkuk at the Iraq Petroleum Company is conjunctivitis, many cases are due to trachoma.
Venereal Diseases	Common forms are syphilis and gonorrhea. Chancroid is also present.
Bejel	Non-venereal form of treponematosis. Widespread among the nomadic population of Iraq.
Leishmaniasis	Present in Mesopotamia as the oriental sore and Baghdad sore, and in the Kala Azar forms. High infection rates in Baghdad and Mosul. Most cases occur in late summer and early fall with the sandfly population is at its peak.
Sandfly Fever	Endemic and widely distributed throughout Iraq. Appears in epidemic form particularly among newcomers to an area. Known as the "three-day fever" because of the duration of the febrile period. Patients

	often incapacitated for as long as 2 weeks. Never fatal. Bed nets with very fine mesh necessary for protection. Residual spraying with DDT effective against sandflies.
Plague	Still occurs, but no reported epidemics since World War II. Large rat population makes the threat of a future outbreak possible.
Cholera	No recent cases reported. Imported by pilgrims.
Typhus	Both epidemic and murine typhus occur. Epidemic typhus occurs in the colder north and northeastern part of the country. Murine typhus can occur anywhere a large rat population exists.
Tetanus	Common occurrence.
Dengue	Present. Mosquito vector is widespread making threat of a large-scale epidemic real.
Relapsing Fever	Louse-borne and tick-borne. Was prevalent but incidence decreasing.
Filariasis	mosquito vectors are known to be present, but no reports have been made suggesting the presence of this disease.
Skin Diseases	High prevalence. Common diseases are scabies and mycotic infection. Favus is common along with madura foot and actinomycosis.
Tularemia	Not a reportable disease in Iraq, but the reservoir of this disease is present, and cases are likely to occur.
Respiratory Diseases	In 1957 a pandemic of influenza occurred. Other common diseases are bronchitis and pneumonia.
Infectious Hepatitis	A major hazard for visitors. Likely that inapparent infection is almost universal in the native population.

Acute Communicable Diseases	Measles, mumps, whooping cough, chickenpox are endemic. Other prevalent forms of this disease are diphtheria, meningitis, and poliomyelitis.

ANIMAL DISEASES TRANSMISSIBLE TO MAN

Rabies	A number of cases occur each year.
Brucellosis	Widespread in cattle, sheep, and goats.
Anthrax	Common among sheep. Most infections occurred among shepherds and those who handle wool and sheep carcasses.
Bovine Tuberculosis	Rampant among cattle. A serious menace particularly if the milk is not boiled or pasteurized.

OTHER ANIMAL DISEASES

African Horse Sickness	Affects horses, mules, and donkeys. Disease is transmitted by the bite of a Culicoides type of sandfly. Incidence of this disease is unknown, but mortality in nearby countries is 98%.

The following diseases of domestic animals are reported to have a widespread occurrence in Iraq:

Disease	Animals Affected
Rabies	Dogs
Mange	Camels, sheep, goats, and dogs
Liver fluke (limited to restricted areas)	Cattle, sheep, goats, and pigs
Round worms	Cattle, Sheep, and goats
Cysticercosis	Cattle, sheep, and goats
Coccidiosis	Fowl
Foot and mouth	Cattle, sheep, and goats
Strangles	Horses
Filariasis	Dogs
Sheep Scab	Sheep
Sheep pox	Sheep
Goat pox	Goats
Fowl pox	Fowl

SECTION V. ENVIRONMENTAL EFFECTS: OPERATIONS

SECTION V. ENVIRONMENTAL EFFECTS: OPERATIONS

SOME GENERAL RULES-OF-THUMB REGARDING:

AIRCRAFT OPERATIONS IN THE DESERT

- REDUCED PERFORMANCE EXPERIENCED DUE TO HIGH AMBIENT AIR TEMPERATURES AND HIGH DENSITY ALTITUDES.
- MAY REDUCE AVAILABLE 'Gs', CAUSE INCREASED TURN RADII AND AIRSPEED BLEED-OFF, AND DECREASES PAYLOAD CAPABILITIES
- HIGH DUST CONCENTRATIONS IN VICINITY OF AIRCRAFT OPERATING ON THE GROUND
- DUST STORMS MAY CAUSE VISIBILITY PROBLEMS AS HIGH AS 8,000 FEET, REDUCING PILOT'S VISIBILITY TO LESS THAN 100 YARDS.
- DUST STORMS MAY BE USED TO COVER A SURPRISE ATTACK
- HOVER OUT-OF-GROUND-EFFECT (OGE) MAY BE DIFFICULT DUE TO THE HIGH TEMPERATURES & DENSITY ALTITUDES
- ROTORS AND PROPELLERS CAN BE SEVERELY ABRADED BY SAND AND DUST, AS CAN CANOPIES AND LENSES
- DUST INGESTION REDUCES ENGINE PERFORMANCE AS WELL AS CAUSES EXCESSIVE CORROSION OF ENGINE PARTS

HOT WEATHER FLYING

SOURCE: TRAINING CIRCULAR NO. 1-13
HEADQUARTERS, DEPARTMENT OF THE ARMY
(18 JANUARY 1979)

HUMAN FACTORS

Hot weather operations require knowledge of special human needs

ENVIRONMENTAL FACTORS

Desert environments demand specific skills for efficient performance

TEMPERATURE, ALTITUDE, AND DENSITY CONCERNS

Aircraft performance is adversely affected by decreased air density

HOT WEATHER FLYING TECHNIQUES

Flying under hot weather conditions requires specialized techniques

MAINTENANCE IN THE DESERT

High temperatures, dust, and sand can make maintenance very difficult to perform

SURVIVAL

How to make the most of any hot weather survival situation

AVERAGE NUMBER OF DAYS FAVORABLE FOR
SPECIFIED MILITARY OPERATIONS

BAGHDAD, IRAQ

MONTH	TIME (LST)	A NOE FLYING	B INCENDIARY BOMBING	C PARADROP	D CHEMICAL WARFARE	E HIGH ALTITUDE VISUAL BOMBING
AUGUST	0900	29.6	3	18	4.0	28
	1500	29.4	8.6	12.4	<.1	28.4
	2100	30.8	<.1	28.2	6.2	30
SEPTEMBER	0900	29.0	1	23.4	14.2	26.6
	1500	29.4	6	18.4	<.1	26.6
	2100	30.0	<.1	29.6	12.4	28
OCTOBER	0900	29.8	0.2	27	23	21.2
	1500	30.1	3	22.2	7	18.8
	2100	30.8	0.2	28.8	18	25

A CEILINGS >= 1000 FT AND VISIBILITY >= 2.5 MILES
B SURFACE WINDS >= 19 MPH AND NO PRECIPITATION
C CEILINGS >= 1000 FT AND VISIBILITY >= 2.5 MILES AND SURFACE WIND < 12 MPH
D SURFACE WINDS 4 TO 12 MPH, TEMPERATURE 32 - 90 F AND NO PRECIPITATION
E SKY COVER < 3/10 AND VISIBILITY >= 2.5 MILES

SOME GENERAL RULES-OF-THUMB REGARDING:

CHEMICAL WARFARE IN THE DESERT

- HIGH TEMPERATURES INCREASE THE VOLATILITY OF MUSTARD AND NERVE AGENTS
- LOW HUMIDITIES SLOW DOWN THE PROCESS OF CHEMICAL DETERIORATION – AGENTS WILL PERSIST LONGER ON THE BATTLEFIELD
- AT NIGHTTIME, THE USUAL TEMPERATURE INVERSION WILL TEND TO TRAP AGENTS NEAR THE SURFACE AND CAUSE THEM TO PERSIST LONGER
- DURING THE DAYTIME, GENERALLY HIGHER SURFACE WINDS AND NO INVERSION WILL AID IN AGENT DISSIPATION
- SOLAR RADIATION, ACTING ON THE SKIN, WILL CAUSE INCREASED PEMNETRATION OF MUSTARD AND NERVE AGENTS
- SWEATING INCREASES THE BLISTERING EFFECT OF MUSTARD AGENTS
- SWEATING RETARDS PENETRATION OF NERVE AGENTS BECAUSE THEY ARE SOLUABLE IN SWEAT

CYCLIC WORK/REST VALUES (MINUTES) WITH NEGLIGIBLE HEAT CASUALTIES

MOPP LEVEL	WORK RATE	TEMPERATURE RANGES			
		70F	70 - 79F	80 - 89F	90F
1	LOW	A	A	A	A
	MODERATE	A	A	60/20	40/50
	HEAVY	A	60/15	40/25	30/50
2	LOW	A	A	A	50/50
	MODERATE	A	A	50/35	30/60
	HEAVY	60/30	45/30	25/30	B
3	LOW	A	A	A	60/30
	MODERATE	A	60/20	40/35	30/50
	HEAVY	40/20	35/20	B	B
4	LOW	A	A	40/30	20/50
	MODERATE	40/20	30/25	20/40	B
	HEAVY	20/25	B	B	B

A = ANY REASONABLE WORK/REST PERIODS SHOULD PREVENT HEAT CASUALTIES

B = WORK TIMES SEVERELY LIMITED, AND EVEN VERY SHORT PERIODS OF HEAVY WORK COULD RESULT IN HEAT CASUALTIES

SELECTED INFORMATION

THE ENVIRONMENT AND ITS EFFECTS ON MATERIEL, PERSONNEL AND OPERATIONS WITH SPECIAL EMPHASIS ON THE MIDDLE EAST

24 AUGUST 90

PART B. DETAILED READINGS

GATHERED AND PREPARED
BY
ENVIRONMENTAL EFFECTS BRANCH
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PART B: TABLE OF CONTENTS

CAVEAT

THE INFORMATION CONTAINED HEREIN WAS EXTRACTED FROM THE FILES OF THE ENVIRONMENTAL EFFECTS BRANCH, U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES, FORT BELVOIR, VIRGINIA.

THIS INFORMATION IS INTENDED TO GIVE THE READER AN APPRECIATION OF THE MIDDLE-EAST ENVIRONMENT AND TO HIGHLIGHT SOME OF THE EFFECTS THAT THE DESERT ENVIRONMENT CAN HAVE ON EQUIPMENT, PERSONNEL AND OPERATIONS.

THIS INFORMATION SHOULD NOT BE CONSIDERED TOTALLY COMPLETE. ENVIRONMENTAL EFFECTS, OTHER THAN THOSE CITED HEREIN, MAY OCCUR.

THIS DOCUMENT IS NOT INTENDED TO SUPERSEDE OR REPLACE ANY CURRENT DOCTRINE OR TRAINING PRACTICES.

SECTION I. ENVIRONMENT -- GENERAL

SECTION I. ENVIRONMENT -- GENERAL

Weather and Climate[1]

A. General weather and climate

Most of Iraq and the Arabian Peninsula have an arid climate. Summers are extremely hot, dry, and almost cloudless, and winters are mild with only moderate cloudiness and meager precipitation. The major exceptions are in the northeast mountains and sections near the south and southwest coasts.[2] In the northeast mountains winters are cool to cold and moderately cloudy with considerable precipitation, and summers are warm, frequently clear, and dry. Parts of the south and southwest coasts have scanty precipitation throughout the year. However, the windward slopes of the higher mountains near the southwest coast get moderate amounts, generally in summer. Temperatures in the southern part of the Arabian Peninsula are high all year except in the mountains, where summers are warm and winters are cool. The primary climatic controls are the airflow patterns that are imposed on the Area by the large semipermanent pressure systems, the migratory pressure systems that traverse the north in winter, and topography.

Mean daily maximum temperatures in summer range mostly above 100°F. except near the coasts, where they are in the 80's and 90's, and in the high mountains, where they probably drop to the low 70's. Mean daily minimums in January, usually the coldest month, range mostly from the 30's to the 50's except on the south and southwest coasts, where they range in the 60's and 70's, and in the high northeast mountains, where they probably drop to the teens. Relative humidities remain high, mostly between 50% and 90%, all year near the coasts. In the interior they are highest, between about 50% and 90%, on winter mornings and lowest, about 10% to 20%, on summer afternoons. Mean annual precipitation is less than 5 inches everywhere except in the southwest and northeast mountains, where amounts approach 30 inches and 40 inches, respectively. Snow is frequent in winter at high elevations in the northeast. Summer cloudiness generally averages below 10% except in the mountains and in some sections of the south and southwest coasts where skies are frequently cloudy. In winter mean cloudiness ranges between about 15% and 50%, with the largest amounts occurring in the lowlands and foothills of the north and at isolated coastal sections in the south. In the high mountains of northern Iraq winter mean cloudiness is estimated to be between 50% and 70%. Low ceilings are infrequent except in the high mountains and along parts of the south coast. Visibility is generally best in winter and poorest in summer, with dust, blowing sand, haze, and fog the chief restrictions. Northwesterly surface winds predominate in summer except near the south coast, where the southwest monsoon prevails. Although winds are quite variable in winter northwesterlies are prevalent at many locations.

The combined NIS 30 & 32 Area, covering nearly 1.4 million square miles, lies between about 12°N. and 37°N. and between 35°E. and 60°E. The Area consists largely of extensive arid plains that are bordered by hills and mountains in the northeast and southwest and to a limited extent in the southeast. The mountains in the northeast are along the borders of Turkey and Iran, with many peaks and ridges extending to over 7,000 feet and the highest to over 12,000 feet. Those in the south and west rise abruptly in most places from narrow coastal plains along the Red Sea, Gulf of Aden, and Gulf of Oman to between 3,000 and 9,000 feet, with the highest peak near 12,000 feet in the southwest. The plains are generally between 2,000 and 4,000 feet in the west, and they slope gradually downward toward the Persian Gulf. Part of the arid plains is gravelly or rocky, but a large portion is sandy, with the most extensive sand dunes in the Rub' al Khali in the south.

Two primary seasons are used throughout this section: winter (November through April) and summer (June through September). These seasons are separated by spring and autumn transitional periods of only one month each, May and October respectively.

B. Climatic controls

The climate of Iraq and the Arabian Peninsula is primarily controlled by the circulations from large pressure systems, by migratory pressure systems and fronts, and by the rugged mountains within and adjacent to the Area. Other important influencing factors include the vastness of the Area and the proximity of large water bodies.

1. General circulation and air masses

a. MAJOR SEMIPERMANENT PRESSURE SYSTEMS—In winter the Siberian high is well established in Central Asia, reaching its peak of development in January, and low pressure is centered in equatorial Africa (Figure 1). These pressure systems interact to produce an airflow pattern over Iraq and the Arabian Peninsula that may be generalized as northerly in winter (Figures 2 and 3).

[1] The entire content of this section is UNCLASSIFIED [redacted]

[2] In this section the terms "southwest coast" and "southwest mountains" refer to the coast and mountains south of Jeddah and from Perim Island eastward to approximately 47°E. "South coast" refers to all of the coast between Perim Island and the eastern tip of the Arabian Peninsula.

c. Oceanic—In winter most of the moisture that reaches the northern parts of the Area comes from the Mediterranean Sea within the circulation of migratory pressure systems. However, the direct climatic influence of this sea is extremely small in summer. Although the Arabian Peninsula is bordered on three sides by water bodies, as a rule their influence on the climate extends only short distances inland. Some of the most obvious effects are the moderation of temperatures, increased cloudiness and rainfall, high humidities, and the occurrence of land and sea breezes near the coasts. The largest amounts of moisture from these waters arrive with the southwest monsoon in summer, but most of it is deposited as heavy rains on the windward slopes of the mountains fringing the southwest coast. Along the Arabian Sea coast these winds generally blow parallel to the coast, and therefore relatively little cloudiness and rainfall results from orographic lift. However, in some sections, primarily between 52°E. and 58°E., the phenomenon known as upwelling is prevalent. It results from the winds blowing parallel to the coast and slightly offshore, so that the resultant wind-driven current sets away from the coast and cooler water is brought to the surface. At some places, of which Şalālah is representative, low clouds, fog, and light rain or drizzle are common in summer as a result of the stabilizing effect the cool water has on the warm, moist air that passes over it.

Another important oceanic influence is caused by the excessive warmth of the Persian Gulf and the Red Sea. These are two of the warmest bodies of water in the world, with mean water surface temperatures exceeding 90°F. over a large part of the Persian Gulf in July, August, and September and in some southern parts of the Red Sea in September. The high water temperatures are conducive to great evaporation and produce very humid conditions in the air over and near these waters. At times the air on the Persian Gulf coast is so packed with water vapor that when one steps outside from an air-conditioned building the water vapor condenses on his exposed body surfaces in much the same way as it normally does on a cool object placed in a hot, humid environment. Further evidence of the excessive moisture in the air of the Persian Gulf is seen by the condensation that occurs at night on metal roofs of buildings within a few miles of the shore. Condensation, or dew, has been known to be so intense at times as to cause a substantial stream of water to flow into the roof's gutter late at night.

C. Special phenomena

1. Local winds

Some wind and weather combinations in the Area have acquired local names. The term *shamal* is applied to a northwesterly wind. It may set in suddenly at any time, and generally lasts from 1 to 5 days, dying down at night and strengthening again during the day. The shamal reaches its greatest intensity in June and July, when it may continue almost without cessation. Such a wind is often sand- or dust-laden in Iraq and the Arabian Peninsula, particularly in summer. The dry silt of the Tigris-Euphrates lowland in summer is the principal source of a dust-bearing shamal.

Kaus is the name applied to a moderate to gale-force southeasterly wind on the Persian Gulf. It is accompanied by humid, cloudy weather and rain squalls. The kaus is associated with the forward sector of a migratory low whose center is located to the west or northwest of the Persian Gulf. The kaus is most frequent in December through April. Following the kaus the wind becomes southwesterly and the weather generally improves within a short time. This southwest wind is known locally as a *suahili*.

A *belat* is a strong, dusty (or sandy) northwesterly wind on the south coast of the Arabian Peninsula. It is most frequent in winter.

It is estimated that *foehn* winds occasionally occur on the plains of northern Iraq in winter. They descend into the Area from the mountains of Turkey and Iran, and the warmth produced in the descending air is partly responsible for the absence of severely cold weather in Iraq.

2. Sandstorms and duststorms

Sandstorms and duststorms are important climatic features of the Area. Visibilities are greatly reduced at times, and the abrasive effects of sandstorms are not only discomforting to personnel but detrimental to structures and exposed machinery. Sand and dust are most often carried from the northwest by the prevailing surface winds over much of the Area. Moreover, because the peninsula is aligned northwest-southeast, surface winds over a large part of the Area frequently have a long fetch over a vast sand surface. For the sand to be lifted higher than a few hundred feet, however, the wind speed must be greater than about 25 knots. Generally, such speeds are attained over relatively short distances. Surface winds in the interior are usually strongest in the afternoon, and therefore this is the most favorable time of day for blowing sand. However, complete settling of the sand back to the surface may require many hours after wind speeds have abated, especially when sand has been lifted to considerable heights. Sandstorms are most frequent in summer, but they occasionally occur in winter, especially on the northern interior plains of the peninsula. Cold fronts occasionally cross this dry surface in winter, and a sandstorm may be generated slightly ahead of the front as well as behind it. In this case a likely sequence is first a sandstorm from a southerly or southwesterly direction, followed by a more intense sandstorm from a northwesterly or northerly direction.

Duststorms are also most frequent in summer, when the deep silt of the Tigris-Euphrates lowland in Iraq is extremely dry. With the intense heat of summer strong convective currents over the lowland may lift dust from the surface to great heights and, if winds aloft are northerly and fairly strong, the dust may be carried far into the peninsula. The top of the dust layer on occasion extends to 15,000 feet and perhaps as far south as the Trucial States.

3. Dust devils

Whirls of sand or dust extending over a very small area, perhaps no more than a hundred feet in diameter, are known as dust devils. They are caused by a very steep lapse rate of temperature in the lower few hundred feet of air over an intensely heated surface. Dust devils are most common in summer over relatively flat sandy surfaces. They generally last only a few minutes, but the rotary circulation is vigorous and ranges in height from a few feet to several hundred feet.

4. Mirages

The intense heating of most of the Area during summer produces mirages frequently, and the inferior mirage is probably most often experienced. It is caused by surface air being heated more strongly than the air immediately above it and producing abnormal atmospheric refraction. Under these conditions the horizon appears depressed, distant low-lying objects may not be seen at all, and objects that are seen appear to be nearer and clearer. Sometimes there appears to be water in a waterless desert because of an apparent lowering of the sky below the horizon.

5. Floods

Flooding probably occurs almost every year in the lower courses of the Euphrates and Tigris Rivers and along the tributaries of the Tigris, where they cut across lowlands of eastern Iraq before entering the left bank of the Tigris. Flooding is most frequent in winter and spring, when exceptionally heavy precipitation in the mountains of Iraq produces torrential flows in the tributaries of the Tigris. Melting snow in the mountains, followed by drainage into the tributaries, compounds the flood problem.

Wadies, stream beds that are normally dry, are numerous in Iraq and the Arabian Peninsula. With an exceptionally heavy rain, as with some thunderstorms, a wadi may be filled to overflowing in a short time, producing a flash flood. Wadies near the southwest mountains are probably flooded quite often in July and August, when the southwest monsoon deposits considerable rainfall in these mountains. Elsewhere in the Arabian Peninsula, the probability of a wadi's being flooded is remote, especially at latitudes south of about 25°N. In some sections rainshowers heavy enough to fill a wadi probably occur no more often than once in 20 years. However, the fact that there are wadies on the fringes of the Rub' al Khali is evidence that even here substantial rainfalls have occurred.

6. Droughts

Not only is the precipitation extremely low in most of this Area, but it is quite erratic. In some years the normally expected rainfall, although meager, fails to appear, and over parts of the interior several years may be rainless. These deficiencies in precipitation may cause great hardship on local personnel engaged in sedentary agriculture and on nomadic types who are almost totally dependent on the availability of natural pastureland.

D. Weather elements and climatic conditions

1. Temperature

a. Surface—This Area is generally noted for its almost unbearable daytime temperature in summer. Only the high mountains offer relief from the afternoon heat. However, radiational cooling at night brings fairly comfortable temperatures at most places. Winters are generally mild except in the high mountains of the northeast, where temperatures are probably near or below freezing much of the time.

Mean daily maximum and minimum temperatures (Figures 5, 25, and 26) closely approximate the average afternoon and early morning temperatures, respectively. In summer mean daily maximum temperatures range mostly between 100°F. and 115°F. except at many of the coastal locations, where they are in the 80's and 90's, and in the high mountains, where they probably drop to the low 70's. Early morning summer temperatures range from the high 60's to the mid-80's except in the high mountains, where they are estimated to be near 50°F. In the coldest winter month, usually January, afternoon temperatures range from the high 50's and low 60's in the northern plains to the low 80's on the south and southwest coasts. However, they probably drop to the mid-50's in the higher elevations of the southwest mountains and to near freezing on the high mountain peaks in Iraq. Early morning temperatures in January range mostly from the 30's to the 50's except on the south and southwest coasts, where they are in the 60's and 70's, and in the high mountains of Iraq, where they are estimated to be in the teens.

In general, diurnal variations in temperature are greatest in the interior during summer. Here, predominantly clear skies promote intense solar heating by day and rapid radiational cooling by night, which results in diurnal temperature ranges of 30 to 40 Fahrenheit degrees. At coastal locations the moderating influence of the water prevents temperature changes from being excessive, and most places experience diurnal variations of only about 10 to 20 Fahrenheit degrees throughout the year.

Temperatures of 100°F. or higher have been observed as early as March in Iraq and as early as February in the Arabian Peninsula and as late as November in both (Figure 27). Many lowland locations throughout the Area have recorded temperatures between 115°F. and 125°F., and it is estimated that temperatures as high as 135°F. have occurred in the Rub' al Khali. Over the interior and even at some coastal locations on the Persian Gulf temperatures of 100°F. or higher are a daily occurrence during much of the summer (Figure 28). However, days this hot are relatively infrequent along the Red Sea coast and the south coast and probably are rare in the high mountains.

Freezing temperatures in Iraq have been observed as early as October and as late as April on the interior plains (Figure 29), and probably as early as September and as late as May on the highest peaks of the mountains. Lowest recorded temperatures on the plains were in the teens at many places and as low as 6°F. at one location.

On the highest peaks temperatures have probably reached considerably below 0°F. Days with minimum temperatures of 32°F. or less (Figure 30) are not frequent at the lower elevations, where about 5 to 10 freezing days may be expected in the coldest winter month. However, the number of days with freezing temperatures is probably much greater in the high mountains. Freezing temperatures in the interior of the Arabian Peninsula have been observed as early as November and as late as March. Lowest recorded temperatures were in the 20's and the teens at some lowland and mountain locations. However, days with minimum temperatures of 32°F. or less are infrequent except probably in the southwest mountains. They are rare on the coasts.

b. UPPER AIR—The cross section for Baghdad West (Figure 6) is considered representative for the Area north of about 28°N., and that for Jidda (Figure 7) is probably a fair representation of conditions south of 28°N. The major exception is in the lower levels at Jidda, where the influences of the Red Sea are prominent.

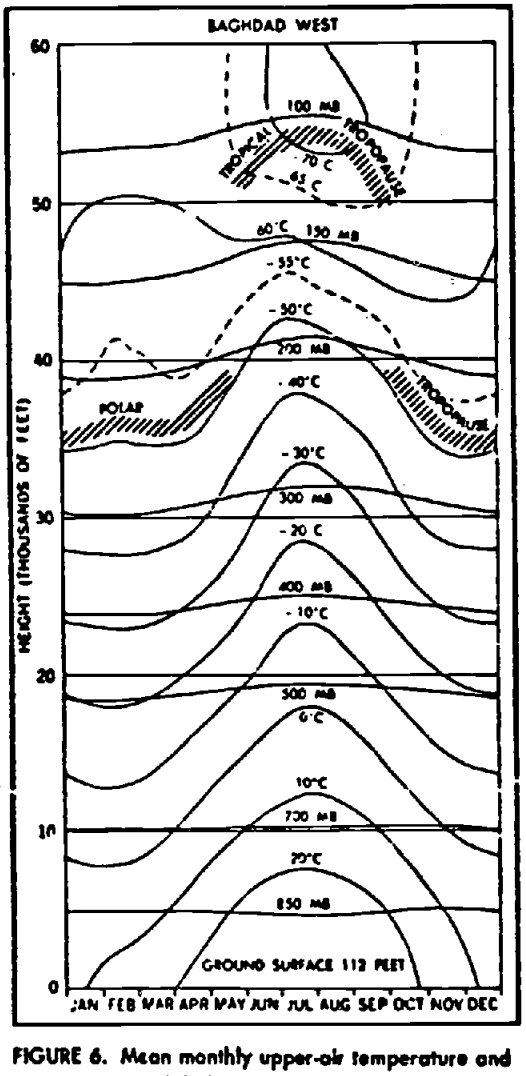

FIGURE 6. Mean monthly upper-air temperature and pressure at Baghdad West, Iraq

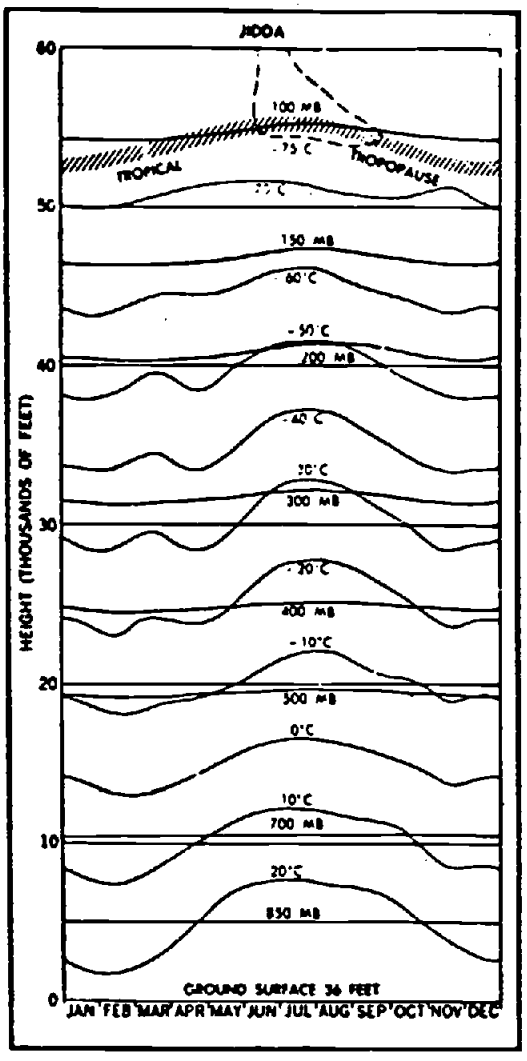

FIGURE 7. Mean monthly upper-air temperature and pressure at Jidda, Arabian Peninsula

A number of differences are apparent in a comparison of the air over Baghdad West with that over Jidda. The tropical tropopause occurs only in summer in the north but is present throughout the year in the south, with an average height between 50,000 and 55,000 feet. Mean temperatures at the tropopause are about −65°C. to −70°C. in the north and −70°C. to −75°C. in the south. The polar tropopause is present only in the north during the colder months, with an average height of 37,000 to 40,000 feet and a temperature near −50°C. During summer, upper-air temperatures vary little from north to south, usually less than 5 Celsius (centigrade) degrees at any level up to about 60,000 feet. In winter regional temperature differences are more pronounced. Below the polar tropopause in the north, temperatures are at least 10 Celsius degrees colder than at the same levels in the south. However, at greater heights regional temperature differences in winter are generally smaller.

The freezing level is normally lowest in January or February, when the average height ranges from about 8,000 feet in Iraq to 15,000 feet in the southern part

of the Arabian Peninsula. It is usually highest in July, with an average height of about 18,000 feet throughout the Area. Large day-to-day departures of several thousand feet from average heights occur during winter in Iraq.

2. Humidity

Relative humidity varies greatly over the Area, both seasonally and diurnally (Figures 8 and 31). Primarily as a result of large temperature ranges, mean relative humidities in the interior are very low, about 10% to 20%, on summer afternoons but range between about 25% and 45% on summer mornings. During winter values are considerably higher, especially in the north, because of the influx of moisture from the Mediterranean Sea. However, relative humidity varies inversely with temperature, and values that are generally between 50% and 90% in the mornings drop to 30% to 55% during the afternoons.

Along the coasts, where temperature variations are smallest, relative humidity is persistently high all year, with values mostly between 50% and 90%. Of course, the lowest values are observed during the afternoons when temperatures are highest. The high humidities together with high temperatures make living conditions on the coasts extremely unpleasant, particularly during summer. The worst conditions are experienced along parts of the Red Sea and Persian Gulf Coasts, which are notorious for their persistent heat and dampness.

3. Precipitation

Probably the most prominent feature of the climate of the Area is the sparsity of precipitation, which has caused it to be one of the world's most desolate regions. The aridity is keenly evidenced by the large geographic area with mean annual precipitation less than 5 inches (Figure 9). Appreciable amounts of precipitation are received only in two widely separated mountainous regions, one in the extreme northeast and the other in the southwest. Here, largest annual averages approach 40 inches or more in the north and 30 inches at two isolated sections in the southwest. Although these larger amounts commonly reflect the influence of topography, they also represent completely different rainfall regimes.

North of about 20°N, a simple, wintertime maximum in precipitation prevails. Winter precipitation primarily results from the passage of Mediterranean depressions and attendant fronts and accounts for more than 80% of the mean annual precipitation. Monthly means (Figures 10 and 32) uniformly decrease southward, from amounts of 4 to 9 inches in the mountains of Iraq, to 1 to 4 in the Tigris-Euphrates valley, to less than 1 in the remainder of the discussion region. The frequency of precipitation (Figures 11 and 33) displays a similar areal distribution in winter, averaging 7 to 12 days per month in the north and gradually decreasing to 1 to 3 in the southern parts of the discussion region. Summers, because of the absence of migratory systems, are extremely dry everywhere in this region, and many places are completely rainless throughout the season. The onset of this drought period is as abrupt as its termination, particularly in Iraq where the showery activity in April and May is not renewed with equal persistence until October (Figure 34).

South of about 20°N, several differing regimes present a more complex pattern of precipitation. On the seaward-facing slopes and ridges of the southwest mountains, the influx of the moist southwest monsoon air, combined with orographic lift, yields a summer rainfall maximum. Elsewhere in these mountains the maximum precipitation may occur in a different part of the year depending on the local exposure to moisture-bearing winds. In addition, some places in the mountains may have double maximums. By contrast, the remaining sections have such small amounts of precipitation that designated periods of maximums are almost meaningless. An exception occurs in the vicinity of Şalālah, where strong offshore upwelling of cold water promotes almost daily drizzle and a somewhat prominent July-August maximum.

Another outstanding feature of the precipitation in this Area is its erratic nature. The greater part of the precipitation in all months develops under conditions of instability, to which topography is the prime contributing factor. Showery precipitation is commonplace, often extremely heavy, short in duration, and very irregular in distribution. Thus the heavy shower that occurs from time to time may bring more rain to a station in a few hours than normally falls there in a year. In many cases the 24-hour maximum is the same as the greatest monthly amount (Figures 35 and 36). The more violent downpours often result in flash floods. These heavy rains are also extremely localized. For example, one side of a street may be quite dry, while the other side is streaming with rain. Or, one field may produce a record crop, while a few miles away there is insufficient rain to germinate the seed. In addition, the amount of rainfall is exceedingly variable from year to year. Few regions outside the mountains in the north and southwest can count on regular annual rains. Failure of rain in a particular season is frequent and is a cause for considerable anxiety in agricultural areas. Periods of nearly a year may be absolutely rainless. Indeed, even longer droughts occur, and whole regions in the peninsular interior may go years without a fall of any kind.

In this tropical and subtropical environment most of the precipitation is in the form of rain, with the notable exception in the mountains of northern Iraq. Here, winter snows occur occasionally on the lower slopes, and snow cover may last for several days before melting. On the higher reaches, above about 3,500 feet, snow occurs frequently, and there may be continuous snow cover for several months. A deep snow cover may persist on the sheltered plateaus above 5,000 feet, and mountain passes are often blocked by drifts. January and February are probably the months with greatest snowfall. Snow is rare elsewhere except probably at elevations above 10,000 feet in the southwest mountains.

4. Cloudiness

Iraq and the Arabian Peninsula are usually considered to be areas of little cloudiness. This is generally true, particularly in summer over most of the interior. However,

FIGURE 9. Mean annual precipitation (inches)

the migratory lows in winter, the maritime influence on the coasts, and the mountain chains in the northeast and southwest all contribute toward a variety of seasonal and regional patterns. In general, seasonal variations in cloudiness are most pronounced in the northern part of the Area. Regional variations, however, are most prominent in the south (Figures 12 and 37). Diurnal variations at most places in the Area are normally small (Figures 12 and 38).

The distribution of cloudiness closely resembles that of precipitation. North of about 20°N, a wide range of cloud types attends the migratory lows and frontal systems that affect this part of the Area in winter. They vary from high cirrus to middle- and low-level cumulus, with towering cumulus and cumulonimbus accompanying the trailing cold fronts. Between storms the normally clear conditions are occasionally interrupted by the formation of cumulus in the afternoon or by thin scattered cirrus. As a result the monthly maximums of mean cloudiness fall in the winter season. Average values range mostly between 15% and 50% at the lower elevations and are estimated between 50% and 70% in the mountains in the north. Mean cloudiness decreases sharply in June and only small cloudiness averages continue through the summer months. The cloudiest region probably is in the northern mountains, where buildups of cumulus occasionally occur.

South of about 20°N, the large variety of cloud regimes establishes the importance of local influences. The great differences between adjoining sections are primarily the result of prevailing wind flows in combination with marine or topographic influences. In the southwest the seaward-facing slopes and ridges and the interior mountains experience pronounced seasonal and diurnal cloud patterns. Mean cloudiness is least in winter, when averages decrease to as little as 10% or 15% in some months. Cumulus clouds are the predominant type, and afternoons are the cloudiest part of the day. Mean cloudiness is greatest during the height of the southwest monsoon, when monthly amounts in July and August range between 40% and 55%. Beginning in late morning during these months moist monsoonal air is forced up the exposed slopes and produces billowing cumulus and cumulonimbus over the ridges. At the same time puffs of cumulus develop and enlarge over the mountains farther inland. The total development reaches a peak by midafternoon and makes this the cloudiest part of the day. Nocturnal cooling dampens the orographic and convective processes and clouds gradually dissipate until morning when clear skies or widely scattered clouds are the usual conditions, especially over the inland portions of the mountains. However, during an unusually strong monsoonal flow, cloud development may continue through the night and large clouds may remain over the ridges.

Along the narrow coasts west of Riyan and south of Jidda the cloud regime is entirely different from that of the adjoining mountains. The coasts experience only slight seasonal variations in cloudiness throughout the year as monthly means range between the mid-20's (%) and mid-40's. Diurnal variations are more distinct, and cloud cover reaches a maximum in the morning all year. These maximums generally occur during the middle of the morning, when the general flow is least inhibited by land or sea breezes. Convergence within the general flow, as it is constricted and channeled through the narrow passage between the Gulf of Aden and the Red Sea, produces layers of stratocumulus clouds. As the strengthening sea breeze modifies the wind direction and the channeling, fewer clouds are formed. As a result there is less afternoon cloudiness.

The coastal region east of Riyan has very pronounced seasonal cloud variations in contrast with its small diurnal variations which differ from place to place. Mean cloudiness is small during the winter months, mostly in the 20% to 30% range, and diurnal cloudiness everywhere varies between morning maximums and only slightly lower nighttime minimums. In June, however, the surge of warm, moist monsoonal air over cold, upwelled waters produces extensive layers of low stratus and stratocumulus. The marked increase in cloudiness continues into July and August. Averages in these months range from the low 90's (%) in the vicinity of Şalālah to the 40's in the eastern and western parts. Diurnally, the large cloud amounts continue throughout the day near Şalālah, but to the east and west of it the morning cloudiness is only moderate and evening cloudiness is about half as much. In late September, as the monsoon and upwelling abate, cloudiness undergoes a marked decrease, and minimums are attained in winter. The interior deserts in the south probably have the simplest cloud regime. Mean cloudiness is greatest in winter, generally less than 30%, and least in summer, when monthly averages everywhere are less than 10%. Diurnal variations, understandably, are small in this sector.

General cloud conditions over the Area are reflected not only by mean cloudiness but also by the frequency

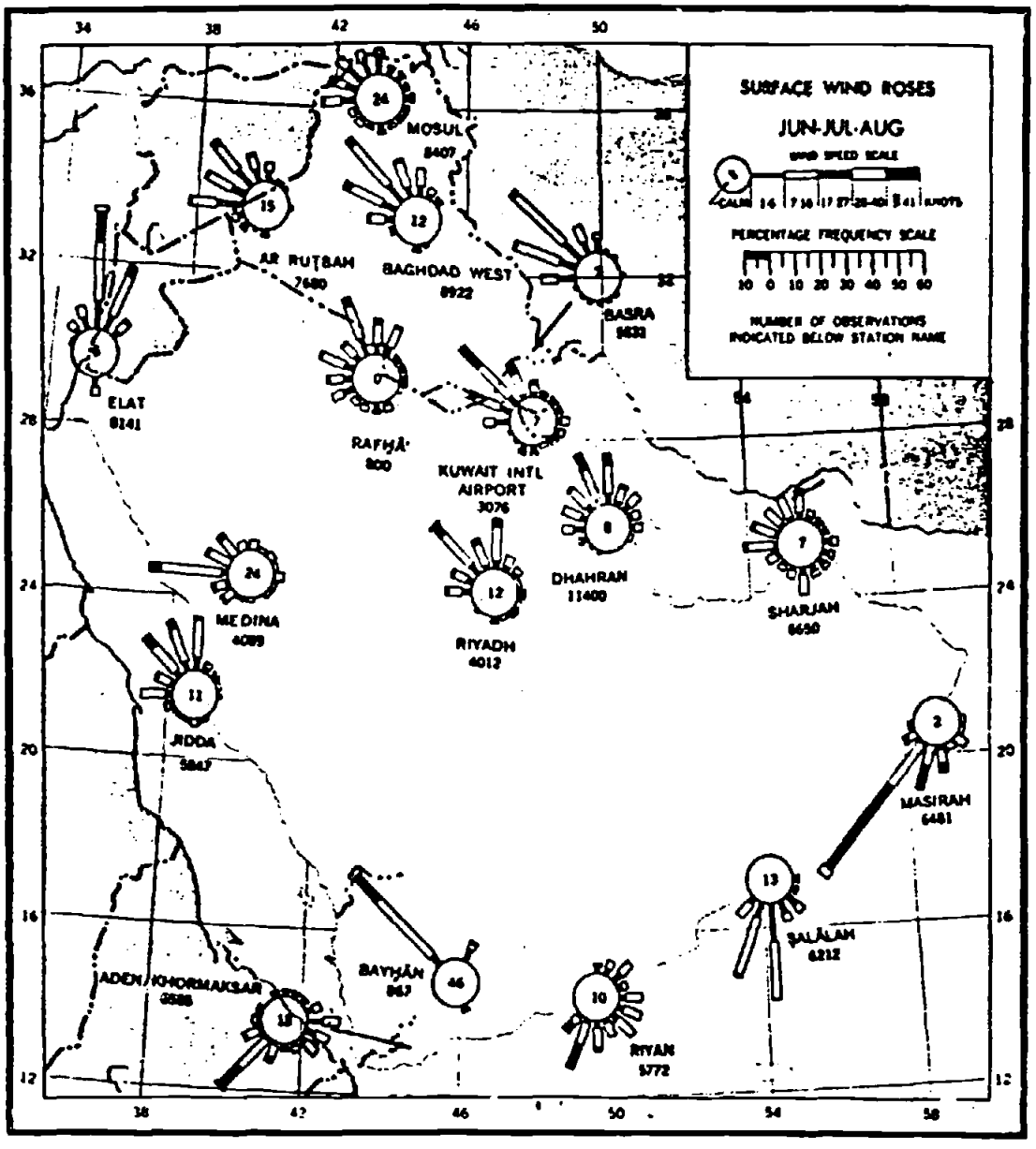

FIGURE 21. Surface wind roses, June-August

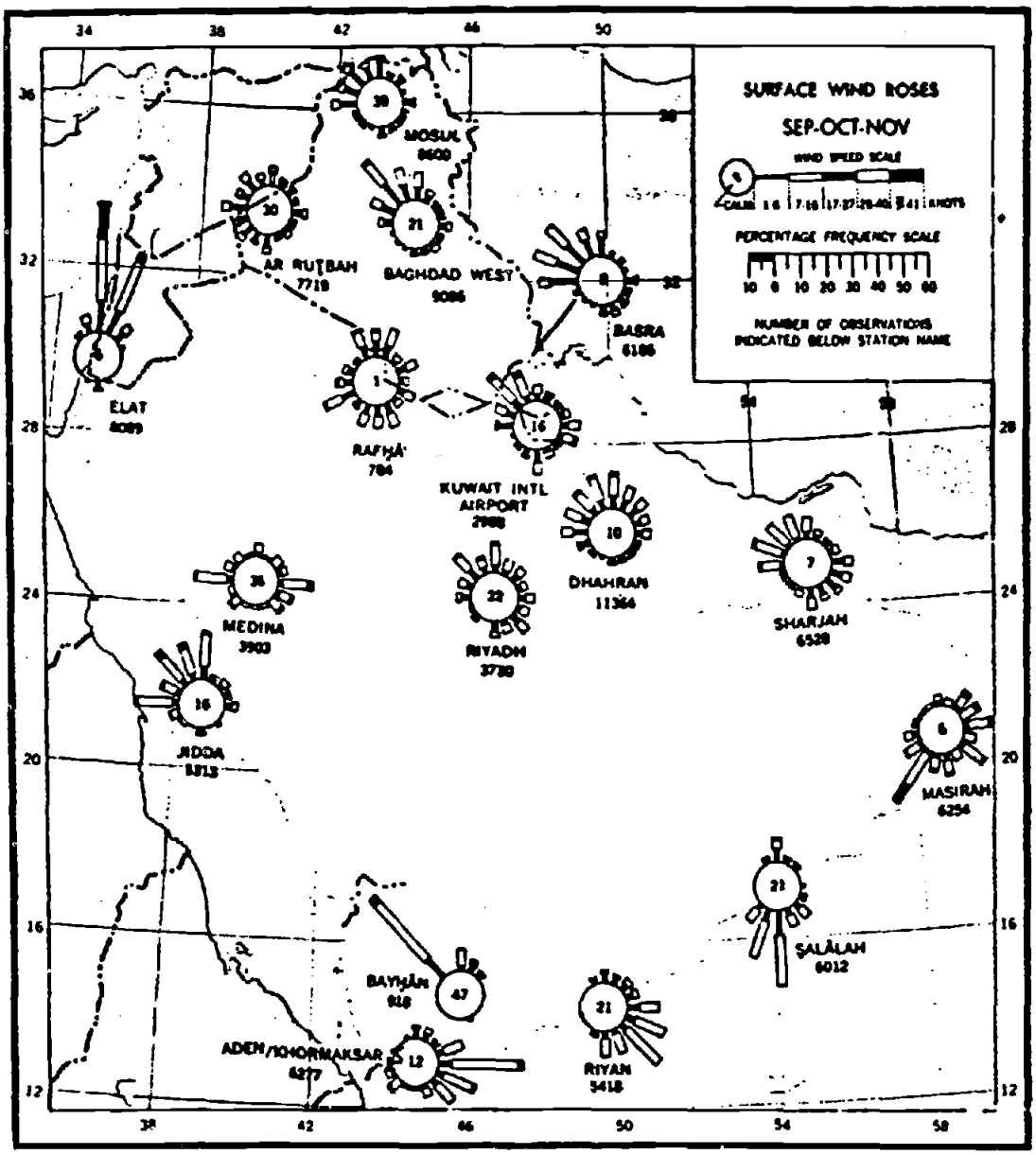

FIGURE 22. Surface wind roses, September-November

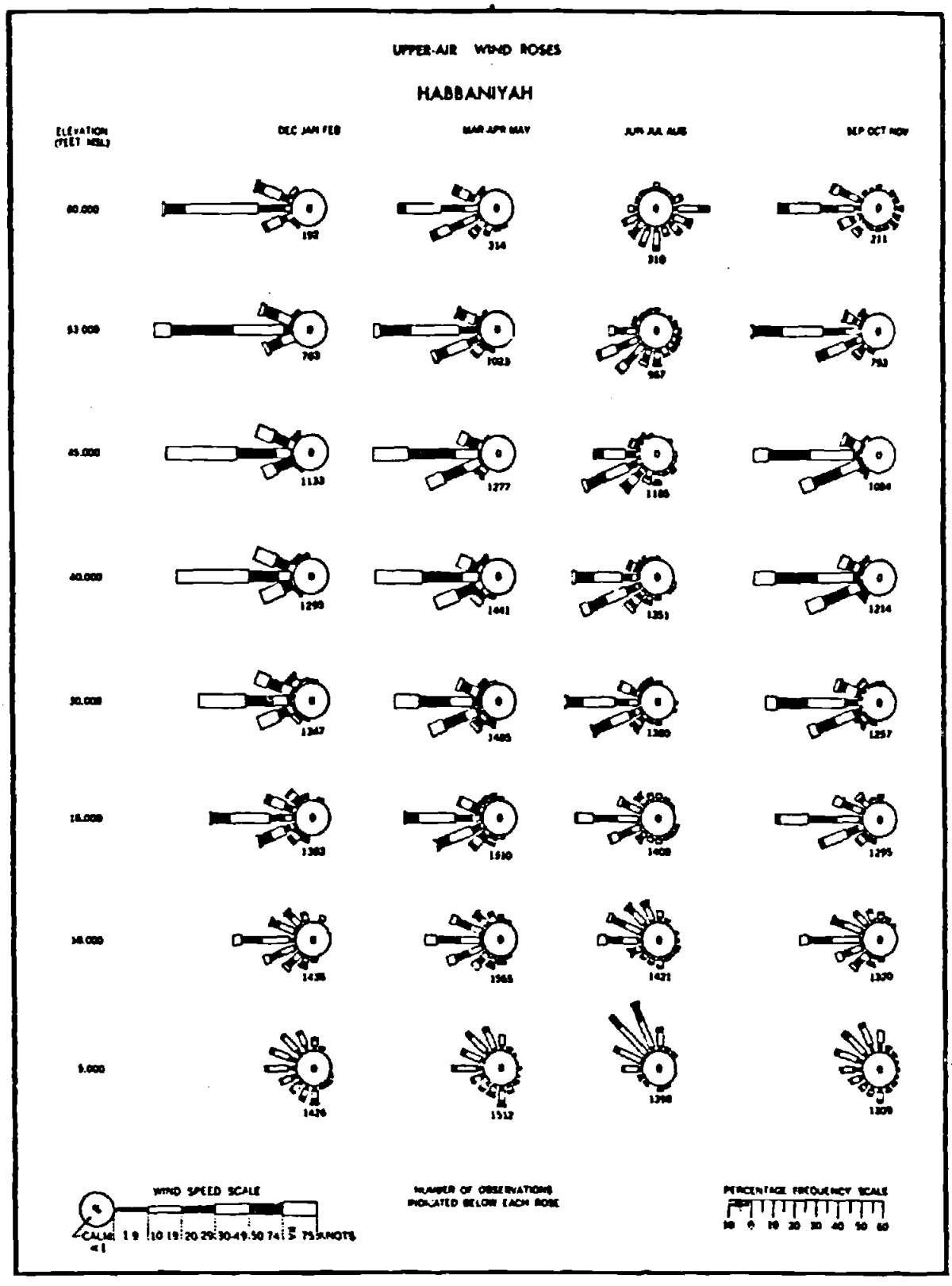

FIGURE 23. Upper-air wind roses, Habbaniyah, Iraq

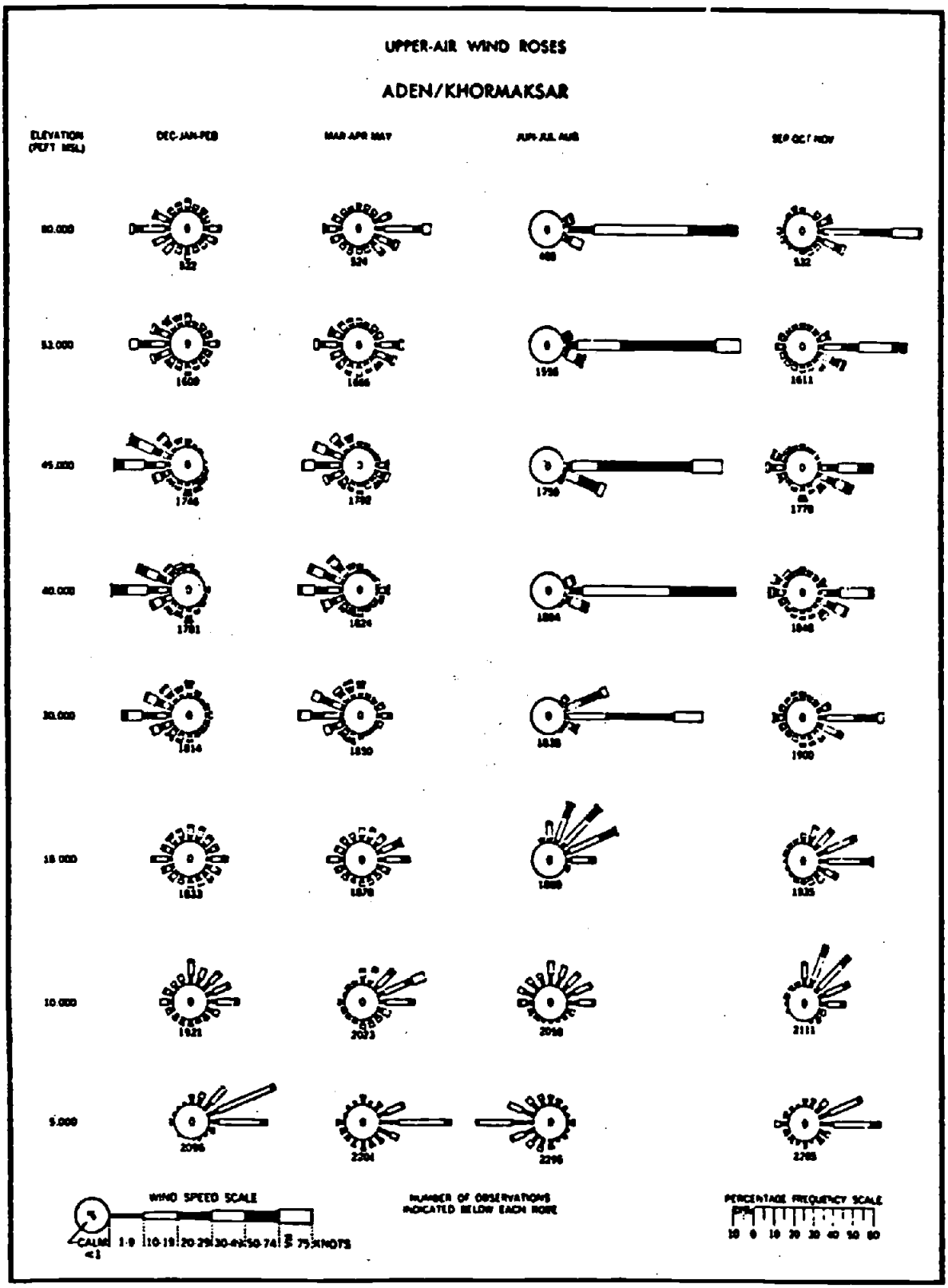

FIGURE 24. Upper-air wind roses, Aden/Khormaksar, Arabian Peninsula

The westerlies prevail throughout the year over Iraq, in September through May over the Arabian Peninsula north of about 20°N., and in November through May over the southernmost part. The most outstanding feature is the westerly jet stream. The core of strongest winds usually lies between about 30,000 and 50,000 feet. Maximum mean speeds within this layer, around 100 knots in January through March, are found near 40,000 feet. Of course, day-to-day variations are pronounced, with speeds ranging, for the most part, from 30 to 150 knots and on rare occasions reaching 200 knots or more. The latitudinal displacement of the jet core is southward to a January limit between 20°N. and 25°N. and northward thereafter.

A complete reversal of the wind field occurs in June over the Arabian Peninsula, and easterlies prevail through August in the northern part and through October in the southernmost reaches. The easterly jet stream is much weaker than its winter counterpart, and the core of strongest winds usually is found between about 40,000 and 65,000 feet. Maximum mean speeds in the jet core, about 65 knots in July over Aden/Khormaksar, occur between 45,000 and 50,000 feet. Wind speeds in excess of 100 knots occur from time to time.

8. Thunderstorms and turbulence

Thunderstorm activity throughout the Area is rather limited. The mean annual number of days with thunderstorms is less than 20 at all stations and, in fact, is less than 10 at three-fourths of the stations (Figure 55). North of about 20°N. thunderstorms occur most often during the winter and transitional months. Average frequencies reach a peak, 2 to 4 per month, in March through May, especially in Iraq. Most of the thunderstorms are associated with the migratory lows and attendant cold fronts. South of about 20°N. thunderstorm activity begins in March or April and continues through the summer. Average frequencies are also low in this region, ranging from less than 1 per month to a maximum of 3 or 4 per month. Greater frequencies probably occur on the upper slopes and ridges of the southwest mountains. Some of the thunderstorms in the Area may grow in intensity to the violent stage. This results in a wide range of accompanying rainfall, from little or none to torrential downpours.

Turbulence may be encountered at any time of year in this Area. Severe turbulence is normally found in thunderstorms, but because of their relatively low frequency thunderstorm turbulence is only occasionally a serious hazard. However, convective and orographic turbulence, especially in clear air, are frequent hazards. The normally clear skies belie the presence of turbulence over the desert regions and in the mountains. The extreme heating over the desert and the combination of heating and orographic influence over the mountains result in turbulent air at levels up to 10,000 feet or higher. This type of turbulence is most prevalent during the hot summer afternoons but may occur in any season. Clear air turbulence is also frequently present near the westerly jet stream in winter and near the easterly jet stream in summer.

9. Combinations of weather elements

The success or failure of several types of operations may be dependent upon the simultaneous occurrence of two or three weather elements. Operations such as high-level visual bombing and aerial photography, as well as takeoff and landing, are generally concerned with sky conditions or ceiling and visibility. The success of other operations such as chemical warfare, incendiary bombing, and parachute operations depends upon the strength of surface winds in combination with various other weather elements. Data for 3 combinations of weather elements are included in Subsection E, Climatic Data Tables, to facilitate the planning of these operations. They include cloud cover or ceiling and visibility (Figures 56 and 57), ceiling, visibility, and surface wind speed (Figure 58), and combinations of surface wind speed, precipitation, and temperature (Figures 59 and 60).

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SOME ASPECTS OF THE CLIMATE OF SOUTH-WEST ASIA

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outh-west Asia provides a challenge to the climatologist because of the general ack of meteorological observations in the interior areas of the region; areas which may be as hot as any in the world. In the interior of Arabia, meteorological observations have recently been made in conjunction with oil exploration nd some of the climatic blanks are now being filled.

January and July maps of mean and extreme temperature and mean precipitation in south-west Asia, revised in the light of the new data, are presented this report along with more specific data for the Rub al Khali or 'Empty Quarter' of Saudi Arabia. The maps are estimates of the average and extreme atterns of occurrence. They should be revised when more complete meteorolo- al records are available.

South-west Asia can be delimited on the map by the five bordering seas: Mediterranean, the Red, the Arabian, the Caspian, and the Black. The fluence of the seas, however, is restricted by the prevailing pressure patterns the restraining influence of mountains so that aridity and continentality haracterize most of the area (see Figure 1).

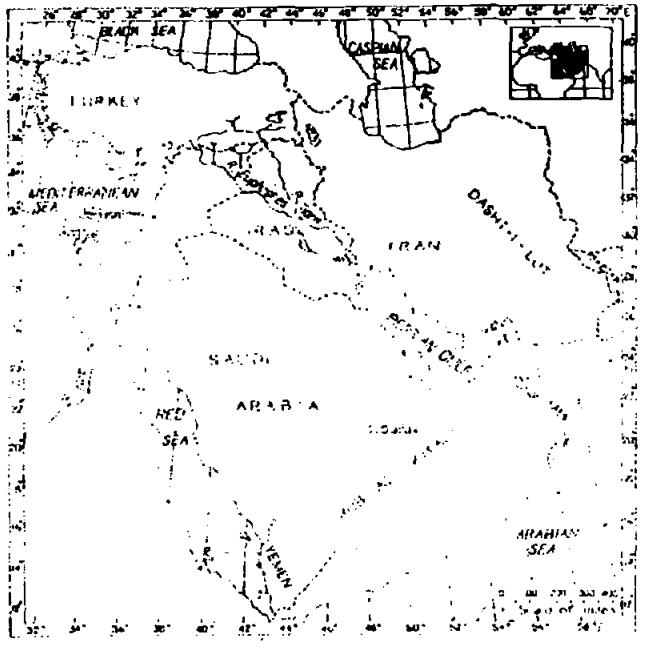


FIGURE 1—MAP OF THE AREA

Winter climate.—In winter a belt of high pressure lies to the north and rth-east of south-west Asia over Mongolia and Siberia. Outflowing air from this high dominates the circulation of all south-west Asia except the southern coast of Iran and the southern portion of the Arabian peninsula. Temporary weakening of this high pressure permits modified polar maritime air from the North Atlantic Ocean to invade the area in migrating storms which generally follow the low-pressure track associated with the comparatively warm waters of the Mediterranean Sea. These storms are the major source of precipitation in much of south-west Asia.

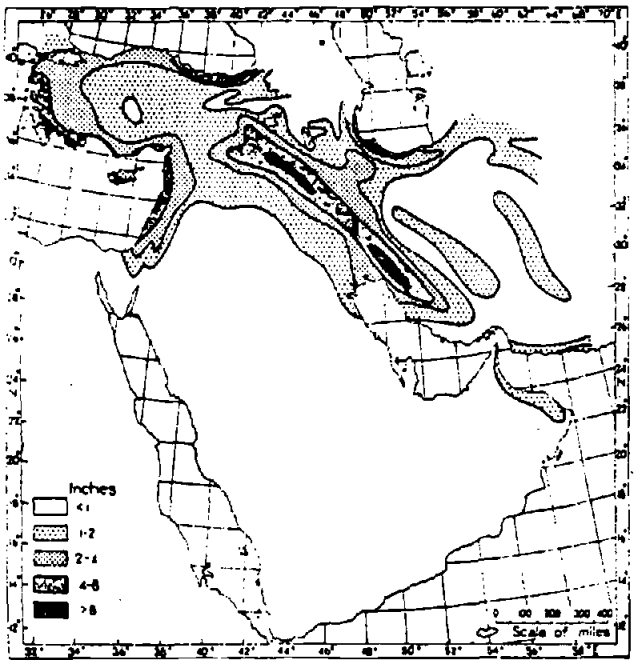
Although winter is the season of maximum precipitation in most of the region, precipitation is plentiful only near the coasts of the three northern seas and on the exposed slopes of the mountains in Turkey and Iran (Figure 2(*a*)). Near the Mediterranean, snow is uncommon at sea level. Farther north and at higher elevations snowfall may be heavy. In the mountains of eastern Turkey high passes are clear of snow only during summer, and even at Jerusalem (2485 feet above MSL) snow depths of three feet have occurred. South of 28°N rainfall is light and snowfall is unusual, although snow occasionally occurs in the southern highlands of Iran and in the mountains of Oman. Heavy snowfalls have been reported at high elevations in Yemen.

Even in winter, part of the south Arabian desert has experienced temperatures above 100°F (Figure 3) and afternoon temperatures are generally above 70°F at elevations below 2000 feet. As far north as the Caspian and Mediterranean littoral, temperatures as high as 80°F occur in January as warm air from the south is drawn into the migratory lows. (In spring and autumn maximum temperatures of above 100°F along the Mediterranean are associated with this same southerly flow of air.) The contrast in air mass as the front passes and cooler maritime air sets in is notable. In Turkey absolute maximum temperatures in January range from near 50°F in the high mountains of the north-east to above 70°F on the Mediterranean and Black Sea coasts. The January mean daily maximum follows a similar pattern with below-freezing averages in the mountains of the east to averages above 50°F on the Mediterranean coast (Figure 4).

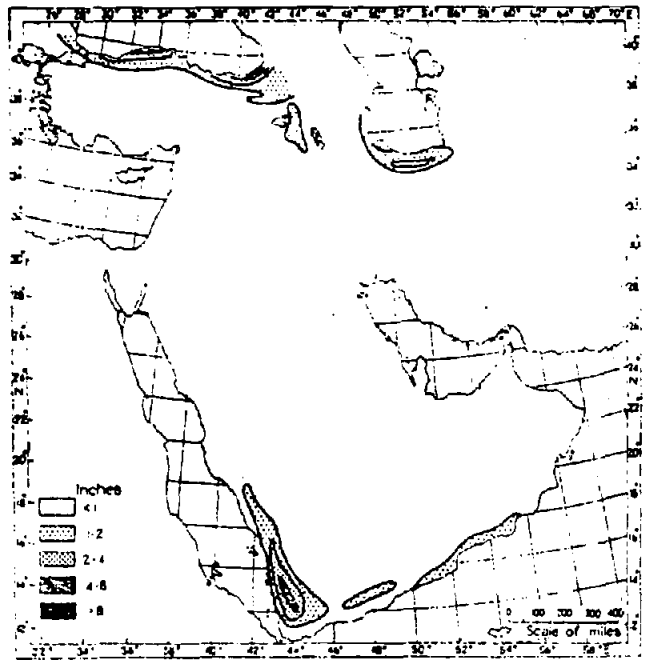
Absolute minimum temperatures in January range from above 60°F at Aden in the extreme south to below −30°F in the mountains of north-eastern Turkey (Figure 5). Similarly, January mean daily minimum temperatures, representative of early morning conditions, range from above 70°F on the Arabian Sea coast to below zero in eastern Turkey and north-western Iran (Figure 6). Frosts have never occurred along the southern coasts and are rare in south-east Arabia.

Summer climate.—In summer the circulation over south-west Asia is controlled by a thermal low centred over north-west India and Pakistan. Low pressure also undoubtedly exists over the interior of Arabia to complicate the circulation over that large land mass. The combination of this low complex with the Azores high to the west results in the transport of dry continental air from the north into the region. Only in the extreme north and in southern Arabia is this pattern broken. In the bulk of the area cloudless skies allow the maximum radiation, and extremely high temperatures result.

Summer precipitation is restricted to southern Arabia, particularly Yemen in the south, and to the border lands of the Black and Caspian Seas in the



(a) January



(b) July

FIGURE 2—MEAN PRECIPITATION

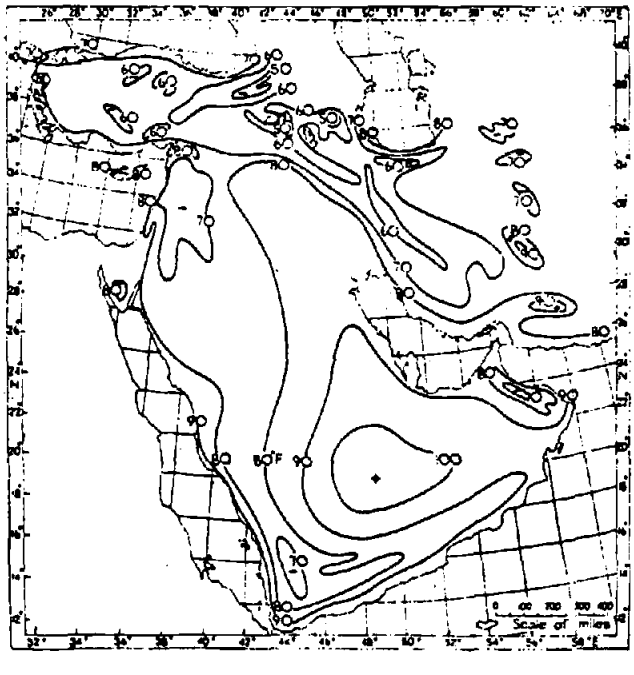


FIGURE 3—JANUARY ABSOLUTE MAXIMUM TEMPERATURE

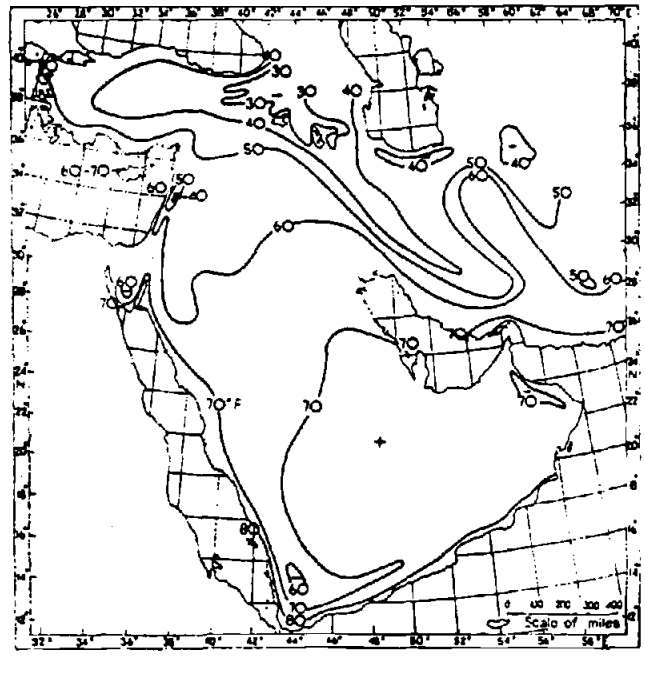


FIGURE 4—JANUARY MEAN DAILY MAXIMUM TEMPERATURE

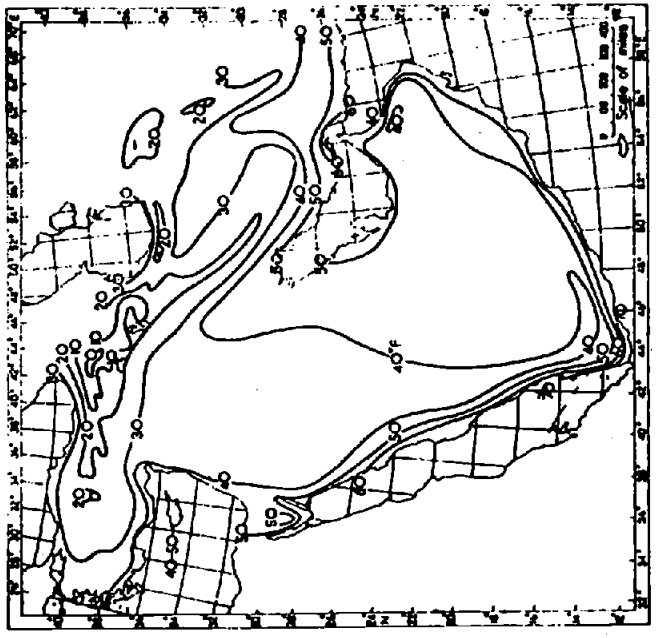


FIGURE 6—JANUARY MEAN DAILY MINIMUM TEMPERATURE

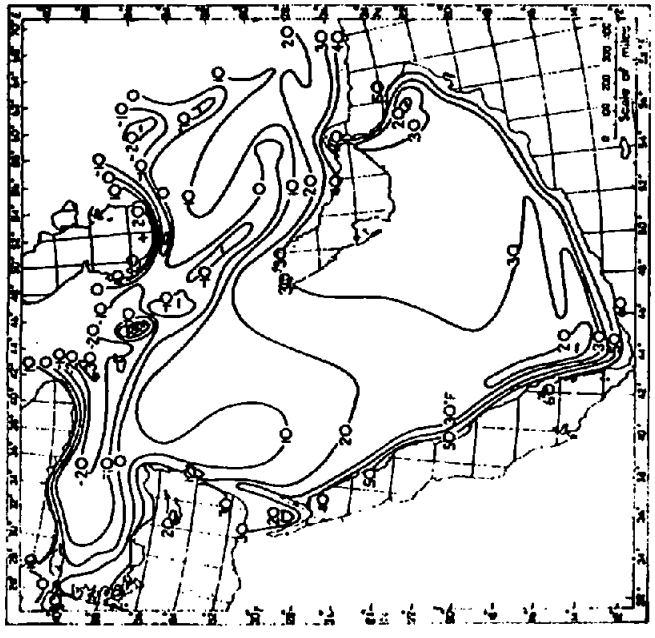


FIGURE 5—JANUARY ABSOLUTE MINIMUM TEMPERATURE

north (Figure 2(*b*)). Some precipitation can be expected each July along the Mediterranean coast near the border of Turkey and Syria, and in the mountains of Iran and Turkey. However in the bulk of south-west Asia any summer may be entirely rainless and in the interior of Iran some stations have never reported rain in June, July, or August.

The most pleasant summer weather in south-west Asia is experienced in the highlands of Yemen where radiation is reduced by clouds associated with the south-west monsoon, and temperatures are moderated by the higher elevations. Rainfall is ample for local farming and for underground supply of water to favoured locations in the Arabian desert.

The distribution of absolute maximum temperatures in south-west Asia is shown in Figure 7. Observations at drilling sites of the Arabian-American Oil Company show that a large part of the interior of Saudi Arabia has absolute maximum temperatures above 120°F, and it is expected that if longer records were available, temperatures above 130°F would have been recorded in the interior of the Arabian desert. Although confirming records are not available, it is likely that the Dasht-i-Lut, a large basin in south-western Iran, is almost as hot. Temperatures above 120°F have also been observed in the Tigris-Euphrates Valley and inland from the Persian Gulf in Iran. The areas of south-west Asia which have not experienced temperatures above 100°F in July are limited to the higher mountains in the north, and to mountains and part of the coastal strip in the south.

Mean daily maximum temperatures are above 110°F in a vast area extending from southern Arabia 1300 miles to northern Iraq and then in a narrow band through southern Iran (Figure 8). The Dasht-i-Lut also has extremely high temperatures. The highest mean temperature in Iran, 106°F in July, was reported from Shahdad on the edge of this basin. The occurrence of mean daily minimum temperatures above 80°F in the Dasht-i-Lut, in much of southern Arabia, and on the littoral of the Persian Gulf and Red Sea further illustrate the torrid summer conditions in south-west Asia (Figure 9). Some stations on the immediate coasts of the Red Sea and Persian Gulf have no record of July temperatures below 70°F (Figure 10).

The largest hot area of south-west Asia is the virtually unpopulated Rub al Khali, an area in south-east Arabia of some 400,000 square miles covered mainly by sand dunes. The extreme heat experienced in the Rub al Khali is illustrated by the temperature trace during a 10-day period at Ubaila (Figure 11). On only one day did the temperature fail to reach 120°F during this period and on 23 July 1954 the minimum temperature for the day was 100°F. Not only was it hot, but at times it was humid. Although afternoon relative humidities were deceptively low, usually below 20 per cent, they often indicated high absolute humidities. The highest dew-point during the 10-day period was 79°F at 0600 local time on 25 July. Later in the summer dew-points above 80°F were observed. When high temperatures are accompanied by high humidities intolerable conditions occur. It is easy to understand the translation of Rub al Khali—abode of emptiness.

A clue to the source of high humidity lies in the fact that rain fell twice during the 10-day period illustrated. It is felt that Ubaila is near the northern

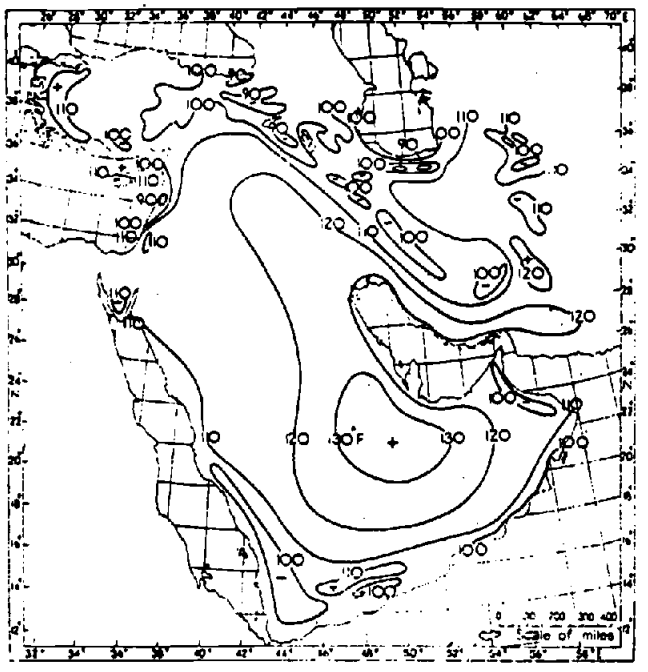


FIGURE 7—JULY ABSOLUTE MAXIMUM TEMPERATURE

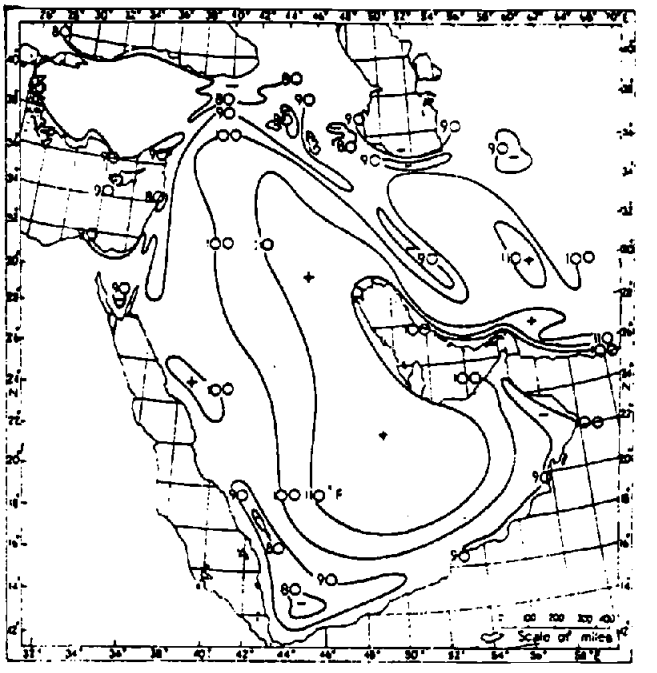


FIGURE 8—JULY MEAN DAILY MAXIMUM TEMPERATURE

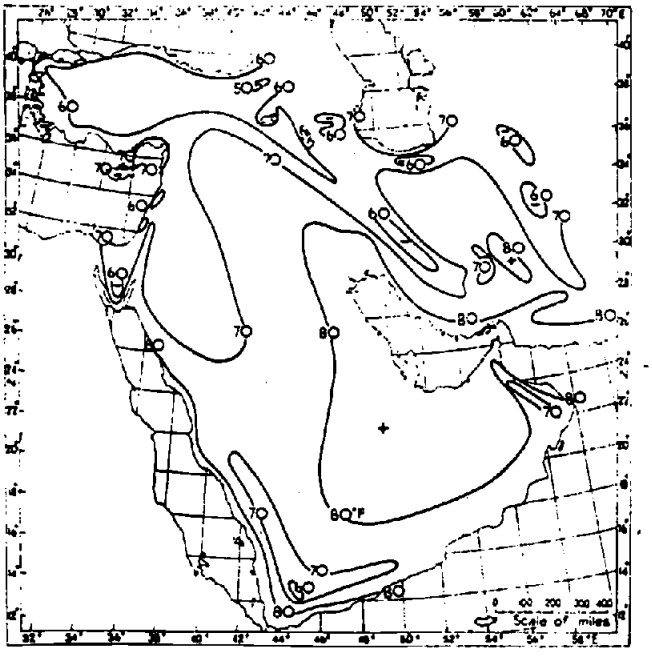


FIGURE 9—JULY MEAN DAILY MINIMUM TEMPERATURE

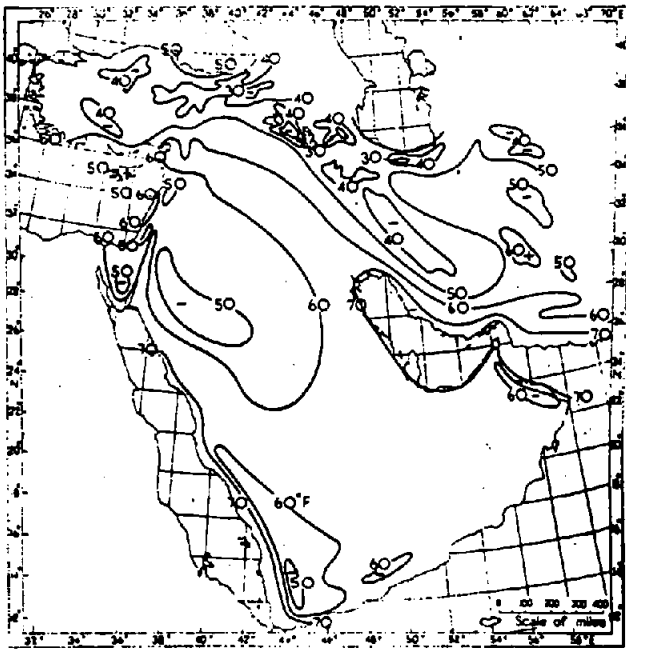


FIGURE 10—JULY ABSOLUTE MINIMUM TEMPERATURE

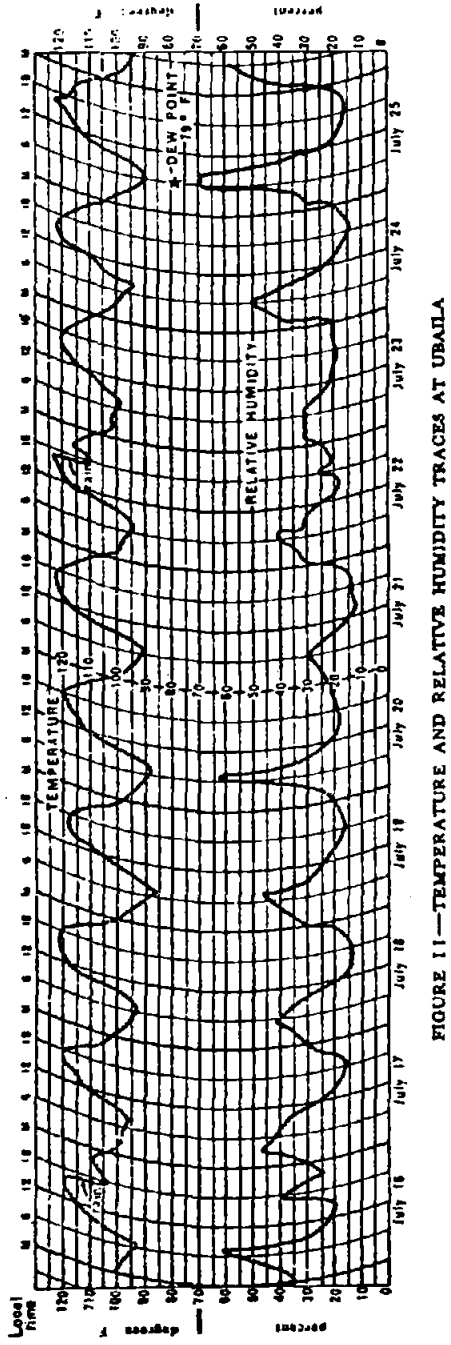


FIGURE 11—TEMPERATURE AND RELATIVE HUMIDITY TRACES AT UBAILA

limit of penetration of the south-west monsoon and therefore is subject to the convective showers that are associated with the influx of moist air from Arabian Sea.

Acknowledgements.—The efforts of a number of people are involved directly or indirectly in the preparation of this report. The climatic maps generalized from maps prepared by climatologists of Earth Sciences Division United States Army Natick Laboratories, Natick, Massachusetts and drawn by A. Greenwald. Much of the data for Arabia, including the hourly thermograph traces for Ubaila, were obtained from the Arabian-American Company by the Air Weather Service, USAF.

A special word of appreciation is due to the personnel, unknown to author, who are responsible for the observations at Ubaila.

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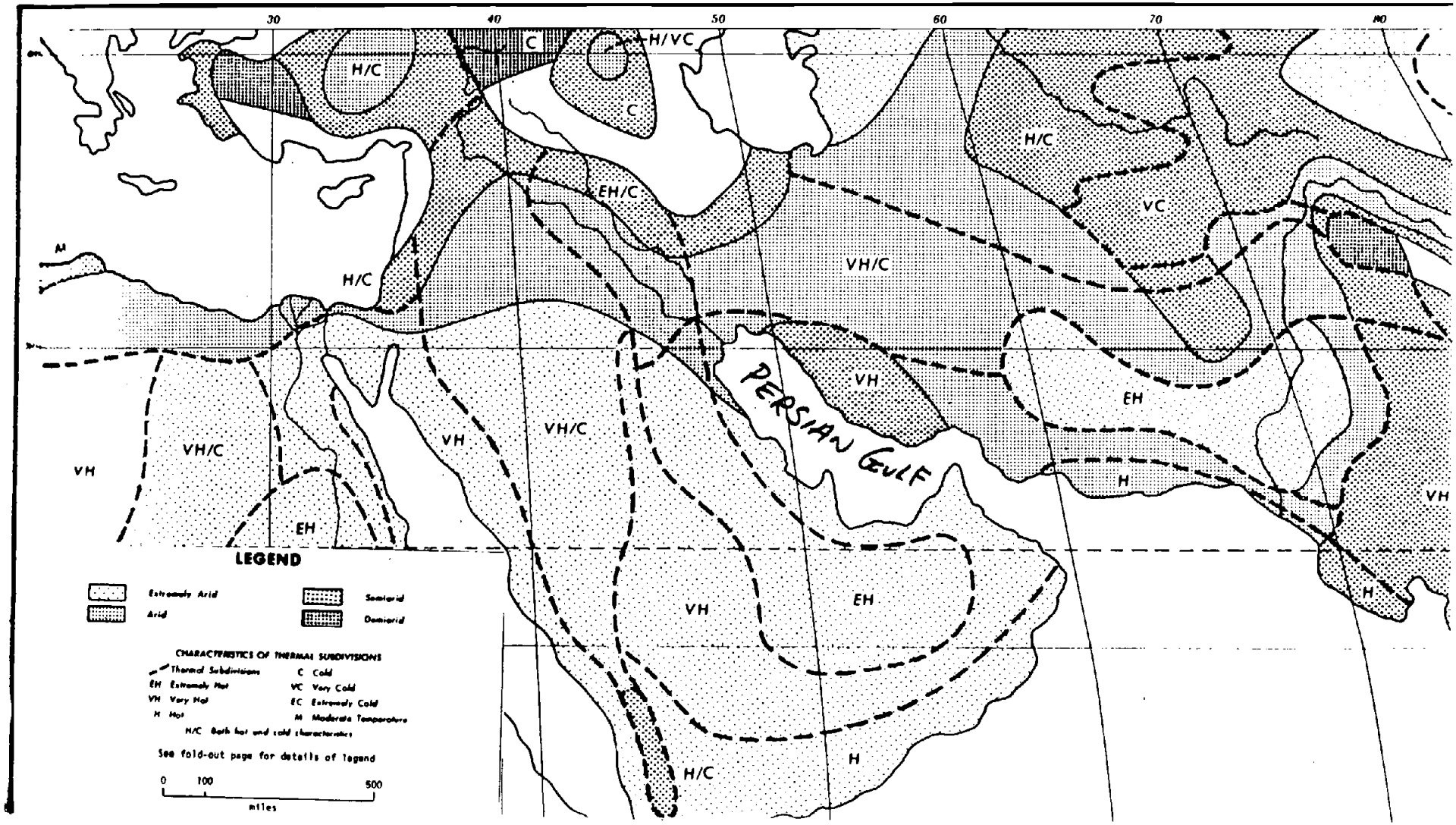
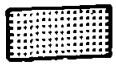
SOUTH-WESTERN ASIA
DISTRIBUTION OF DRY CLIMATIC TYPES



LEGEND

Extremely Arid — 10 to 12 months with no more than 1 rainy day per month (a rainy day has ≥ 0.1 in. precipitation)



Arid — 10 to 12 months with no more than 3 rainy days per month.

Semiarid — 6 to 9 months with no more than 3 rainy days per month.

Demiarid — 4 to 5 months with no more than 3 rainy days per month and 10 to 12 months with no more than 6 rainy days per month.

Thermal Subdivisions

(these frequently include parts of two or more adjacent aridity regions; identifying symbol applies to entire area delineated by the heavy dashed line).

EH	Extremely Hot	At least 2 months with mean daily maximum temperature 105°F or higher (this implies temperatures exceeding 115°F up to one-half the days and exceeding 95°F on most days).
VH	Very Hot	At least 2 months with mean daily maximum temperature 95—104°F (temperatures exceeding 95°F at least one-half of the days and exceeding 115°F occasionally).
H	Hot	At least 2 months with mean daily maximum temperature 85—94°F (temperatures exceeding 95°F up to one-half the days).
C	Cold	At least 2 months with mean daily minimum temperature 25—44°F (this implies that temperature will drop to and below freezing up to two-thirds of the nights).
VC	Very Cold	At least 2 months with mean daily minimum temperature 0—24°F (temperature dropping below freezing from two-thirds to most of the nights and below zero as many as half of the nights).
EC	Extremely Cold	At least 2 months with mean daily minimum temperature below 0°F (temperature dropping to -25°F or colder from occasionally to more than half of the nights).
H/C		Denotes thermal subdivision which is Hot part of the year and Cold another part. Many combinations of EH, VH and H with C, VC, and EC occur somewhere in the world's arid and semiarid climates.
M	Moderate temperature	At least 10 months neither Hot nor Cold; no more than 1 month with mean daily maximum temperature 85°F or above and/or no more than 1 month with mean daily minimum temperature 44°F or below.

SECTION II. ENVIRONMENT -- SITE SPECIFIC

SECTION II. ENVIRONMENT -- SITE SPECIFIC

Some Notes on the Climate of Kuwait, with Special reference to Summer Weather

General

The climate of Kuwait may be classed as a hot and dry phase of the subtropical climates. Long hot summers and brief mild winters with little rainfall during any season are the chief characteristics of this hot-dry type. Winds are prevailingly off-shore winds during all seasons, blowing persistently from the northwest quadrant. Because of this persistence, the air that is carried into the region arrives in Kuwait in an essentially dry state after a long journey over the arid and semi-arid lands of the northern Arabian peninsula and eastern Mediterranean countries. What little rain does fall totals only about 5 inches per year, and this is concentrated largely in the winter season from November to March. Most of the rainfall is received in the form of showers associated with the passage of cyclonic storms that occasionally sweep through the area during the winter season. Summer, in contrast, is a season of extreme drought, with no rain whatsoever having ever been recorded during the months from June through September.

Summer Weather

Temperature

Normal (mean) temperatures equal or exceed 90°F for a full four month period beginning with June and ending with September, with the highest average, 95°F, being attained during August. Some idea of the severity and length of this heat-stress period can be gained by comparison with equivalent statistics for Yuma, Arizona, the hottest city within continental United States. Of the four months from June to September, only the hottest two, July and August, have normals in excess of 90°F. July, the warmest month, has a mean of 94.6°F, and August, a mean of 93.7°F. both June and September, with normals of 87.8°F and 88.3°F respectively, are about 2 degrees cooler on the average than the same months in Kuwait.

Daily temperatures can be expected to rise above 100°F for an hour or longer on most afternoons in Kuwait, and on a few days, particularly in July and August, they may exceed 110°F. Extreme temperatures in excess of 115°F can be expected but rarely, though they have occurred sometime during the period of record in each of the four summer months. Temperatures above 120°F are possible, but relatively improbable, since the highest temperature on record (in 16 years of observation) is 119°F. This value compares rather poorly with heat extremes for other desert regions; for example, in the desert portion of Libya, at El Azizia, the world record of 136°F was established, and at Death Valley, California, a temperature of 134°F was once experienced, the record high for North America. At night, temperatures characteristically fall 20 to 25 degrees below their daytime highs, one result of the desertic character of the

climate. The nighttime minima in summer characteristically range between 82 and 83 degrees, but on a few nights temperatures in the high seventies can be expected.

Surface Winds

Though wind observations for Kuwait are not available, a good estimate of the wind regime can be made form data for nearby stations (e.g. Basra, Bahrein) and from knowledge of the windflow characteristics of the region in general.

In summer, a westward extension of the deep low pressure cell centered over northwest India a fairly steep pressure gradient for northwesterly winds over all sections of the northern Arabian peninsula. At Kuwait, near the northern head of the Persian Gulf, winds between west and north blow persistently throughout the summer months. From the beginning of June to mid-July (the period referred to as the 40-day shamal) the winds are stronger than in late summer and blow practically without interruption. This does much to moderate the heat at the head of the Gulf during the early part of the summer. During the 40 or so days of the shamal, the average force of the wind at coastal locations is about 3 on the Beaufort scale (8 - 12 mph). There is a marked decrease of wind speed in the latter part of summer when winds weaken to an average of beaufort force 2 (4 - 7 mph) or less. Actually, there is considerable variation in speed. winds frequently are strong, and occasionally reach gale force (32mph or higher), at which times the northwesterly winds are frequently laden with sand and dust.

Land and sea breezes are most strongly developed when the prevailing winds are light. Thus there is a tendency for the northwesterly winds to mask out the land and sea breezes in early summer, and a strengthening of these local winds in late summer. In early summer, therefore, the effect of the diurnal breezes is to produce only a slight shift or veering of the prevailing winds. When the prevailing winds are light such as in late summer, the land and sea breeze effect is marked by a complete reversal of direction from sea-to-land in the afternoon, and from land-to-sea at night and early morning. At Kuwait the sea breezes blow with regularity from east or southeast during August and September. The onset of the afternoon breeze frequently is accompanied by a strengthening of the wind to 8 to 12 mph and a rise in relative humidity by as much as 10 or 15 percent.

Atmospheric Moisture

Since the summer season at Kuwait is rainless, it might be suspected that the relative humidity is extremely low. Yet, this is not the case, or, better stated, this is not always the case. Being a coastal location, Kuwait is subject to the humidifying influence of an adjacent large water body. Consequently,

humidities are much higher on the average than for desert regions in general. For all months from June through September, early morning (0530 observation) values for relative humidity average between 50 and 55 percent; in the afternoon (1430 observation) they average between 45 and 50 percent. These values are high, for example, when compared with those for the driest month at Yuma, Arizona, when relative humidity averages 36% at 0530, and 11% at 1730; when compared with averages of 57% (0530) and 25% (1730) for August, the wettest month at Yuma, however, the Kuwait averages are not so widely different.

The combination of high temperature and high relative humidity has a depressing effect on human comfort. The following remarks on this subject relate only indirectly to Kuwait, since they are based on studies for Bahrein Island. Yet, the climatic similarities between the two locations are so striking, that much of what applies to Bahrein, by analogy also applies to Kuwait. It has been estimated that when wet-bulb temperature (another measure of humidity) exceeds 75°F, continuous hard physical labor is impracticable. From June to September, this figure is exceeded (at Bahrein) practically every day at the times of both the morning and afternoon readings. In August 1930, wet-bulb readings of 85°F-88°F were recorded on two successive days on a ship near Bahrein Island. The highest monthly mean of wet-bulb temperature for Bahrein is 67°F computed from the afternoon observations for the month of August. Such values tend to stamp the Persian Gulf as an area of extreme heat stress during all summer months. Away from the coasts, the heat stress factor probably becomes less significant rapidly, for it is estimated that the humidifying influences extend inland a few miles only at best.

CLIMATIC TABLES: KUWAIT CITY

TABLE 1: TEMPERATURE

	J	F	M	A	M	J	J	A	S	O	N	D	ANN.	YRS. REG.
Absolute Maximum	82	78	90	103	109	119	118	115	117	105	100	79	119	16
Mean Monthly Max.	71	73	83	96	105	109	113	113	110	101	89	75	-	13
Mean Daily Max.	61	65	72	83	94	98	103	104	100	91	77	65	85	14
Mean Monthly	55	58	66	76	86	90	94	95	90	82	70	59	72	14
Mean Daily Min.	49	51	59	68	77	82	86	86	81	73	62	53	69	15
Absolute Min.	33	36	40	54	60	72	78	68	67	57	43	36	33	16

TABLE 2: PRECIPITATION

Mean (inches)	0.9	0.9	1.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.6	1.1	5.1	10
Max. in 24 hrs. (inches)	1.0	1.7	1.5	0.5	0.3	0.0	0.0	0.0	0.0	1.0	2.2	1.2	2.2	10
Av.No.Dys w/Precip. > 0.1 -	2	2	2	0.9	0.3	0	0	0	0	0.1	1	3	11	10

TABLE 3: RELATIVE HUMIDITY (%)

Mean of 0530 observations	77	68	72	67	67	62	45	50	52	64	66	76	64	2
Mean of 1430 ovser-vations	61	61	61	55	55	49	41	46	51	60	59	65	55	3

TABLE 4: CLOUDINESS

Mean	(tenths of sky (coverage)	3.9	4.0	3.1	2.9	2.3	0.1	0.5	0.4	0.2	1.5	2.7	4.1	2.1	7

TABLE 5: WINDSPEEDS (BEAUFORT FORCES) & PREVAILING DIRECTIONS FOR KUWAIT AS REPRES. BY

BASRA (Approx.'100 mi. N. of Kuwait)	N1	N1	S1	N1	N1	NW2	NI	W1	W1	W1	W1	W1
BAHREIN IS.(Approx.300 mi. SE of Kuwait)	NW2	NW2	NW2	NW2	NW2	NW2	NW1	NW1	NW1	NW1	NW2	NW2
SHUAIBA, IRAQ(near BASRA)	W3	W3	NW3	NW3	NW4	NW4	NW4	NW3	NW3	NW3	NW3	W3

NOTE: All temperatures listed were observed under standard shade conditions. Objects in the sun may become 20 to 40F° hotter than this during the heat of the day.

SECTION III. ENVIRONMENTAL EFFECTS: MATERIEL

SECTION III. ENVIRONMENTAL EFFECTS: MATERIEL

Environmental Effects

Wind blown sand is particularly damaging to wood such as poles, fences, buildings, etc., painted surfaces, metal and glass. Windshields of cars, trucks and planes gradually lose their transparency, first becoming pitted and then frosted.

Standing vehicles are not damaged by sand and dust nearly as much as when they are moving, especially when moving into the wind.

Standing vehicles should be parked so that the windshields do not face the direction of the wind. Windshields of standing vehicles can also be covered when there is blowing sand and dust.

Desert blowing sand and dust reduce the life of many many engine parts, cylinder, bearings, helicopter blades, etc., by as much as 50%.

Aircraft operating from unpaved airstrips in the desert suffer from rapid cylinder wear and higher rates of oil consumption than normal.

Sand migration and deposition can partially or completely bury roads, railroads, airstrips, pipelines and all types of fixed equipment.

Deposition of sand or its erosion by the wind poses problems in maintaining pipelines.

Fine dust penetrates most minute openings. Bearings, gears, delicate aircraft instruments, electric equipment, etc., must be protected from dusty desert conditions which will hinder their operation.

Due to eletrostactic effects from windblown sand and dust ignition systems of some vehicles do not operate during dust storms unless the frame is grounded.

In Saudi Arabia electrostactic charges of as much as 150,000 volts have made telephone and telegraph communications of a railroad unoperable during sandstorms.

The effects of electrostatic charges produced by the friction of dust and sand particles during storms can be avoided by adequately grounding equipment with a wire of piece of metal chain and by thoroughly shielding the electrical systems of such equipment. Men working with wires and with electrical equipment should wear insulated gloves and use insulated tools.

Precautions that normally are taken when dealing with live wires of relatively low voltage should also be practiced.

a. The areas of most effective wind abrasion are active sand dunes, tracts along large dry washes, and certain exceptional areas such as a mountain notch where wind is funnelled through a gap. In all these situations there must be: an abundant source of incoherent sand, strong winds, no surface crusts, and little binding action by vegetation. Such areas are unstable from a geologic standpoint, since they are not in equilibrium with their environment.

b. Dry playa surfaces, wet playa surfaces (salt flats), lava flows, cinder fields, desert pavements, and desert flats are areas of little wind abrasion. The dry playa and salt flat surfaces are well protected by a surface crust of clay, salt, or a mixture of the two, in which material normally available for wind transport is held in place by a natural binder. In the lava and cinder areas there is available little loose material small enough to be carried by the wind, and the rough, irregural surface breaks up the flow of wind across the surface. In regions of desert pavement the surface is protected by a layer of coarse lag gravel, the finer material long since having been removed.

In Iraq sandstorms are rare, but dust storms are common and can be encountered anytime of the year. Most severe ones are in northern Iraq in October, central Iraq in March, and southern Iraq in June and July.

Clouds of dust restrict visibility to as little as 20 yards.

Dust obscures vision, clogs the nostrals, cakes over the skin, dries the throat, and cause tissue trauma when blown by a high-velocity wind.

When a vehicle is driven over a dust laden surface into the wind, the dust problem is not overwhelming, but if traveling with the wind one can barely see where he is going.

Dust clouds linger quite a while after a vehicle has passed, even with a mild wind.

When traveling in a group across desert country, travel side by side rather than one in front of the other minimizes the dust for the occupants.

Dazzle, or glare, produced by the sun's rays reflecting into the observer's eyes is of relatively high intensity and it will affect visual acuity. In general, glare reduces eye sensitivity and object visibility.

Dark glasses should be worn through all daylight hours.

Even with dark glasses, the glare causes some fatigue in the eyes.

When going into a darker area after being in the sun, the eye must adapt to new lighting; the lower the indoor lighting, the longer the adaption period.

Refraction of light waves due to heat waves diminishes sense-of-sight efficiency.

The magnification of fire-control equipment distorts vision even more. Accurate ranging appears to be almost impossible under these conditions.

Exposure of the retina to high-intensity light slows the rate of adaptation to darkness to such an extent that a measureable degree of night blindness may persist.

Subsequent exposure to bright sunlight will cause a repetition of night blindness, and troops may exhibit a degree of chronic night blindness as long as they remain in an area where the level of brightness is normally verry high during the day.

Mirages due to extreme hot surface temperatures can distort, change the appearance or may even completely obscure an object either natural or man made.

At times some objects appear to be much closer than they actually are.

Mirages are fully noticeable about 3 hours after sunrise, but is absent prior to that time.

Mirages at their worst can reduce visibility to a few hundred yards, but the effects can be reduced considerably if one ascends even a few feet above ground level.

In southern Iran and along the coasts of the Arabian Peninsula winter is the only season with a combination of temperature and humidity especially suited to microbiological activity.

Temperatures of 65° to 75°F with relative humidities of 70 to 85% tend to produce moderate microbiological activity and temperatures of 75 to 90% with relative humidities of over 85% tend to produce severe deterioration.

Materiel, especially metals, when exposed to direct sun light becomes very hot and even hotter if it is operating equipment.

With an ambient temperature of 105 to 110°F a 57mm recoilless rifle and its ammunition after six hours were at a temperature of 130°F. After rapidly firing 8 rounds the external surface temperature was over 300 degrees, after 30 rounds over 430°F. Insulated gloves were necessary during the loading operations.

Under the above noted operation the gun crew, an acclimatized crew was fatigued after about 10 minutes of continuous loading and firing of the rifle.

In general the pain threshold of human receptors to heat is 128°F which will vary, some due to skin callous, variable sensitivity, etc.

During the day the desert surface gets very hot. If possible do not sit or lie on the ground. It is 30 to 45 degrees cooler a foot above the ground than it is right on the ground.

At 45°C, sluggishness and an unwillingness to work and move about are noted.

At 40-45°C maximum muscle strength is reduced about 20%.

TABLE I
ENVIRONMENTAL VERSUS MILITARY FACTORS

LEGEND

1 Environmental factor exerts pronounced influence on military activity

2 Environmental factor exerts moderate influence on military activity

Blank Environmental factor exerts no notable influence on military activity

These entries are based on consensus of subjective opinions of a study team.

	Military Operations and Components																																			
	Personnel equipment			Storage of food supplies (Class I)		Medical facilities and supplies				Weapon operation at firing individual or crew served				Munitions: Operations and storage (Class V supplies)					Fuels: Use and storage (Class III supplies)				Vehicle operation				Aircraft				Communication: equipment and use			Construction operations	
																											Fixed wing		Rotary						
	Personnel	(1) Combat support	(2) Non-combat and life support	(1) Preserved: Canned and packaged	(2) Perishable	(1) Permanent structure	(2) Temporary structure	(3) Instruments	(4) Perishable medical supplies	(1) Individual	(2) Mortar	(3) Howitzer and other field guns	(4) Rocket & missiles	(1) Small arms, grenades	(2) Artillery, bombs	(3) Mines	(4) Incendiaries	(5) Rockets	(1) Aviation gasoline	(2) Motor vehicle gasoline, Diesel	(3) Lubricants	(4) Solids	(1) Wheeled	(2) Tracked	(3) Crossing and fording	(4) Water	(1) Transport	(2) Reconnaissance	(1) Transport	(2) Reconnaissance	(1) Line transmission	(2) Air transmission	(3) Visual transmission	(1) Road building, bridging	(2) Water supply
1.0 CLIMATE																																				
Haze and optical phenomena—shimmer and glare	2									1	1	1	1										1	1	2	1	1	1	1	1			1		
Fog	1									1	1	1	1										1	1	1	1	1	1	1	1		2	1	2	
Cloud cover—amount and base of lowest ceiling										2	2	2	2										2	2	2	2	1	1	1	1		1	1		
Blowing sand and dust	1	1	2	2	1		1	2	1	1	1	1	1						2	2	2	2	1	1	2	2	1	1	1	1	2	1	1	1	2
Precipitation type, intensity, frequency	1			1	2		1	2	1	1	1	1	1	2	2	2	1	2	2	2	2	2	1	1	2	2	1	1	1	1	2		1	1	2
Moon and star intensity	1									1	1	2	2										1	1	1	1	2	2	1	1			1	2	
Ambient temperature—maximum and range	1	2	1	1	1	2	1	1	1	2	2	2	1	2	2	2	2	1	1	1	1	2	1	1	1	1					2	2		1	1
Humidity—relative and absolute, comfort index	1	2	1	2	1	2	1	1	1					1	2	2	1	1													2	2			
Wind speed direction and turbulent variations	1						1			1	1	1	1		2		2	2					2	2	1	1	1	1	1	1	2	2		1	2
Solar radiation and percentage of sunshine	1	1	1	2	1	2	1		1	2	2	2	2						1	1	1	2	2	2	2	2								2	
Evaporation rate	1		2	1	1				1								2		1	1															
Atmospheric pressure	2																		2	2			2	2			1	1	1	1		2			

TABLE 1 (continued)
ENVIRONMENTAL VERSUS MILITARY FACTORS

LEGEND

1 = Environmental factor exerts pronounced influence on military activity

2 = Environmental factor exerts moderate influence on military activity

Blank = Environmental factor exerts no notable influence on military activity

These entries are based on consensus of subjective opinions of a study team.

	Military Operations and Components																																			
	Personnel equipment			Storage of food supplies (Class I)		Medical facilities and supplies				Weapon operation at firing individual or crew served				Munitions: Operations and storage (Class V supplies)					Fuels: Use and storage (Class III supplies)				Vehicle operation				Aircraft				Communication: equipment and use			Construction operations	
																											Fixed wing		Rotary						
	Personnel	(1) Combat support	(2) Non-combat and life support	(1) Preserved: Canned and packaged	(2) Perishable	(1) Permanent structure	(2) Temporary structure	(3) Instruments	(4) Perishable medical supplies	(1) Individual	(2) Mortar	(3) Howitzer and other field guns	(4) Rocket & missiles	(1) Small arms, grenades	(2) Artillery, bombs	(3) Mines	(4) Incendiaries	(5) Rockets	(1) Aviation gasoline	(2) Motor vehicle gasoline, Diesel	(3) Lubricants	(4) Solids	(1) Wheeled	(2) Tracked	(3) Crossing and fording	(4) Water	(1) Transport	(2) Reconnaissance	(1) Transport	(2) Reconnaissance	(1) Line transmission	(2) Air transmission	(3) Visual transmission	(1) Road building, bridging	(2) Water supply
2.0 TERRAIN																																				
2.1 Landforms																																				
Feature orientation						2	2			2	2	2	2										2	2	2		2	2	2	2		2	2	2	2
Elevation	2					2	2	2	2		2	2	2						2	2			2	2	2		1	1	1	1		2	2	2	2
Relief	2					2	2			2													1	1	1		1	1	2	2	1	1	1	1	2
Slope	2					2	2			2	2	2	2										1	1	2		1	1	2	2	1	2	2	1	2
Surface materials	2					2	2				2	2	2										1	1	1	2			2	2				1	1
2.2 Hydrology	2		2	2		1	2			2	2	2											1	1	1	1					2			1	1
2.3 Vegetation																																				
2.3.1 Ground Level Vegetation																																				
Color	2		1																													1				
Perennials, annuals	2														2		2	2					2	2	2							2	2		
Trunk base size	2									2	2	2	2	2	2	2	2	2					1	1	2	2						1	1		
Shallow rooted—deep rooted	2																						1	1	2								1		
Individual plants vs. plant communities	2									2	2	2	2	2	2	2	2	2					2	2	2				2	2	2		1	1		
2.3.2 Overhead Vegetation																																				
Color	2		1			2	2																2	2	2	2		2	2	2			1		
Perennials, annuals	2					2	2								2		2	2					2	2	2			2	2	2			2	2	
Individual plants vs. plant communities	2					2	2							2	2	2	2	2					2	2	2			2	2	2	2		1	1	
3.0 ANIMAL LIFE	1		2	1		2	2		2																	2	2								

Section 5 - Desert Maintenance

Equipment maintenance is highly critical in desert operations. Organizational maintenance cannot be overlooked; it is at this stage that serious damage and failure can be avoided by detecting and correcting minor deficiencies which could lead to a major breakdown. Gen. Charles L. Scott after WWII said,

> ". . . Anyone who doesn't believe in stressing motor maintenance or in providing liberally for it in armor or mechanized units should take a trip to the desert and become converted. It is littered with millions of dollars worth of tanks and motor vehicles, many of which could have been saved by preventive maintenance. . ."

The excessive heat, abrasive materials of the sand/dust, and rugged terrain of the desert environment are constantly at work to disable equipment. One of these factors alone could put a vehicle out of action. However, together and acting simultaneously, they represent a formidable obstacle to military equipment operation.

5.1 Heat. The high temperatures encountered in the desert prevent adequate heat dissipation of the cooling and lubricating system of vehicle engines. When a cooling system becomes ineffective it can adversely affect the lubricating system and vice versa. Temperatures in excess of 107.2°C (225°F) have been recorded for engine oil during operation. Therefore, particular attention should be given to vehicle cooling systems as overheating is a major problem in desert operations. The operator should frequently check the temperature gauge. Liquid cooling systems should be flushed and cleaned frequently. Distilled water should be used if possible, and a coorosion inhibitor should be added. The coolant level needs checking often due to the high evaporation rate in the desert. The radiator pressure caps should be checked for proper operation, as one pound of pressure raises the boiling point approximately three degrees. The exterior of the radiator should be cleaned to prevent the accumulation of sand and dust which restricts airflow and impedes cooling. Hoses deteriorate more rapidly in the desert due to extreme heat. They should be inspected at more frequent intervals than those prescribed in the technical manuals. Fan belts deteriorate rapidly and should be checked for cracks and breaks. Spares should be available.

Frequent bleeding of hydraulic systems may be required to maintain pressure. This is due to the great diurnal temperature variations experienced in the desert. A 40-degree difference between morning and afternoon temperatures is not unusual.

Excessive temperatures can be generated by a combination of ambient heat, radiation and friction. Rubber tires and track pads have been known to blow out due to concentration of heat above 121°C (250°F) in the interior rubber.

Batteries must be given special care by having water levels checked frequently due to excessive evaporation. Overcharging will result in higher evaporation

rate; therefore, voltage regulators should be set to lowest practical charging rate.

5.2 Sand/Dust. The adverse effect of the desert environment on maintenance requirements of armament and individual weapons is primarily due to blowing sand and dust. Moving parts in the recoil mechanism, brakes, and elevating and traversing mechanisms can easily become contaminated by abrasive particles. This will lead to higher rates of wear for the affected parts. In small caliber weapons, sand and dust will cause clogging, and jamming. Lubrication will compound the problem due to formation of abrasive paste. Therefore, weapon systems should be kept dry and clean if possible. If the weapon is not being used, it should be covered to protect vulnerable parts.

Relays and contactors are easily contaminated by sand and dust preventing contacts from closing. Fixed equipment, such as stationary engines, generators, compressors, pumps, and machine tools, also suffer from the abrasive effects of windblown sand and dust. Rings are worn, cylinders scored, commutators scratched, and bearings damaged. Frequent inspection and cleaning of air filters and protective screening is required. A higher than normal replacement rate should be anticipated and replacement parts kept on hand.

Erosion of helicopter rotor blades and turbine engine compressor blades may be a significant problem during desert operation. Numerous metallic and plastic compounds have been tried to reduce rotor erosion but with little success. The only sure method to alleviate high rotor replacement is by limiting low level hovering and using surfaced helipads.

The infiltration of sand and dust occurs even in the most minute openings. This ability of fine-grained material to enter areas poses a severe problem to stored electronic equipment and delicate aircraft instrumentation which requires the exclusion of foreign material. Extreme care should be exercised when working with such materiel.

Impact of windblown particles produces large electrostatic voltages. An electrostatic charge of as much as 150,000 volts was produced in Saudi Arabia during a severe dust storm. Proper grounding of equipment should be insured prior to handling.

All maintenance should be performed in a protected environment to prevent contamination as much as possible. Tasks which require exposure of lubricated surfaces, should not be performed under adverse conditions.

5.3 Terrain. The rocky nature of many desert areas causes severe vibration problems on vehicles and transports. Frequent inspection should be made of all air lines, bolts, nuts, etc. to insure proper tightness.

Tires of dual-wheeled vehicles must be inspected more frequently after driving through rock covered areas, to remove any lodged rock particles and to insure that the tires are properly inflated. A flat tire on one of the dual wheels will not be noticed while driving and could result in premature failure of the other tire if load is excessive.

SECTION IV. ENVIRONMENTAL EFFECTS: PERSONNEL

SECTION IV. ENVIRONMENTAL EFFECTS: PERSONNEL

ENVIRONMENTAL EFFECTS ON PERSONNEL

There is no reason to fear the desert environment, and it should not adversely affect the morale of a soldier who is prepared for it, provided he takes certain precautions to protect himself and his equipment. It should be remembered that there is nothing unique about either living or fighting in deserts; native tribesmen have lived in the Sahara for thousands of years. The British maintained a field army and won a campaign in the Western Desert in World War II at the far end of a 12,000-mile sea line of communication with equipment considerably inferior to that in service now. The desert is essentially neutral, affecting both sides equally; the side whose personnel are best prepared for desert operations has a distinct advantage.

The desert is fatiguing, both physically and emotionally. A high standard of discipline is essential, as an individual's single lapse may cause serious damage to his unit or to himself. Commanders must exercise a very high level of leadership and train their junior leaders to assume greater responsibilities required by the wide dispersion of units, normal in desert warfare. Soldiers with good leaders are more apt to accept heavy physical exertion and uncomfortable conditions. Every soldier must clearly understand why he is fighting in such harsh conditions and should be kept informed of the operational situation. Ultimately, however, the maintenance of discipline will depend on individual training.

Commanders must pay special attention to the welfare of troops operating in the desert, as soldiers will be unable to find any "comforts" except those provided by the command. Welfare is an essential factor in the maintenance of morale in an environment that appears—and is—harsh, especially to the inexperienced. There is more to welfare than the provision of mail and clean clothing; although these are important. Soldiers must be kept healthy and physically fit; they must have adequate, tasty, and regular food, and be allowed due periods of rest and sleep. These things will not always be possible and discomfort is inevitable, but if troops know that their commanders are doing everything they can to make life tolerable they will accept the difficulties that arise.

ACCLIMATIZATION

Acclimatization to heat is necessary to permit the body to reach and maintain efficiency in its cooling process. A period of approximately 2 weeks should be allowed for acclimatization, with progressive degrees of heat exposure and physical exertion. Although this strengthens heat resistance there is no such thing as total protection against the debilitating effects of heat. Situations may arise where it is not possible for men to become fully acclimatized before being required to do heavy labor. If this happens heavy activity should be limited to cooler hours and soldiers should be allowed to rest more frequently than normal. A gradual program of work is shown in appendix G

SUN, WIND, AND SAND

Radiant Light. The sun's rays, either direct or bounced off the ground, affect the skin and can also produce eyestrain and temporarily impaired vision. Overexposure will cause sunburn. Persons with fair, freckled skin, ruddy complexions, or red hair are more susceptible to sunburn than others, but all are susceptible to some degree. Sunburn is characterized by painful reddened skin, can result in blistering, and can lead to other forms of heat illness. Soldiers should acquire a suntan in gradual stages, in the early morning or late afternoon, to gain some protection against sunburn. They should not be permitted to expose bare skin to the sun for longer than 5 minutes on the first day, increasing exposure gradually at the rate of 5 minutes per day. In all operational conditions they should be fully clothed in loose garments. This will also reduce sweat loss. It is important to remember that:

The sun is as dangerous on cloudy days as it is on sunny days.

Sunburn ointment is not designed to give complete protection against excessive exposure.

Excessive sunbathing or dozing in the desert sun *can be fatal.*

Wind. The combination of wind and dust or sand can cause extreme irritation to the mucous membranes and chap the lips and other exposed skin surfaces. Irritative conjunctivitis, caused when fine particles enter the eyes, is a frequent complaint of vehicle crews, even if wearing goggles. Chapsticks and skin and eye ointments must be used by all personnel.

Climatic Stress. Climatic stress on the human body in hot desert can be caused by any combination of air temperature, humidity, air movement, and radiant heat. The body is also adversely affected by such factors as lack of acclimatization, overweight, dehydration, alcoholic excess, lack of

Radiant light comes from all directions.

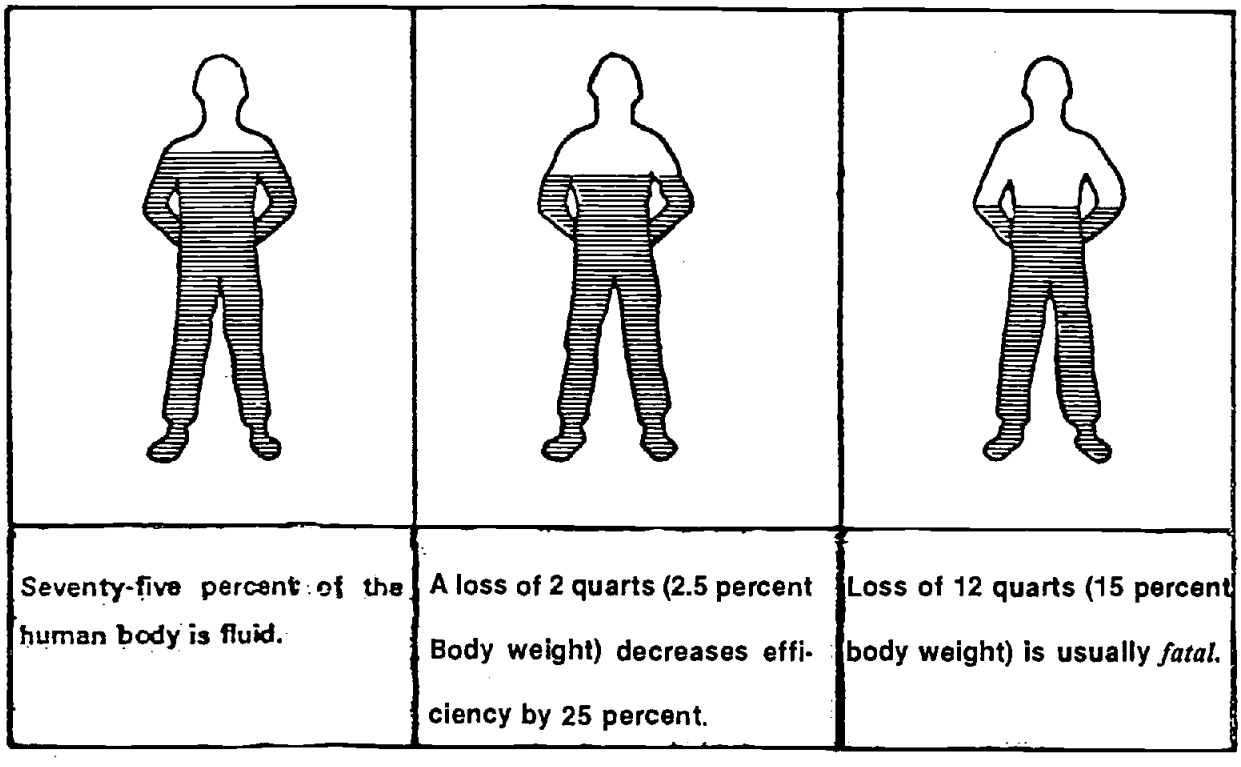
Protect the back of your neck.

sleep, old age, and poor health. The body maintains its optimum temperature of 98.6°F, by conduction/convection, radiation, and evaporation (sweat). The most important of these in daytime desert is evaporation, as air temperature alone is probably already above skin temperature. If, however, relative humidity is high, air will not easily evaporate sweat and the cooling effect is reduced.

Sandstorms. Fast, windblown sand can be extremely painful on bare skin, so this is one reason why persons must always be fully clothed. When visibility is reduced by sand storms to the extent that military operations are impossible, soldiers should not be allowed to leave their group unless secured by lines for recovery.

WATER, DEHYDRATION, AND SALT

Water. Approximately 75 percent of the human body is fluid. All chemical activities in the body occur in a water solution, which assists in the removal of toxic body wastes and plays a vital part in the maintenance of an even body temperature. A loss of 2 quarts of body fluid (2.5 percent of body weight) decreases efficiency by 25 percent and a loss of fluid equal to 15 percent of body weight is usually fatal.



Seventy-five percent of the human body is fluid.	A loss of 2 quarts (2.5 percent Body weight) decreases efficiency by 25 percent.	Loss of 12 quarts (15 percent body weight) is usually *fatal.*

Potable drinking water is the most basic need in the desert. It is necessary to ensure that there is no possibility of nonpotable water being mistaken for drinking water. Water that is not fit to drink but not otherwise dangerous (it may be merely over-salinated) may be used to aid cooling. It can be used to wet clothing, for example, so that the body does not use so much of its internal store.

Issue water containers must be used only for drinking water. Sufficient water must be carried on a vehicle to last the crew until the next planned resupply plus a small reserve. Water containers should be carried in positions that:

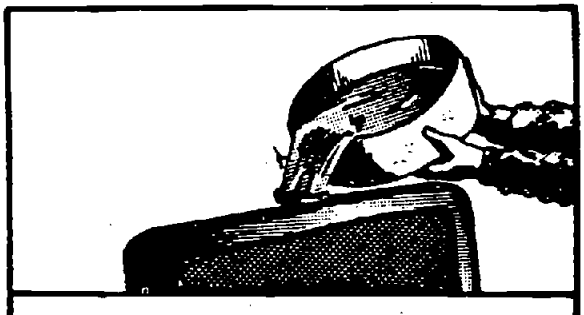
Clamp them firmly to the vehicle body to prevent seams splitting by vibration.

Are preferably in the shade and in an air draft.

Are guarded against the possibility of puncture by shell splinters.

Are easily dismounted in an emergency.

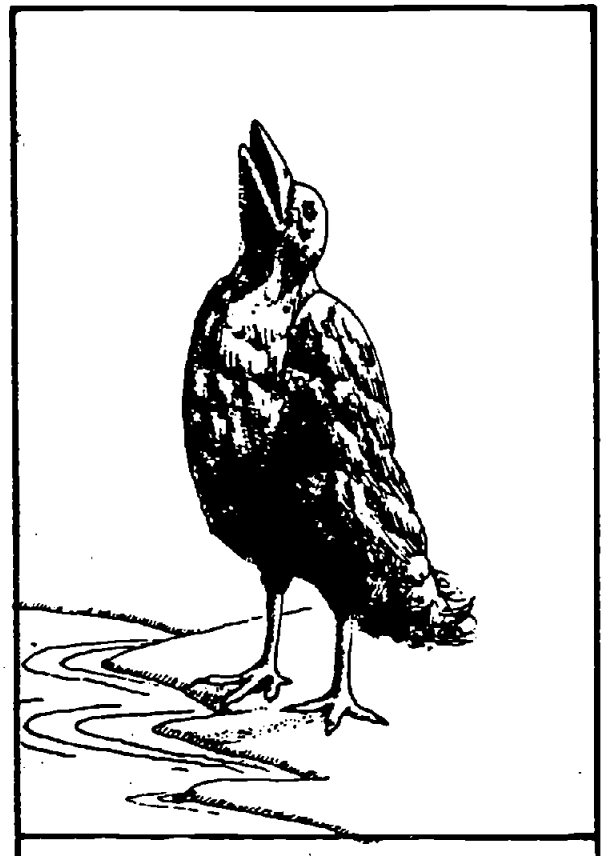
Soldiers must be trained not to waste water. Water that has been used for washing socks, for example, is perfectly adequate for a vehicle cooling system. Drinking water must be taken only from approved sources to avoid disease or water that may have been deliberately polluted. Care must be taken to guard against pollution of water sources. If rationing is in effect, water should be issued under close supervision of officers and noncommissioned officers.



Dirty water can be suitable for radiators.

Soldiers cannot be trained to adjust permanently to a decreased water intake. An acclimatized soldier will need as much if not more water than the nonacclimatized as he sweats more readily. If the ration is not sufficient there is no alternative but to reduce physical activity or restrict it to the cooler parts of the day. Any temporary deficiency should be made up if maximum efficiency is to be retained.

In very hot conditions it is better to take *smaller* quantities of water often rather than large quantities occasionally. The latter case leads to waste by causing excessive sweating and may induce heat cramps. As activities or conditions become more severe, water intake should be increased accordingly.



Drink like a bird, sip—don't guzzle your water

The optimum drinking water temperature is between 10°C and 15.5°C (50-60°F). Lister bags or even wet cloth around metal containers helps to cool water.

Alcohol lessens resistance to heat due to its dehydrating effect. Smoking, particularly during the day, increases the desire for water and should be avoided.

Units performing sustained heavy activities such as a forced march or digging in, may require more than 3 gallons of drinking water per man at 80 degrees Wet Bulb Globe Temperature Index and any increase in the stress will increase this need. A guide to water requirements is shown in appendix G.

Dehydration. During high desert temperatures a resting man may lose as much as a pint of water per hour by sweating. In very high temperatures and low humidity sweating may not be noticeable as it evaporates so fast the *skin will appear dry. Whenever possible, sweat should be retained on the skin to improve the cooling process and the only way to do this is to avoid direct sun on the skin. This is the most important reason why desert soldiers must remain fully clothed.* If a soldier is working, his water loss through sweating (and subsequent requirement for replenishment) increases in proportion to the amount of work done.

Thirst is not an adequate warning of dehydration

Thirst is not an adequate warning of dehydration as the sensation may not be felt until there is a body deficit of 1 to 2 quarts of water. Very dark urine is often a warning of dehydration. Soldiers do not always drink their requirement readily and may need to be encouraged or coerced to drink more than they think necessary, especially during periods of acclimatization. Packets of artificial fruit flavoring will encourage consumption due to the variety of pleasant tastes.

Salt. Salt in correct proportions is vital to the human body, but the more a man sweats, the more salt he loses. The issue ration has enough salt for a soldier drinking up to 4 quarts of water per day. Unacclimatized soldiers need additional salt during their first few days of exposure and all soldiers need additional salt when sweating heavily.

If the water demand to balance sweat loss rises, extra salt must be taken under medical direction. Salt in excess of body requirements however may cause increased thirst, a feeling of sickness, and can be dangerous. To avoid this, these general rules should be followed:

Extra salt should only be taken in proportion to the available extra water.

The quantity taken, in any form, must be strictly controlled according to medical advice.

Salt tablets should not be used unless dissolved into a solution.

A convenient way to provide additional salt when the salt in food is not adequate is to salt all drinking water to a concentration of 0.1 percent. A table listing the quantities required is shown in appendix G. Water must be tested before adding salt as some sources are already saline, especially those close to sea.

DESERT SICKNESS

Heat Illness. The temperature of the body is regulated within very narrow limits. Too little salt may lead to heat cramps; too little salt and insufficient water may lead to heat exhaustion. A general collapse of the body cooling mechanism will lead to heat stroke, which is potentially fatal. To avoid these illnesses, soldiers must be physically fit, thoroughly acclimatized, and drink sufficient water with necessary salt. If soldiers expend more calories than they take in they will be more prone to heat illnesses. Since men may lose their desire for food in hot climates they must be encouraged to eat, with the heavier meal of the day scheduled for the cooler hours.

Continued supervision by commanders and the use of the buddy system are important, especially for those personnel, such as mechanics, who work alone or in pairs. It is necessary to recognize heat stress symptoms quickly. When suffering from heat stroke, the most dangerous, there is a tendency for a man to creep away from his comrades and attempt to hide in a shady and secluded spot; if not found and treated he will die. When shade is required during the day, it can best be provided by tarpaulines or camouflage nets, preferably doubled to allow air circulation between layers and dampened with any surplus water. The major symptoms, and first aid treatment for heat illnesses are shown in appendix G.

Diseases. Diseases found in the desert include plague, typhus, malaria, dengue fever, dysentery, cholera, and typhoid. Some of these can be prevented by vaccines or prophylactic measures. High levels of field hygiene and sanitation are necessary to preclude disease where there are no vaccines or prophylactic measures.

Fungus Infections and Prickly Heat. The excessive sweating common in hot climates can aggravate prickly heat and some forms of fungus infections of the skin. The higher the humidity the greater the possibility of their occurrence. Although many deserts are not humid, there are exceptions, and these diseases are likely in humid conditions.

Respiratory Diseases and Cold Weather Injuries. Soldiers may tend to stay in thin clothing until too late in the desert day and become susceptible to chills, so respiratory infections may be common. Personnel should gradually add layers of clothing at night, (such as sweaters), and gradually remove them in the morning. Where the danger of cold weather injury exists in the desert, commanders must guard against attempts by inexperienced troops to discard cold weather clothing during the heat of the day.

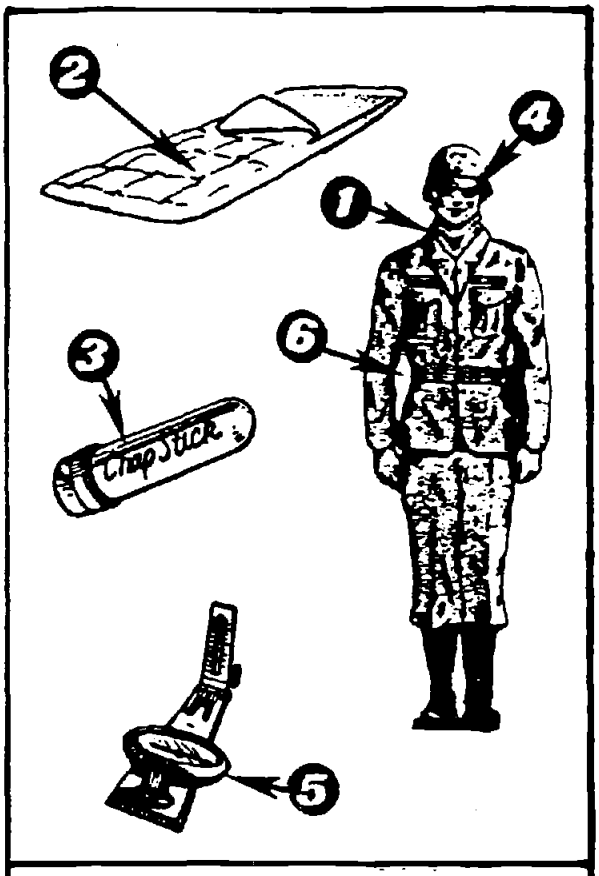
Infections from Polluted Water. Skin diseases can be caused by polluted water; so untested water should not even be used for washing clothes; although it can be used for vehicle cooling systems or vehicle decontamination.

SNAKES

Snakes abound in desert conditions, ranging from the totally harmless to the lethal. As a general rule, a poisonous snake will present a serious danger to an adult only if over 2 feet long, but it is dangerous to touch any snake. Bites from harmless snakes can easily become infected. Snakes seek shade (cool areas) under bushes, rocks, trees, and shrubs. These areas should be checked prior to sitting or resting. Soldiers should always check before putting on boots and clothing in the morning.

CLOTHING

Standard light-weight clothing is suitable for desert operations but should be a camouflage color, not fatigue green. Non-starched long sleeve shirt and full length trousers are worn, tucked into combat boots. Special clothing may be required by tankers, and field and air-defense artillerymen, as they live in an environment of oils and greases and with high risk of burns if their vehicle is hit by enemy fire; this clothing must have an ability to "breathe." Jungle boots should not be worn as sand will sift into them. A scarf or triangular bandage should be worn loosely around the neck. It is used to protect the face during sand storms, as a sweat rag, and to protect much of the face and neck against sand and sun. The helmet liner is adequate for desert use as it offers sufficient airspace for air circulation and gives a certain amount of eyeshade and neck protection; the steel helmet is worn over it in combat. Each soldier should have the following equipment:



HOW TO DRESS

1. Sweater, field jacket, a woolen scarf for cold and night use and a cotton-type scarf for day use.
2. Sleeping bag.
3. Chapstick (some personnel may be allergic to chapsticks and should use vaseline), antisunburn ointment, salt tablets, foot powder, and insect repellant. Eye lotion or drops can also be useful.
4. Sunglasses. These must not hinder peripheral vision and must be kept in a sealed case to prevent scratching when not in use.
5. A lensatic compass, if available.
6. Web belt with 2-quart canteen attached.

Combat boots will wear out quickly in desert terrain, especially if it is rocky, and the leather will dry out and crack unless a nongreasy mixture such as saddle soap is applied. Although difficult to do, clothing must be kept relatively clean by washing in any surplus water that is available. When water is not available, airing and sunning clothing will help to kill bacteria.

HYGIENE AND SANITATION

Hygiene and sanitation are covered in detail in FM 21-10. This paragraph highlights some of the points that are of special importance to the commander in the desert.

Personal Hygiene. Proper standards of personal hygiene must be maintained not only as a deterrent to disease but as a reinforcement to discipline and morale. Daily shaving and bathing are required if water is available. Electric razors, adapted to run from a vehicle power source, should be used instead of "wet shaves." Cleaning the areas of the body that sweat heavily is especially important; underwear should be changed frequently and foot powder used often. If sufficient water is not available, troops may clean themselves with sponge baths, solution-impregnated pads, a damp rag, or even a dry, clean cloth.

Health. Troops should be checked for sign of injury, no matter how slight, as the dirt of the desert or insects can cause infection of minor cuts and scratches. Small quantities of disinfectant in washing water can reduce the chance of infection. Minor sickness can have serious effects in the desert. Prickly heat and diarrhea, for example, can upset part of the sweating mechanism and increase water loss, making the soldier more prone to heat illnesses. The buddy system can help ensure that prompt attention is given to these problems before they incapacitate individuals.

Sanitation. Intestinal diseases can easily increase in the desert. Proper mess sanitation is essential. Trench-type latrines should be used if the soil is suitable but must be dug deep, as shallow latrines become exposed in areas of shifting sand.

General Information

Iraq is a middle-eastern nation with a variable climate. Summers are hot – with temperatures reaching 120°F (49°C) except in mountainous areas. Winters are mild and snowless (except in the mountains) with temperatures ranging from 50 - 60°F (10 - 16°C).

Health Requirements

AIDS: All Iraqis, Arabs, and foreigners entering Iraq must report to the established Special Centers for a blood test within five days of their date of arrival in Iraq. Special Centers are located in Baghdad and other government centers. This requirement does not apply to persons older than 60 years.

Yellow fever: A yellow fever vaccination certificate is required from travelers coming from infected areas.

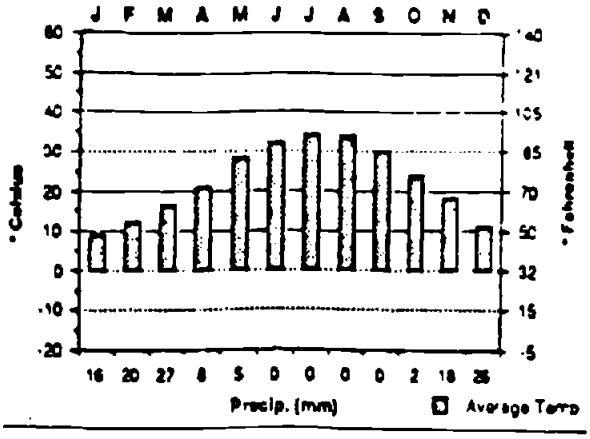
Travel Immunizations

These recommendations are not absolute and should not be construed to apply to all travelers. A final decision regarding immunizations will be based on the traveler's proposed itinerary, duration of stay and purpose for traveling.

Cholera: Although limited in effectiveness, vaccination may be appropriate for persons living and/or working in less than sanitary conditions for more than 3 months where medical facilities are unavailable. Vaccination may also be appropriate for travelers with impaired gastric defenses who are planning an extended visit or being exposed to unsanitary conditions. Vaccination is not advised for pregnant women, infants younger than 6 months old, or persons with a history of severe reaction to the vaccine.

Hepatitis A: Immune globulin (IG) is recommended for all susceptible travelers, especially as length of stay increases. IG is particularly important for persons who will be living in or visiting rural areas, eating or drinking in settings of poor or uncertain sanitation, or who will have close contact with local persons (especially young children) in settings with poor sanitary conditions. Persons staying longer than 5 months should receive IG regularly.

Weather in Baghdad



Hepatitis B: Vaccination is advised for health care workers, persons anticipating direct contact with blood from or sexual contact with inhabitants, and persons planning extended stays of 6 months or greater (especially those who anticipate using local health care facilities, staying in rural areas, or having intimate contact with the local population).

Polio: A one-time booster dose of OPV or IPV is recommended for travelers who have previously completed a full primary series of OPV or IPV (3 doses of vaccine, 2-months interval between first and second dose, and 6-12 months interval between second and third dose). Pregnancy is a relative contraindication for administration of IPV and to a lesser degree to OPV. If immediate protection for a pregnant woman is required, OPV is recommended. Refer to CDC guidelines for persons who have not completed the primary series.

Rabies: Preexposure vaccination should be considered for persons staying longer than 30 days who are expected to be at risk to bites from domestic and/or wild animals (particularly dogs), or for persons engaged in high risk activities such as spelunking or animal handling. Need for vaccination is more important if potential exposure is in rural areas and if adequate postexposure care is not readily available.

Typhoid: Vaccination should be considered for persons staying longer than 3 weeks, adventurous eaters, and those who will venture off the usual tourist routes into small cities, villages and rural areas. Importance of vaccination increases as access to reasonable medical care becomes limited. Contraindications depend on vaccine type.

Note: All standard vaccines (i.e., MMR, Td, DPT, influenza, pneumococcal, etc.) should be

kept up-to-date as a matter of good health practice unrelated to travel. One-time measles booster is recommended for persons born after 1956.

Malaria Information

Risk areas: Malaria risk exists in the Northern Region: Duhok, Erbil, Kirkuk, Ninawa and Sulaimaniya provinces. WHO reports risk is highest from May through November in areas below 1,500 meters, and that it is almost exclusively in *P. vivax* form.

Protective measures: CDC recommends that travelers visiting risk areas undertake chemoprophylaxis with chloroquine in addition to personal protective measures.

Current Health Risks

News sources in Iraq have reported that brucellosis (Malta fever) has reached epidemic proportions in some parts of the country. The source of that report was not identified. Brucellosis is contracted by consuming unpasteurized dairy products or meat which is not cooked well-done.

Notice posted 5/3/90.

Other Disease Status

Insect-borne diseases: these do not generally pose widespread hazards to the traveler.

- Hemorrhagic fever (Crimean-Congo) – occurs
- Leishmaniasis (cutaneous) – occurs
- Leishmaniasis (visceral) – occurs
- Tick-borne relapsing fever – occurs
- Typhus (including murine and tick-borne) – occurs

Food-borne and water-borne illness: poses a major hazard in most areas.

- Brucellosis – prevalent
- Cholera – occurs
- Dracunculiasis – occurs
- Echinococcosis (hydatid disease) – occurs
- Hepatitis (viral) – common
- Poliomyelitis – prevalent
- Schistosomiasis – occurs
- Taeniasis – occurs
- Typhoid fever – common

Other hazards:

- Trachoma and animal rabies may be problems.

Special Precautions

General Cautions

Recent medical and dental exams should ensure that the traveler is in good health. Carry appropriate health and accident insurance documents and copies of any important medical records. Bring an adequate supply of all prescription and other medications as well as any necessary personal hygiene items, including a spare pair of eyeglasses or contact lenses if necessary.

Drink only bottled beverages (including water) or beverages made with boiled water. Do not use ice cubes or eat raw seafood, rare meat or dairy products. Eat well-cooked foods while they are still hot and fruits that can be peeled without contamination. Avoid roadside stands and street vendors.

Swim only in well-maintained, chlorinated pools or ocean water known to be free from pollution; avoid freshwater lakes, streams and rivers. Wear clothing which reduces exposed skin and apply repellants containing DEET to remaining areas. Sleep in well-screened accommodations. Carry anti-diarrheal medication. Reduce problems related to sun exposure by using sunglasses, wide-brimmed hats, sunscreen lotions and lip protection.

Specific Concerns

AIDS occurs. Blood supply may not be adequately screened and/or single-use, disposable needles and syringes may be unavailable. When possible, travelers should defer medical treatment until reaching a facility where safety can be assured.

Travel Advisories

The Department of State advises American citizens that, with the advent of the ceasefire between Iran and Iraq, wartime conditions no longer prevail in Iraq. Nonetheless, because of the continuing tension between Iran and Iraq, travel is not recommended to areas north and east of Mosul and along border areas with Iran. Travel is also not recommended to marsh areas north of Basrah. Visitors to Iraq should also be advised

that bans on travel to the north of Mosul are periodically imposed.

All U.S. citizens are strongly urged to register with the U.S. Embassy after arrival in Iraq. The Embassy is located across from the Foreign Ministry Club in Masbah quarter of Baghdad. The telephone numbers are 719-6138 and 719-6139. The telex number is 212287 USINT IK. An alternate telex is the commercial section telex, number 213966 USFCS IK. The fax number is 718-9297.

Posted: 5/17/90 – Expires: 12/31/90.

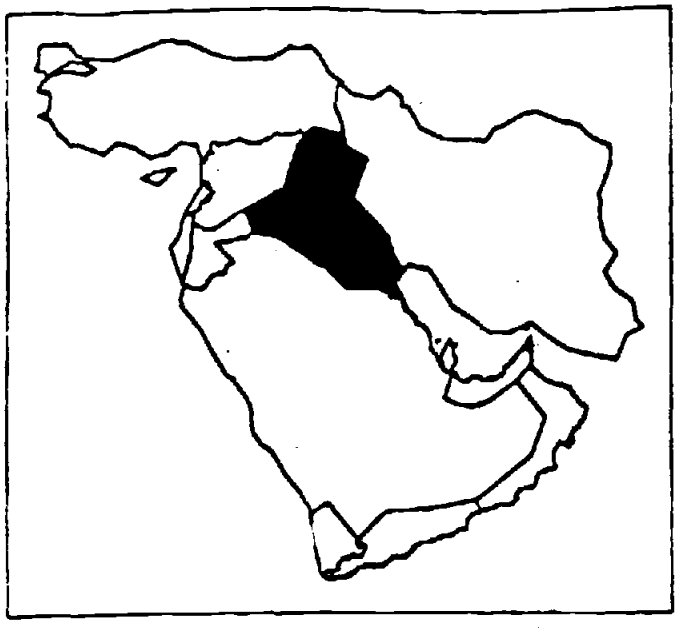
Embassy Phone Numbers

Direct dial country code = 964.

Baghdad (city code = 1)
U.S. Embassy – 719-6138/9
British Embassy – 537-2121/6

Iraq

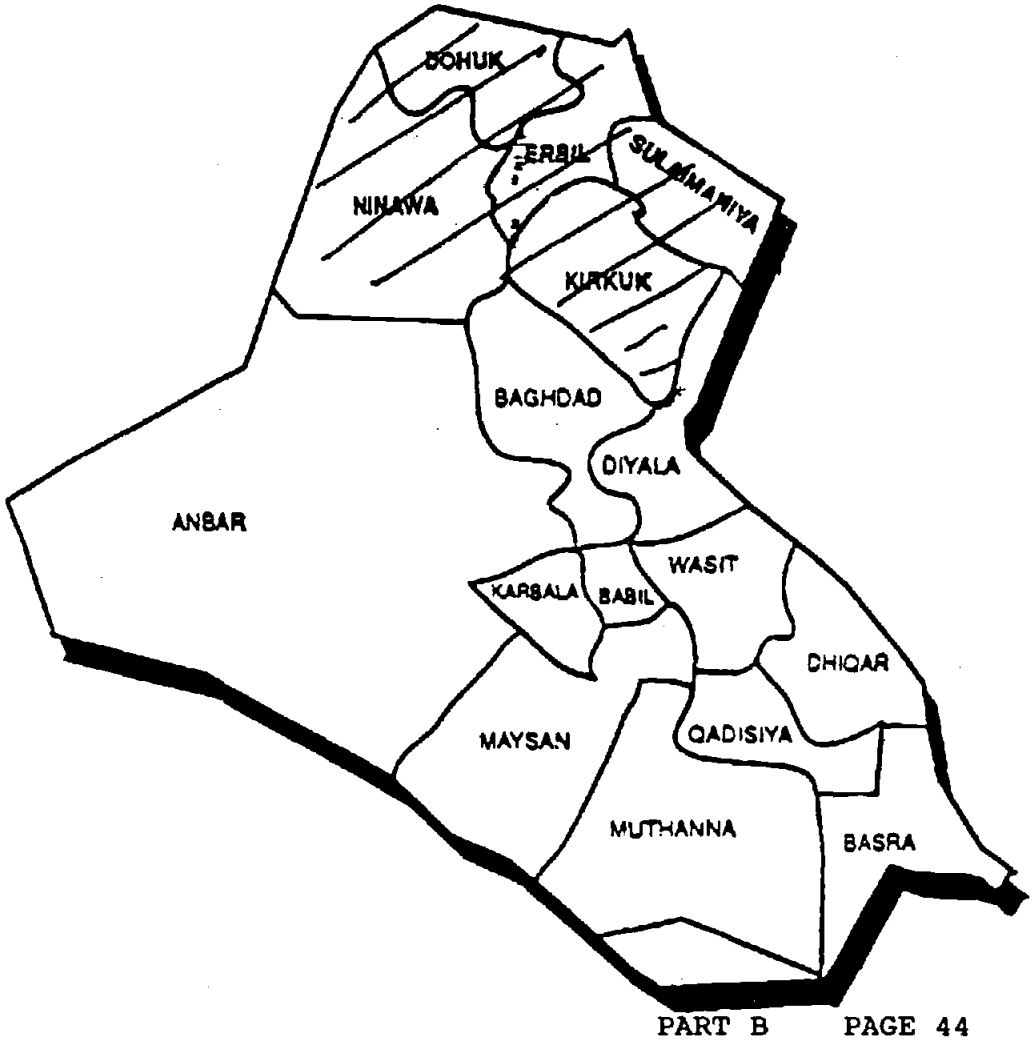
8/89



Malaria risk areas in Iraq:

Malaria risk exists in the Northern Region: Duhok, Erbil, Kirkuk, Ninawa and Sulaimaniya provinces. (WHO reports risk is almost exclusively in *P. vivax* form.)

Malaria Risk Area



General Information

The State of Kuwait is located in the northeastern corner of the Arabian Peninsula. It is bounded on the north and west by Iraq, on the south by Saudi Arabia, and on the east by the Arabian (Persian) Gulf. The country consists mainly of sandy, riverless desert interspersed with small hills. Kuwait's climate is typical of the region. During summer (April-October), temperatures often exceed 120°F (49°C), though 110 - 115°F (43 - 46°C) daytime temperatures are more common.

Mean annual rainfall is 4 - 5 inches (11 cm) and occurs mostly during December and January. The short autumn and spring seasons (November, February and March) are delightful. During the winter (December, January) it is often cold enough to require a coat. Sand and dust storms occur throughout the year, especially between March and August. Periods of high humidity occur, but during the hottest months (June, July and August), the humidity level ranges from 16% to 22%.

Health Requirements

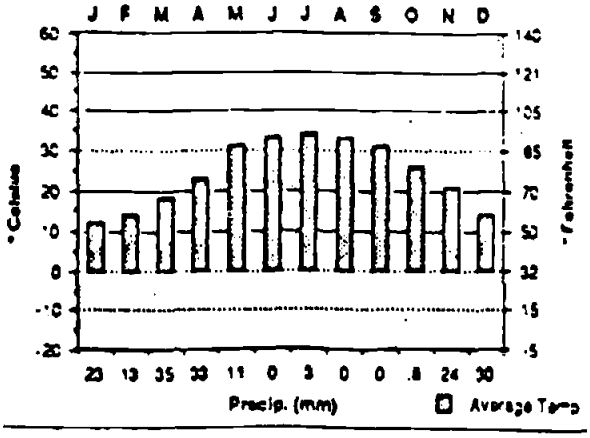
AIDS: Proof of a negative AIDS test is required from contractors applying for residence visas. Results of tests performed in the United States or other foreign countries are accepted.

Travel Immunizations

These recommendations are not absolute and should not be construed to apply to all travelers. A final decision regarding immunizations will be based on the traveler's proposed itinerary, duration of stay and purpose for traveling.

Hepatitis A: Immune globulin (IG) is recommended for all susceptible travelers, especially as length of stay increases. IG is particularly important for persons who will be living in or visiting rural areas, eating or drinking in settings of poor or uncertain sanitation, or who will have close contact with local persons (especially young children) in settings with poor sanitary conditions. Persons staying longer than 5 months should receive IG regularly.

Weather in Al Kuwait



Hepatitis B: Vaccination is advised for health care workers, persons anticipating direct contact with blood from or sexual contact with inhabitants, and persons planning extended stays of 6 months or greater (especially those who anticipate using local health care facilities, staying in rural areas, or having intimate contact with the local population).

Polio: A one-time booster dose of OPV or IPV is recommended for travelers who have previously completed a full primary series of OPV or IPV (3 doses of vaccine, 2-months interval between first and second dose, and 6-12 months interval between second and third dose). Pregnancy is a relative contraindication for administration of IPV and to a lesser degree to OPV. If immediate protection for a pregnant woman is required, OPV is recommended. Refer to CDC guidelines for persons who have not completed the primary series.

Typhoid: Vaccination should be considered for persons staying longer than 3 weeks, adventurous eaters, and those who will venture off the usual tourist routes into small cities, villages and rural areas. Importance of vaccination increases as access to reasonable medical care becomes limited. Contraindications depend on vaccine type.

Note: All standard vaccines (i.e., MMR, Td, DPT, influenza, pneumococcal, etc.) should be kept up-to-date as a matter of good health practice unrelated to travel. One-time measles booster is recommended for persons born after 1956.

Other Disease Status

Insect-borne diseases: these do not generally pose widespread hazards to the traveler.

- Leishmaniasis (cutaneous) – occurs
- Leishmaniasis (visceral) – occurs
- Tick-borne relapsing fever – occurs
- Typhus (including murine and tick-borne) – occurs

Food-borne and water-borne illness: pose a major hazard in most areas.
- Brucellosis – prevalent
- Cholera – occurs
- Dracunculiasis – occurs
- Echinococcosis (hydatid disease) – occurs
- Hepatitis (viral) – common
- Poliomyelitis – prevalent
- Taeniasis – occurs
- Typhoid fever – common

Other hazards:
- Trachoma and animal rabies may be problems.

Special Precautions

General Cautions

Recent medical and dental exams should ensure that the traveler is in good health. Carry appropriate health and accident insurance documents and copies of any important medical records. Bring an adequate supply of all prescription and other medications as well as any necessary personal hygiene items, including a spare pair of eyeglasses or contact lenses if necessary.

Drink only bottled beverages (including water) or beverages made with boiled water. Do not use ice cubes or eat raw seafood, rare meat or dairy products. Eat well-cooked foods while they are still hot and fruits that can be peeled without contamination. Avoid roadside stands and street vendors.

Swim only in well-maintained, chlorinated pools or ocean water known to be free from pollution. Wear clothing which reduces exposed skin and apply repellants containing DEET to remaining areas. Sleep in well-screened accommodations. Carry anti-diarrheal medication. Reduce problems related to sun exposure by using sunglasses, wide-brimmed hats, sunscreen lotions and lip protection.

Specific Concerns
- Colds, flu, and respiratory, sinus and external ear infections are typical medical problems due to dust and dust borne germs.
- March through September is extremely hot and dry and precaution should be taken against heat stroke and heat exhaustion. Those staying for long periods should pay attention to hydration to prevent urinary tract stone formation.

Travel Advisories

The Department of State advises travelers to Kuwait that even though hostilities between Iran and Iraq have ceased, no formal peace treaty has yet been signed. Travelers should be aware that the potential for terrorist activity exists. All American citizens planning to remain in Kuwait for an extended period are urged to register with the U.S. Embassy (telephone 242-4151).

Posted 3/89 – Limit: Indefinite.

Embassy Phone Numbers

Direct dial country code = 965.

Kuwait

U.S. Embassy – 242-4151 thru 9
British Embassy – 243-9220 thru 2

General Information

Saudi Arabia is a middle-eastern nation with a hot, dry, desert climate. Temperatures in the interior reach 130°F (54°C). Coastal areas present higher humidity.

Health Requirements

AIDS: Application for a work visa requires accompanying proof of a negative AIDS test. Results of tests performed in the United States are accepted. In addition, foreign workers will be retested for antibodies to the AIDS virus three months after arrival.

Meningitis: All pilgrims and visitors to holy places should be in possession of a valid certificate of vaccination against meningococcal meningitis issued not more than two years and not less than ten days before date of arrival. All travellers from Benin, Burkina Faso, Cameroon, Chad, Egypt, Ethiopia, India, Ivory Coast, Mauritania, Morocco, Niger, Nigeria, Pakistan, Senegal, Sudan, Syria, Togo and Yemen who do not have a valid certificate of vaccination against meningococcal meningitis will be subject to health checks on arrival and quarantined if suspected of having meningitis.

Yellow fever: A yellow fever vaccination certificate is required from all travelers coming from countries any parts of which are infected.

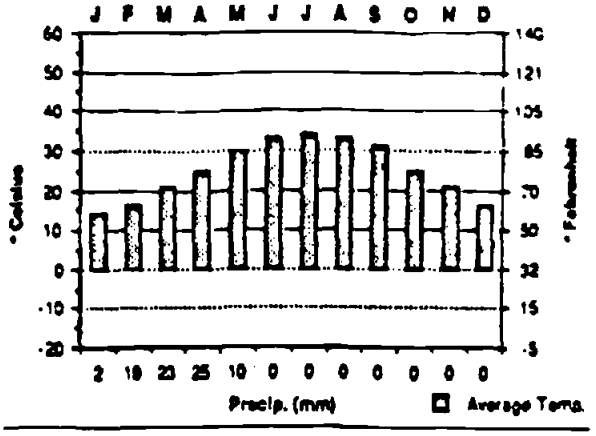
Travel Immunizations

These recommendations are not absolute and should not be construed to apply to all travelers. A final decision regarding immunizations will be based on the traveler's proposed itinerary, duration of stay and purpose for traveling.

Hepatitis A: Immune globulin (IG) is recommended for all susceptible travelers, especially as length of stay increases. IG is particularly important for persons who will be living in or visiting rural areas, eating or drinking in settings of poor or uncertain sanitation, or who will have close contact with local persons (especially young children) in settings with poor sanitary conditions. Persons staying longer than 5 months should receive IG regularly.

Hepatitis B: Vaccination is advised for health

Weather in Riyadh



care workers, persons anticipating direct contact with blood from or sexual contact with inhabitants, and persons planning extended stays of 6 months or greater (especially those who anticipate using local health care facilities, staying in rural areas, or having intimate contact with the local population).

Meningitis: Meningococcal vaccine is recommended for persons undertaking the Haj (pilgrimage). Pregnancy is a relative contraindication to vaccination, and the vaccine should not be administered to children younger than 2 years old.

Polio: A one-time booster dose of OPV or IPV is recommended for travelers who have previously completed a full primary series of OPV or IPV (3 doses of vaccine, 2-months interval between first and second dose, and 6-12 months interval between second and third dose). Pregnancy is a relative contraindication for administration of IPV and to a lesser degree to OPV. If immediate protection for a pregnant woman is required, OPV is recommended. Refer to CDC guidelines for persons who have not completed the primary series.

Rabies: Preexposure vaccination should be considered for persons staying longer than 30 days who are expected to be at risk to bites from domestic and/or wild animals (particularly dogs), or for persons engaged in high risk activities such as spelunking or animal handling. Need for vaccination is more important if potential exposure is in rural areas and if adequate postexposure care is not readily available.

Typhoid: Vaccination should be considered for persons staying longer than 3 weeks, adventurous eaters, and those who will venture off the usual tourist routes into small cities, villages and rural areas. Importance of vaccination increases as access to reasonable medical care becomes limited. Contraindications depend on vaccine type.

Note: All standard vaccines (i.e., MMR, Td, DPT, influenza, pneumococcal, etc.) should be kept up-to-date as a matter of good health practice unrelated to travel. One-time measles booster is recommended for persons born after 1956.

Malaria Information

Risk areas: Malaria risk exists throughout the year in all areas except the Eastern, Northern and Central provinces, the high altitude areas of Asir Province, and the urban areas of Western Province (Jeddah, Mecca, Medina, and Taif). WHO reports risk is predominantly in *P. falciparum* form.

Protective measures: CDC recommends that travelers visiting risk areas undertake chemoprophylaxis with chloroquine in addition to personal protective measures.

Other Disease Status

Insect-borne illness: these do not generally pose widespread hazards to the traveler.
- Leishmaniasis (cutaneous) – occurs
- Leishmaniasis (visceral) – occurs
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Drink only bottled beverages (including water) or beverages made with boiled water. Do not use ice cubes or eat raw seafood, rare meat or dairy products. Eat well-cooked foods while they are still hot and fruits that can be peeled without contamination. Avoid roadside stands and street vendors.

Swim only in well-maintained, chlorinated pools or ocean water known to be free from pollution; avoid freshwater lakes, streams and rivers. Wear clothing which reduces exposed skin and apply repellants containing DEET to remaining areas. Sleep in well-screened accommodations. Carry anti-diarrheal medication. Reduce problems related to sun exposure by using sunglasses, wide-brimmed hats, sunscreen lotions and lip protection.

Specific Concerns
- AIDS occurs. Blood supply may not be adequately screened and/or single-use, disposable needles and syringes may be unavailable. When possible, travelers should defer medical treatment until reaching a facility where safety can be assured. (Reports indicate that the Saudis routinely test blood donations for AIDS.)
- Dust is a year-round problem and an aggravation to allergy sufferers.
- Snakes are seldom seen, but are occasionally found, along with scorpions.

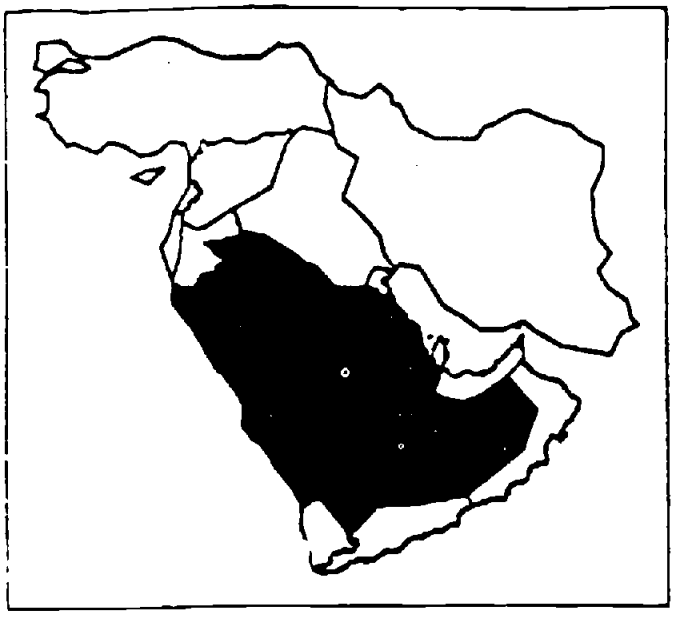
Embassy Phone Numbers

Direct dial country code = 966.

Al Khobar (city code = 3)
  British Trade Office – 857-0595
Dhahran (city code = 3)
  U.S. Consulate General – 891-3200
Jedda (city code = 2)
  U.S. Consulate General – 667-0080
  British Consulate General – 683-7282
Riyadh (city code = 1)
  U.S. Embassy – 488-3800
  British Embassy – 488-0077

Saudi Arabia

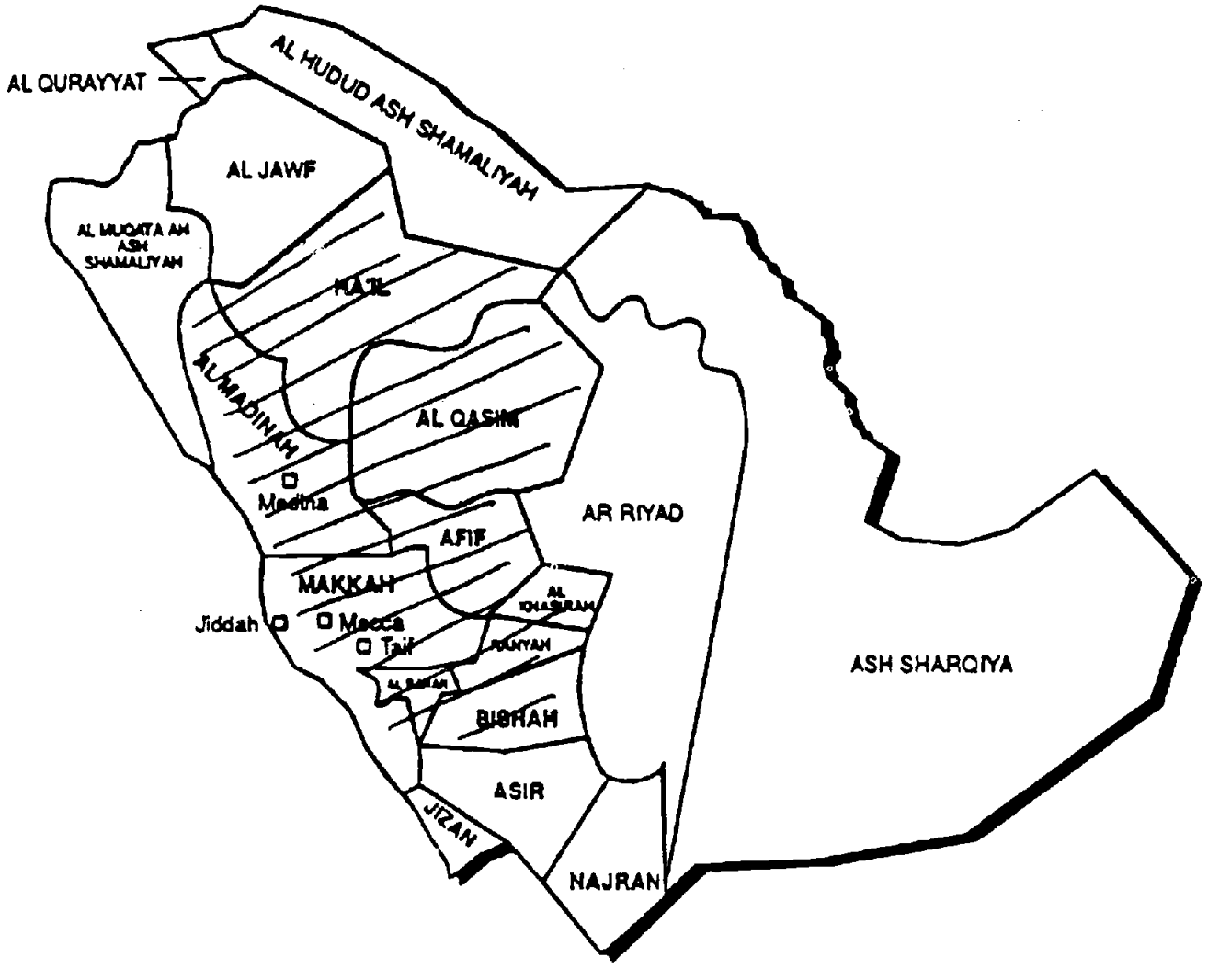
8.89



Malaria risk areas in Saudi Arabia:

Malaria risk exists throughout the year in all areas except the Eastern, Northern and Central provinces, the high altitude areas of Asir Province, and the urban areas of Jeddah, Mecca, Medina, and Taif. (WHO reports risk is predominantly in *P. falciparum* form.)

Malaria Risk Area



WORKING DRAFT

THE THREAT OF DISEASE AND NON-BATTLE INJURY TO US MILITARY PERSONNEL ON OPERATION DESERT SHIELD

21 AUGUST 1990

DEPARTMENT OF ADVANCED PREVENTIVE STUDIES
DIVISION OF PREVENTIVE MEDICINE
WALTER REED ARMY INSTITUTE OF RESEARCH
WASHINGTON, D.C. 20307-5100

Contents

EXECUTIVE SUMMARY OF HEALTH THREAT

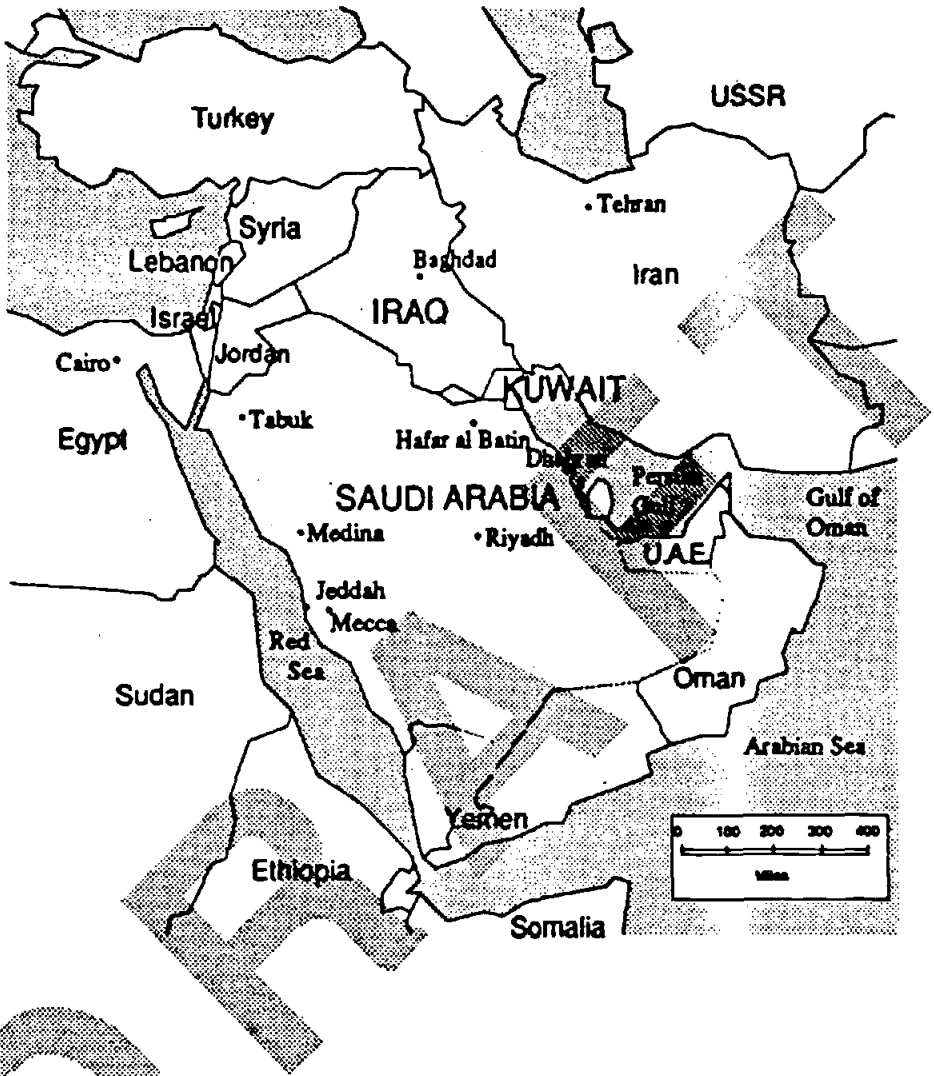
The greatest immediate DNBI threat to U.S. personnel deployed to Saudi Arabia, Kuwait, and Iraq will be heat related. Jet lag, psychological stress, physical exertion, and the lack of acclimatization, all coupled with the heat, will significantly compromise performance within the first three days. Acclimatization, which may take 10 to 14 days, proper work-rest cycles, adequate hydration (up to two quarts per hour) and **command emphasis** are important parts of a heat injury prevention program for the desert.

In the first few weeks, **diarrheal diseases** of several etiologies (e.g. enterotoxigenic *E. coli*, *Salmonella, Shigella, Campylobacter, E. histolytica, G. lamblia,* and viruses) can spread rapidly and lead to tactically significant performance decrements. Fluid loss because of diarrhea will greatly worsen the effects of the heat. **Acute respiratory diseases** can also be expected to surface at this time due to the dusty environment. Serious emphasis on food and water **sanitation** and personal hygiene is mandatory. Prophylactic antibiotics are not indicated for most operational settings because antibiotic and antimotility therapy can return most troops with diarrhea to normal duty in less than 24 hours.

Within the first month of deployment, hyperendemic or epidemic levels of **febrile illnesses** can develop. Viral respiratory diseases, arboviruses (sand fly fevers, dengue, Sindbis, Congo-Crimean fever), enteric fevers, hepatitis A, hepatitis E, and rickettsial diseases are all possible candidates. Of this group, **Sand fly fever** is the most likely to cause tactically significant morbidity because of its historic relevance in this theater, its current endemicity and the lack of either immunization or specific treatment. Area vector control and personal protective measures, to include insect repellents, properly worn uniforms, and insect netting, need to be given serious attention by commanders. **Malaria** should be relatively well controlled with weekly chloroquine prophylaxis if the tactical situation brings troops into endemic areas. Although chloroquine-resistant *P. falciparium* has not been confirmed in the area, clinicians need to be alert to its possible presence, particularly in the southwestern Arabian peninsula. Leptospirosis (found only in the few watery areas) could be prevented with weekly doxycycline if potential exposures occur.

After several weeks into deployment, the diarrheal problems and febrile illnesses will still manifest themselves, but other diseases such as hepatitis B, cutaneous and visceral leishmaniasis, and helminthic infections may be noticed. Acute schistosomiasis may also be a problem if troops traverse bodies of fresh water. In addition, health problems plus the continued strain of battle readiness will generate **psychological problems**, and troop tensions may be acted out.

Ongoing medical surveillance will be important because tracking disease incidence will provide early recognition of outbreaks, evaluate disease control measures, optimize therapy, and broaden the medical intelligence base.



THE GEOGRAPHIC AND CULTURAL SITUATION

SAUDI ARABIA

Saudi Arabia, the largest country on the Arabian peninsula, is approximately the size of the eastern half of the United States. Saudi Arabia borders Kuwait and Iraq on the northeast and Jordan on the northwest. Most of the land surface is sand, making up the Great Arabian Desert in the southeast. The northern areas are grassy and scrub steppes, while the eastern coastal plains are lowlands. The desert climate, from March through September (the hottest months), allows temperatures exceeding 120°F, dropping abruptly at night into the 70's. Winter weather is usually mild, although freezing temperatures may occur. The weather in coastal regions is moderated by the bodies of water; however, the humidity in some places is over 85% and frequently 100% for long periods of the year. The average annual rainfall of four inches may come in only one or two torrential rains. Entire areas may not receive rain for several years. No permanent rivers or bodies of water exist, making oases important reservoirs. Desalinated sea water is a major source of potable water in parts of Saudi Arabia. The level of sanitation is generally higher than that found in most other Middle Eastern countries.

KUWAIT

The State of Kuwait is located in the northeastern corner of the Arabian Peninsula, bordering Saudi Arabia on the south, Iraq on the north and west, and the Persian Gulf on the east. The country is sandy,

riverless desert with small hills. June, July and August are the hottest months, with temperatures usually between 110-115°F during the day. Sand and dust storms occur year-round but are most common between March and August. The mean annual rainfall of four to five inches occurs during December and January. These winter months are cool enough to require a coat (60's). The humidity varies throughout the year: from 20% in June through August to around 60-70% in the winter months.

IRAQ

Except for a very narrow neck of land extending between Kuwait and Iran to the Persian Gulf, Iraq is a landlocked country. Kuwait borders the southeastern corner; Saudi Arabia shares the remainder of the southern border. Iran is to the east and Jordan, Syria, and Turkey lie to the west and north. The country slopes from 12,000 ft. mountains along the border with Turkey and Iran to marshes in the southeast near Kuwait. In the northern steppes region just below the mountains, large oil fields, arable land, and the homeland of the Kurds are found. A wide stony plain interspersed with rare sandy stretches (the Syrian Desert) occupies the west and southwest regions of the country. The hottest months, June through August, are dry and temperatures go up to 110°F. Freezing temperatures occur during the winter in the north and northeastern regions as well as in the western desert. Annual rainfall in the south and southwest ranges from four to seven inches and falls from November to April. The *Shamal* winds, from mid-June to mid-September, bring very dry air. This air promotes evaporation and intensive sun-heating of the land surface, so vegetation requires extensive irrigation to survive. Sharqi winds in April to June and September to November are dry and dusty, gusting to 50 mph, often accompanied by violent dust storms.

TEMPERATURE AND RELATIVE HUMIDITY IN THE AOR DURING LATE SUMMER/EARLY FALL

	Avg. Daily High °F	Avg. Daily Low °F	Rel. Humidity
Al Kuwayt, Kuwait			
August	104	86	48%
September	101	81	52%
October	92	74	62%
Al Qaysumah, Saudi Arabia			
August	108	77	18%
September	104	72	17%
October	97	65	25%
Dhahran, Saudi Arabia			
August	108	85	46%
September	103	81	51%
October	95	74	59%
Riyadh, Saudi Arabia			
August	108	76	27%
September	103	72	33%
October	94	61	36%
Baghdad, Iraq			
August	110	76	23%
September	104	70	27%
October	92	61	36%

THE PEOPLE

The indigenous population of these lands is largely descendant from the same nomadic desert people. The Islamic religion has significantly impacted the character of the inhabitants. Numerous sects and subsects within this religion have historically maintained deep-seated rivalries, contributing to local unrest. Common to all sects, however, is an ingrained belief that God's will explains all occurrences, resulting in a fatalistic view towards illness, misfortune, and death. The soldier's guarantee of going to Allah after dying in battle nurtures martial fervor. Disregard for caution when driving motor vehicles, belief that religious practitioners have medical healing powers, and human-wave attacks in war are typical examples of how their belief in Allah affects their behavior.

MEDICAL THREAT ASSESSMENT: SAUDI ARABIA, KUWAIT, IRAQ

JET LAG

The disruption of normal circadian rhythms encountered when rapidly crossing several time zones will result in fatigue, irritability, headache, reduced efficiency, and early morning wakefulness within the first 24 hours, extending up to five days after landing. This, exacerbated by the usual pressing need upon arrival to establish the base camp and reconnoiter the area, will result in exhaustion and impaired judgment. Scheduling sleep before deployment to coincide with Middle Eastern time zones, avoiding alcohol and caffeinated beverages, maintaining adequate hydration (two to three glasses of water during every four hours of flight), and refraining from overeating are key factors to counter the effects of jet lag. The use of 0.125 mg Halcion at departure, while refraining from alcohol and sleep interruption, has much anecdotal support as a countermeasure to jet lag.

STRESS

The uncertainty which accompanies all rapid deployments, the unknown threats in enemy strength and capabilities (e.g. chemical warfare), the ground situation, the foreign environment, the threat of strange diseases, the unknown duration of deployment, and the threat of personal harm, compounded by jet lag, must be anticipated to negatively affect sleep patterns, the ability to rest, and hence the performance of the mission. Physical exercise, adequate rest (when possible 12 hours on duty, 12 hours off duty and away from the work area), and the perception of keeping the troops informed are all important means of countering this problem.

CLIMATE

The hot environment in this area is worsened by dry breezes in some areas and high humidity in others, making the heat significant even for the indigenous people. **Unacclimatized personnel, under stress, suffering jet lag, dealing with the logistical problems of water supply, and facing the physical exertion which accompanies deployment, are particularly susceptible to heat injuries, to include heat cramps, heat exhaustion, and heat stroke. These injuries should be expected to be the dominating initial threat (often greater than the enemy forces).** Measures anticipating heat casualties and insuring hydration and acclimatization (usually requiring 10 to 14 days) must be instituted and followed. Simple measures by which each individual soldier can monitor and prevent dehydration must be broadcast.

Other sun-related problems like sunburn, vision disturbances, and lip and mucosal surface chapping should be expected. Sunblock and chapstick or vaseline should be used. Increased incidence of colds,

flu, allergies, and respiratory/sinus/ear infections are typical medical problems also encountered in this dusty, sandy environment. Wearing a cloth around the neck that can be used as a cover for the nose and mouth in dusty conditions is helpful.

PESTS AND VECTORS

Insect and animal pests indigenous to this area present problems as vectors for disease spread and/or because of their ability to inflict bodily harm by bites or venoms. **Sand fly fever** is a significant military threat. Sand flies are also responsible for both cutaneous and visceral leishmaniasis, which occur in the Middle East. **Mosquitoes** carrying malaria, dengue fever and other arboviral diseases are prevalent. **Filth flies** are the most significant insect problem in the desert, spreading diseases such as cholera, dysentery, and typhoid. The problem is magnified by the poor sanitary practices of the host country and the sanitation difficulties encountered in the field setting. **Good camp vector control is mandatory.** **Fleas** are responsible for murine typhus and small, sporadic outbreaks of plague in the region. **Lice** are a common problem in the Middle East and may be transmitted to newly arrived military personnel by close contact with local inhabitants. *Transmission of relapsing fever is possible.* **Ticks** in the region may transmit tick-borne relapsing fever, typhus, and Crimean-Congo hemorrhagic fever. **Leeches** in the marshy southeast area of Iraq present a psychological and physical problem.

The **wolf spider** (hairy "tarantula") is found along the Persian Gulf coast. A spider similar to the Black Widow is present. **Scorpions** may be found in bedding, boots, etc. Some species found in the Persian Gulf area reportedly can kill a man in four hours and have killed troops camped in the desert. Specific antisera exists. **Snakes** found in the Middle East include the Desert black snake (*W. aegyptia*) and the cobra (*Naja haje*), both elapids. Vipers, which account for most of the human bites, include puff adders (*Bitis* spp.), horned vipers (*Cerastes* spp.), saw-scaled vipers (*Echis* spp.), false horned vipers (*Pseudocerastes* spp.), and true adders (*Vipera lebetina*). Packs of feral **dogs** are known to be aggressive and should be avoided because of the risk of bites and rabies. Water spigots should be protected or raised high from the ground to prevent animals from licking the spouts.

Rats and mice, unavoidable in the crowded and unsanitary conditions of the region and in the field setting, provide the means for fleas to spread disease. **Rodent control is essential.** Frequent garbage burial is necessary and this may be challenging due to the difficulty of digging in the densely compacted sand or soil. **Gerbils and ground squirrels** are naturally infected with *Leishmania* and complete the sand fly/animal cycle of transmission to man.

MAJOR DISEASES IN THE AREA OF OPERATIONS

The possible medical problems in this region of the world are considerable. A tentative prioritization of historical threats to form the basis of preventive medicine planning and practice is warranted. This prioritization is based on the potential for tactically significant morbidity and the availability of effective and easily implemented measures to mitigate the threat.

List of Disease Threats and the Primary Preventive Measures to be Emphasized

1.	Heat Related Injuries	adequate hydration and salt replacement
2.	Diarrheal diseases	strict field sanitation
3.	Sand Fly Fever	personal and area vector control
4.	Hepatitis A	ISG and sanitation
5.	Malaria	weekly chloroquine, personal protective measures and area vector control
6.	Other Arboviral diseases	personal protective measures and area vector control
7.	Helminthic infections	food sanitation and behavioral measures
8.	Leishmaniasis	personal protective measures and local vector control
9.	Schistosomiasis	proper wearing of the uniform and exposure avoidance

10.	Sexually Transmitted Diseases	personal protection
11.	Meningococcal Disease	immunization
12.	Q Fever	behavioral measures (e.g. education and avoiding sheep sheds, barns)
13.	Plague	rodent control, immunization, and chemoprophylaxis if needed
14.	Rabies	animal avoidance, immunization if needed
15.	Spirochaetal Disease	doxycycline if exposure likely
16.	Typhus	sanitation and personal hygiene
17.	Toxoplasmosis	food and water sanitation
18.	Brucellosis	avoidance of unpasteurized dairy products
19.	Trachoma	fly control
20.	Anthrax	behavioral measures

1. ***HEAT INJURIES*** **THE GREATEST OVERALL THREAT.** Heat not only is the primary medical problem, it also exacerbates other diseases, obfuscating diagnosis and treatment. It is a command responsibility to prevent heat injuries, and this may be a difficult task because U.S. troops are unacclimatized, water supplies are extremely limited and may be contaminated, the equipment on which we rely to ameliorate the situation may not function optimally in the heat and sandy environment, and the enemy we face has been combat-hardened to survive in this environment.

2. ***DIARRHEAL DISEASES*** Diarrheal diseases are the greatest infectious disease threat for troops deployed to the Middle East. Bacterial, protozoan, parasitic, and viral causes can be expected.

Traveler's Diarrhea
Diarrheas within the first two weeks, with a median self-limited duration of two to five days, should be expected. A high degree of suspicion for complications resulting from dehydration in the excessive heat and bowel superinfections should be maintained. Aggressive rehydration with oral rehydration salts and intravenous fluids if needed is recommended. Antibiotic treatment of moderate to severe diarrhea is indicated; empiric drugs often used include trimethoprim/sulfa (1DS bid for 3 days) or ciprofloxacin (500mg bid for 3 days or a single 1 gm dose). Prophylactic antibiotics should generally not be used except for critical tactical situations and then only for limited amounts of time. Prompt antibiotic treatment, coupled with loperamide, will resolve most diarrheas within 24 hours.

Enterotoxin producing ***E. coli***, ***Salmonella*** spp., ***Shigella*** spp., and ***Campylobacter*** are common food- and water-borne bacterial etiologies, which can be prevented by early and aggressive preventive medicine measures, including hand washing, water purification, adequate cooking, pasteurization, camp sanitation, identification of carriers, and vector control to eliminate or reduce filth flies.

Norwalk and Norwalk-like viruses are common causes of diarrheal outbreaks. Severity of dehydration may be greatly increased due to the heat, and resultant problems may magnify these usually self-limited diarrheas.

Other Enteric Infections
Typhoid presents a potential threat in the regional and military settings under consideration. Typhoid immunization is recommended, but in no way substitutes for preventive measures. The threat of cholera is a region-wide but relatively minor concern that sanitation and other preventive measures can successfully overcome more readily than the marginally effective immunization. Cholera has not been a significant threat in WW II or recent US conflicts. **Amebiasis and giardiasis** are widespread throughout the region.

3. ***SAND FLY FEVER*** This self-limiting but debilitating flu-like febrile illness is the most widespread vector-borne disease in the Middle East, having its peak incidence in August. The epidemics occurring during military operations in the two World Wars make Sand fly fever of major concern to present deploy-

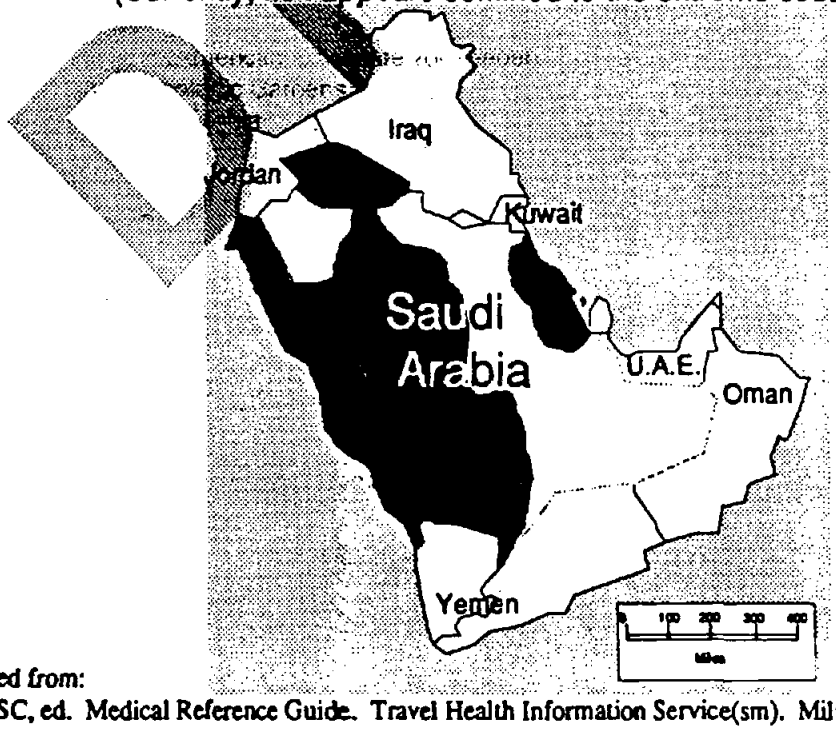
ments. Use of repellent-impregnated netting (spray monthly with permethrin insecticide), skin and clothing insect repellents, and properly worn uniforms to minimize accessible skin surfaces are measures to combat the sand fly vector. Sand flies are most active from dusk to dawn. Area residual insecticides should be applied to sand fly habitats around human dwellings (e.g. sandbag crevices, cracks in walls and soil, etc.).

4. ***HEPATITIS A*** Large wildfire outbreaks in a camp situation can occur, crippling a military operation. The use of Immune Serum Globulin (ISG) is highly recommended, but it is not 100% efficacious, necessitating imposition of aggressive food and water sanitation measures. Food and latrine sanitation must be emphasized.

5. ***MALARIA*** Chloroquine-sensitive malaria is present in Saudi Arabia and Iraq. Reports of chloroquine-resistant *P. falciparum* in the southwestern Arabian peninsula are unconfirmed; clinicians need to be alert to this possibility and be prepared to treat such cases with a drug such as mefloquine. Though Kuwait has not reported endemic malaria recently, parasitemic Iraqi troops could reintroduce this problem. The malaria risk in Saudi Arabia, primarily from *P. falciparum*, is year-round, except in the urban areas of Jeddah, Mecca, Medina, and Taif, and in the eastern, northern, and central provinces. *P. vivax* constitutes the malaria threat in northern Iraq from May throughNovember. In southern Iraq, the marshy and irrigated areas allow transmission of *P. vivax, falciparum*, and *malariae* throughout the year. Weekly prophylaxis with chloroquine (300 mg base or 500 mg phosphate) and personal protective measures, such as use of repellant and bed netting, will largely control this threat to U.S. forces.

6. ***OTHER ARBOVIRAL FEVERS*** Dengue: The *Aedes aegypti* mosquito, which transmits this virus, is present in the region, but no recent epidemics have been reported. An outbreak among a non-immune population, like deployed troops, cannot be ruled out. West Nile fever, transmitted by mosquitoes, and Crimean-Congo hemorrhagic fever, transmitted by several means including ticks, have

Potential Areas of Malaria Risk in Saudi Arabia*
(Currently, risk appears confined to the extreme southwest.)



*Collated from:

Denny SC, ed. Medical Reference Guide. Travel Health Information Service(sm). Milwaukee, Wisconsin: Shoreland Medical Marketing, Inc, 1989.

Magzoub M. *Plasmodium falciparum* and *Plasmodium vivax* infections in Saudi Arabia, with a note on the distribution of anopheline vectors. J of Trop Med and Hygiene. 1980:83;203-206.

scattered incidence in the general region. Repellents, netting, and other vector control measures are all necessary precautions. Sindbis, another fever causing virus that is associated with arthritis and a papular or vesicular rash, transmitted by *Culex univattatus* mosquitoes, has been isolated in provinces adjacent to the Gulf of Arabia.

7. ***HELMINTHIC INFECTIONS*** Ascariasis, ancyclostomiasis (hookworm), enterobiasis, echinococcosis, trichuriasis, strongyloidiasis, taeniasis, and dracunculiasis account for the 60-75% helminthic infection occurrence in the Arabian population and thus can be expected in the troops. Proper food and water handling, strict camp sanitation, and identification and treatment of carriers should contain these problems, though their continued introduction from indigenous sources can be expected.

8. ***LEISHMANIASIS*** This is the classical region of the world for cutaneous leishmaniasis, a condition transmitted by sand flies in which nodular skin lesions commonly evolve into painful or painless slowly or non-healing ulcers several centimeters in diameter. While not an acutely debilitating disease, its presence can be psychologically disturbing, and its inpatient treatment may be prolonged and impact on the health care system. Visceral leishmaniasis, an often fatal disease, also occurs in this area. Prevention revolves around avoiding sand fly bites through vector control, use of repellents, and other personal protective measures. Sand flies can penetrate through standard mosquito netting, so monthly spraying of the netting with permethrin insecticide is advised.

9. ***SCHISTOSOMIASIS*** Schistosomiasis (*S. mansoni* and *S. haematobium*) is found in many fresh water sources in the region. It can present initially as a febrile illness with significant impact on troop readiness. Proper wearing of the uniform to reduce direct contact of cercaria with the skin and minimizing potential exposures are key to prevention. Fresh water swimming, except in chlorinated pools, should be prohibited.

10. ***SEXUALLY TRANSMITTED DISEASES*** Syphilis, gonorrhea, chancroid, hepatitis B and AIDS occur. The large foreign workforce in this area makes STDs a considerable problem which would otherwise not be thought present in the usually restrictive Moslem culture.

11. ***MENINGOCOCCAL DISEASE*** Outbreaks of Type A have occurred in Saudi Arabia during the crowded conditions of the Haj (pilgrimage). Meningococcal vaccination received within the past five years should largely eliminate concern for outbreaks of this disease within the U.S. military forces. Asplenic individuals should definitely be immunized before deployment to this area.

12. ***Q FEVER*** This rickettsial disease is endemic to eastern Saudi Arabia. Transmission to man may be by inhalation of dried dusts from infected goats and sheep and from comsumption of raw cow's milk. While the indigenous population will have acquired immunity, naive transient military units are very susceptible to outbreaks of short duration, necessitating vaccination or safe disposal of infected animals.

13. ***PLAGUE*** *Yersinia pestis*, transmitted by infected fleas which usually live on rodents, is endemic in parts of the region. Reported cases have increased especially in the southern region of Saudi Arabia. Poor sanitation, promoting growth of rodent populations, contributes to the risk of outbreaks. Immunization is only about 50-70% effective.

14. ***RABIES*** The large feral dog population makes this disease a year-round concern, though of small proportions. Avoidance of these animals as well as forbidding the usual camp pets accompanying long deployments is the best action. Special Operations troops who routinely operate within the indigenous population should receive the rabies vaccination series. Medical treatment facilities should be prepared with rabies immune globulin (RIG) and human diploid cell rabies vaccine (HDCV) to treat bites.

15. ***SPIROCHAETAL DISEASES*** Leptospirosis: This disease is distributed worldwide and has been one of military significance. Most areas of Saudi Arabia are low risk, but the marshy areas at the southeastern tip of Iraq have conditions that are ideal for this infection. Relapsing fever: A louse- or tick-borne

spirochaetal disease, it is associated with poor personal hygiene and is endemic in the population. Epidemics may occur.

16. ***TYPHUS*** Both flea-borne murine typhus and the louse-borne epidemic typhus occur. The murine type is found wherever large rodent populations exist, a common condition in war camps and areas where waste disposal is difficult. Louse-borne typhus occurs in the northern regions of Saudi Arabia, and its tendency for outbreaks during crowded unhygienic conditions needs emphasis.

17. ***TOXOPLASMOSIS*** The numerous mammalian reservoirs and the 33% human prevalence in Saudi Arabia make this infection mentionable, though it is usually asymptomatic. Ingestion of infected meat and exposure to feline excrement are the modes of transmission.

18. ***BRUCELLOSIS*** News sources have reported epidemics of brucellosis occurring in Iraq. Unpasteurized milk and contact with infected animals' tissues (placenta, abortion products), blood and urine, as well as airborne transmission.

19. ***TRACHOMA*** This chlamydial infection of the eye, transmitted mechanically by flies, has epidemic potential to produce ocular disturbances up to the point of visual impairment. It is especially aggravated by sand and dust.

20. ***ANTHRAX*** Outbreaks occur. Spores of the organism are capable of surviving for years in the soil. Undercooked, infected meats as well as spores aerosolized from contaminated hides are modes of transmission.

OTHER MEDICAL CONSIDERATIONS

Increased respiratory infections, infections of the external ear, sinuses, eyes, and exacerbations of allergies can be anticipated due to the dust, sand, and heat. Protective clothing, sunglasses, sunscreens, and shading should be used.

Chemical Weapons

The well publicized threat of chemical weaponry (CW) (and the corollary assuming biological warfare (BW) inclinations) raises the possibility of contamination of all food and water sources and medical equipment, the curtailment of medical procedures, and the complication of routine medical treatment in a contaminated environment. Sufficient planning to face medical and logistical problems generated by a CW/BW situation must be undertaken. The use of multiple CW agents as well as CW and BW agents used simultaneously may occur. Furthermore, their deployment can occur far from the front line–anywhere in the COMM-Z. Thousands of casualties resulting from a single attack can quickly overwhelm the medical system unless these scenarios are properly anticipated and rehearsed. All echelons must be prepared to decontaminate and treat these patients. Remember: although the number of casualties from chemical warfare in World War I exceeded those from any other munition, the fatality rate was very low (1-2%).

A critical problem for medical personnel will be avoiding self-exposure as they care for contaminated casualties. Casualties should be treated and decontaminated as far forward as the tactical situation allows. The enemy's known chemical agents, mustard and nerve gases (GA, GB, GF), will be more concentrated in the heat but their persistence will be shortened. Furthermore, these agents do not linger in the sand as long as in arable soils, decreasing the length of the threat. Missions Oriented Protective Posture (MOPP) gear will markedly increase the risk and rate of heat injuries. Self-treatment with atropine will result in a markedly decreased ability to sweat, causing severe hyperthermia. Matter removed upon debridement of contaminated wounds should be deposited in household bleach

(5% chlorine) only, as higher concentrations combined with mustard gas will result in conflagration. Secondary vaporization of blister agents and slow absorption of nerve agents through the skin may result in delayed serious manifestations of exposure. Also, vaporization of nerve agents from debridement products alone may be lethal to the medical staff.

AIDS occurs and the local blood supply may not be adequately screened. Single-use syringes and needles may not be available in the indigenous hospitals, making the threat of HIV and hepatitis B contamination high. Although Saudi Arabia purportedly routinely tests blood donors for HIV, the quality of the test procedures used is unknown.

Awareness of the prevalence of illicit drugs (e.g., opium) in these general regions should raise suspicions for drug-altered behavior and related diseases. Individuals requiring daily medications (e.g. Thyroid hormone, antihypertensives) should carry adequate quantities upon deployment to forestall shortages. Extra contact lenses and eyeglasses should likewise accompany the soldier on the deployment.

SPECIFIC RECOMMENDATIONS

IMMUNIZATIONS AND PROPHYLAXES

Immune serum globulin to prevent hepatitis A should be given to all deployed, with boosters given periodically (0.02 cc/kg for up to 3 months of protection, 0.06 cc/kg for 3-5 months of protection). Typhoid vaccination, likewise, should be up to date (within three years). Though the efficacy of this immunization may not be 100%, the risk of an epidemic in a field setting offsets the discomfort of the shot. The meningococcal vaccination, which is given to all basic trainees, is required to be current within five years. Soldiers who are asplenic for any reason should receive the pneumococcal and meningococcal vaccinations.

All standard vaccines should be current (MMR, tetanus/diphtheria, polio). A one-time adult booster of polio for those who have completed a full primary series of OPV or IPV may be given (polio is prevalent in Iraq), though this recommendation has usually been met in basic training. A one-time measles booster is recommended for persons born after 1956, though again this has usually been accomplished in basic training. All health care workers should have been immunized against hepatitis B. Special Forces soldiers and animal handlers should receive the rabies vaccination series. Cholera vaccine, however, is too limited in effectiveness to warrant its administration. Instead, sanitation measures should be employed to the fullest extent. Plague requires a series given over six months, and the threat is not perceived as presently being significant enough to warrant immunization.

Malaria prophylaxis with chloroquine should be started two weeks prior to deployment and continued on a weekly basis until four weeks after malaria exposure ceases. Primaquine should be administered on a weekly basis (45 mg) for eight weeks after exposure ceases (or 15 mg daily for 14 consecutive days if not G6PD deficient). Screening for G6PD deficiency is desirable before placing someone on primaquine. If mission requirements deploy personnel into the marsh areas of southeastern Iraq, where they may have to traverse bodies of fresh water potentially contaminated by the urine of animals, weekly doxycycline prophylaxis (200 mg) for leptospirosis may be desirable.

HEAT

Hydration enforced by command emphasis is required. "Feeling thirsty" has been shown to be insufficient in predicting hydration needs, and scheduled water drinking is necessary. Hyponatremia by overhydration can best be avoided by regularly eating combat rations to provide adequate salt intake.

Decreasing activity in the mid-day is the Middle Eastern method of coping with the environment. The use of sunglasses to avoid wind and dust irritation to the eyes as well as to diminish glare is necessary. Head gear to shade the face and neck and provide cooling to the head is also needed. Protection over the ears and nostrils is often needed to keep dust and sand particles from entering these orifices. Clothing and high-grade sunscreen to protect the skin from sunburn is especially necessary for U.S. troops unaccustomed to the doubly intensive sunlight in the desert. Lip balm is necessary to prevent lip chapping. Soldiers must be cautioned not to handle objects left in the sun (vehicles, water cans, etc.) to avoid third degree burns. Petroleum products stored in cans must be vented to prevent expansion and explosions resulting in significant injuries.

WATER

As in any field setting, and especially in large unit deployments and in defensive settings where sanitation is marginal, disease can spread rampantly through food and water transmission. In these countries, the indigenous urban water supplies (often desalinated and piped from the ocean) are never assumed to be adequately treated: oases and rural sources are ready and central receptacles for infectious agents, making the treatment of all water supplies mandatory for the unit (or the individual, depending upon the specific mission). Field water tanks, Lyster bags, and other storage containers can be (and are) easily contaminated by inadequate purifying technique, by ignorance in handling the container, by insect and rodent pests, by wind-borne and airborne agents (infectious, chemical, etc.), and by malicious intent.

Therefore, regardless of location, treat all water for the proper amount of time prior to use unless it is carbonated, recently boiled, or known to be adequately purified by iodination or chlorination. Keep the storage containers covered or capped and guarded. Use bottled water only if the seal has been unbroken. Do not use ice cubes (sometimes made from untreated water) unless their source and handling is known to be hygienic. Even alcohol in cocktails has been shown to be ineffective in disinfecting the ice. Avoid swimming, wading, or bathing in bodies of standing or slow-moving fresh water (pools, ponds, canals) unless the water is well chlorinated. Water-borne bacterial and viral agents as well as parasites (e.g., *Schistosoma*) are easily transmitted by this route.

FOOD

As mentioned above, disease transmission through foods is also a major threat. Meats, seafood, and vegetables should be refrigerated if possible, stored covered, thoroughly cooked, and served piping hot, regardless of the origin of the food (U.S. or indigenous). No seafood or shellfish should be eaten raw. Leafy vegetables may be contaminated with enteric agents. Locally procured fruits are usually considered safe if they are peelable; however, injection of local water (often contaminated) into melons is sometimes used to increase the weight and therefore the price of the item. Eggs should be well cooked. Milk (except powdered and evaporated milk) is unpasteurized and unsafe, as are butter, ice cream, cheeses and yogurt. (The brucellosis reported in Iraq may be due to lack of pasteurization.)

INSECTS

The use of personal protective measures such as repellent, clothing, impregnated bed netting, staying off the desert floor, checking all articles of clothing before donning, shaking out bedding before entering, and "buddy" inspections, all are extremely important in limiting the insect threat. The Army's current approach to insect repellents involves use of two products, a DEET containing repellent lotion for skin (NSN 6840-01-284-3982 code 2B) and a clothing repellent called permethrin (NSN 6840-01-278-1336). **Proper wearing of the uniform in conjuction with this system will provide nearly complete protection from vector-borne diseases.** The repellent lotion should be applied to exposed skin including ears, face, and neck. Its area of application should extend 2 to 3 inches under the edges of the uniform to prevent sand flies from crawling under clothing. The permethrin repellent is a spray that must be applied according to the directions on the can. The entire uniform exterior must be sprayed until it looks wet. The permethrin should also be applied to bed netting because the mesh is too large to be a barrier to the small sand flies.

The clothing impregnant should be applied prior to deployment if possible and again after the fifth washing. Maintaining personal hygiene, effectively disposing of garbage and human waste, and keeping foods and water sources covered and fly-proofed are also of paramount importance.

It is recognized that the difficulty in implementing these measures may be severely restricted by the tactical situation; however, the decimation of similar armies in this area throughout history by disease alone must lend considerable weight to the emphasis on preventive medicine.

VENOMOUS THREATS

Snake bites and scorpion stings may prove rapidly lethal. Capturing the snake without destroying the head, if not too great a risk, will aid in its identification. Use the usual measures in keeping the patient quiet, restricting only venous return, cleaning, incising and suctioning the site, and maintaining life-support until antivenom can be located. Snakebite experts and specific antivenom for snakes indigenous to this area are:

Professor Lattifi (a physician)
Institute d'Etat de Serum et Vaccin, Razi
PO Box 656
Teheran, Iran
(a source of regional antivenoms)

Institut Pasteur
Rue du Docteur Laveran
Alger, Algerie
(antivenom source)

Andre Dedries (a physician and retired general)
10 Melchet
Tel Aviv, Israel

Al Algousa Sharea
Alvezara
Cairo, Egypt

Elazor Kochva
MD, PhD
Professor of Zoology
Tel Aviv University

Dr. Findlay Russell,
Professor of Pharmacology
University of Arizona
Tucson, AZ 85721
[Note: Dr. Russell is considered to be one of the top snakebite experts]

Larry Curtis (American expatriate zookeeper)
Director of Zoologic Gardens
Riyadh, Saudi Arabia

COMBAT STRESS

Historically, combat stress reactions occur at a rate of about one for every three or four wounded in action. In a tense situation where opposing forces are anticipating but not engaging in action and where environmental stresses are high, the number of stress reactions and stress related increases in disease and non-battle injuries can skyrocket. The following factors all are applicable in this theater: defensive posture; high NBC threat and use of MOPP gear; harsh, hot climates; inadequate water supply; and high disease threat. Protective measures to be taken include maintaining high unit identity and cohesion, placing combat experienced personnel throughout the unit, encouraging popular support both in the theater and at home, keeping the troops informed, and refraining as much as possible from the "hurry up and wait" routine, and making the tasks meaningful.

A high degree of training will instill confidence in the equipment — not only in firepower, but in medical capabilities and chemical protective measures. Uncertainty about family and the folks back home adds to the stress load, but family issues like debt, sickness, divorce, while often difficult to resolve at home, become more burdensome upon deployment. Communication by regular mail is probably the most important measure that can alleviate stress problems. A designated, concerned and reliable point of contact in the rear who specifically handles family problems and special communications is required. Phone calls should not be allowed as a means of treating stress. Not only will unwelcome news by phone

add to the stress, but soldiers will learn to manifest stress symptoms in order to be granted the privilege of calling (secondary gain for medical symptoms).

Misconduct combat stress reactions such as abusing drugs and alcohol, fighting among soldiers, and awakening of racial tensions all can be expected to arise due to the alien culture and religion of the Arabs and other allies, the uncertain end-point of the deployment, the purported atrocities and disregard for the Geneva Convention by the enemy, the monotonous duties which will inevitably result from a defensive posture, and the availability of "recreational" drugs (opium, etc.). Again, protective factors include restricting alcohol availability, enforcing illicit drug prohibition, and communicating popular support for the deployment locally and in CONUS. Promoting a spirit of cooperation with the local population will introduce the troops to the foreign culture and contribute to an understanding of their ways, forestalling a polarization between the soldier and the people for whom he has been tasked to defend.

The burden of treating combat stress is on the leadership, and the key to its treatment is keeping the individual out of the medical system. Stress problems should be treated as far forward as possible while still giving the patient two to four days rest and change of routine. The patient should not be allowed total inactivity, but rather given purposeful, simple chores, such as helping other patients in an aid station setting. Once labeled with a medical condition, soldiers "acquire" symptoms which they believe will reflect a genuine medical condition — hence "battle fatigue" results in a weary soldier, and "shell shock" results in a dazed patient. Medical symptoms that do not seem to be substantiated by clinical findings should be suspected of being stress-induced and treated far forward, followed carefully, but not labeled with a diagnosis. The widespread attention to heat injuries makes this diagnosis likely to be abused as a "ticket home", so that manifesting such a problem may be considered an honorable means of being evacuated to CONUS. Pride in the unit, confidence in equipment and leadership, identifying stress-related problems, and treating them forward, but with compassion, are major command objectives to avoid degradation of troop morale.

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SECTION V. ENVIRONMENTAL EFFECTS: OPERATIONS

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HOT WEATHER FLYING SENSE

SOURCE: TRAINING CIRCULAR NO. 1-13
HEADQUARTERS, DEPARTMENT OF THE ARMY
(18 JANUARY 1979)

TOPICS

Human factors

CLOTHING

Keep head covered

Wear trousers and long-sleeved shirts loosely to allow ventilation

Use a cloth neckpiece to protect the nape of the neck

Do not attempt to travel barefoot. Protect feet from blistering and alkali burns.

DIET

Be careful of cultivated fruits and vegetables. They may be fertilized with human excrement. it is easy to become infected from these fruits and vegetables unless the skin is peeled off or the outer surface is cut off. Cook all vegetables before eating them.

TYPES OF HEAT COLLAPSE

Cramps

Symptoms The first warming of heat cramps is usually cramps of the legs or stomach muscles.

Treatment Keep the patient resting and give him salt dissolved in water

Exhaustion

Symptoms In exhaustion, the patient becomes flushed and then pale, will sweat heavily, and skin will be moist and cool. Unconsciousness or delirium my result.

Treatment Place the patient in the shade, flat on his back, and give him salt dissolved in water (two tablets to a canteen).

Stroke

Symptoms Heat stroke is a very serious medical emergency which is due to a failure of the thermo-regulatory mechanism and, in most cases, is characterized by a sudden onset of delirium and coma. It is associated with an extremely high body temperature--above 40.6° (105°F) and an absence of sweating.

Treatment Because this condition is often fatal, means of effectively cooling the body must be instituted as soon as possible. The optimum treatment is immediate whole body submersion in ice water. The individual should receive medical attention immediately; but if there is any delay, the unconscious person should be placed in a well-

ventilated area and sprayed with cold water to promote cooling by evaporation and convection to lower the body core temperature below 39°C (102°F) quickly. Heat stroke can be prevented by insuring that unacclimatized subjects are not exposed to heavy workloads in high environmental temperatures.

ENVIRONMENTAL FACTORS

Lack of water

Wells are the source of most water on the desert.

Lack of vegetation

Desert vegetation is scant and specialized to withstand the rigors of desert life.

WATER TABLE DEPTH INDICATORS	
	approximate depth in feet
Palm Trees	2-3
Salt Grass	6
Cottonwood and Willow	10-12

Extreme temperatures

The range of temperatures during the day is high as a result of the direct effect of the sun's rays. The desert night brings a rapid drop in temperature especially on elevated plateaus, as the surface cools quickly under the clear night skies.

Bright sunshine and moonlight.

Low cloud density results in bright conditions of light during the day and on moonlit nights.

Dust storms

Strong winds may raise towering dense clouds of dust and sand. This condition is more prevalent in sandy areas, but exists to a degree in all arid and semi-arid regions.

Rivers

Most deserts are crossed by rivers.

Factors affecting helicopter operations

Daytime temperatures

High daytime temperatures severely restrict the lift capability of helicopters by reducing:

- horsepower output
- rotor efficiency
- decreasing takeoff ability and rate of climb

Sand and dust

Most aircraft maintenance problems are caused by sand and dust created by aircraft hovering, taking off, and landing. Sand and dust particles can:

- pit windshields,
- damage propellers and rotor blades,
- act as an abrasive on internal parts when drawn into engines.

To reduce wear and resultant maintenance requirements:

be careful to select maintenance, runup, refueling, and takeoff areas that minimize the amount of dust and sand that could disturbed by rotors propellers, or by the normal winds.

cover all openings in the aircraft as soon as the engine is stopped.

cover moving parts on the aircraft when not in use so that exposed lubricated parts will not pick up sand.

Operate reciprocating engines at low speeds, whenever possible, over loose sand.

Perform running takeoffs and landings, if feasible, to reduce updraft of sand caused by rotors.

Use oil or other dust palliatives on takeoff areas; however, consideration must be given to the effect of the use of such agents on camouflage and concealment.

Protect fuel and lubricant supplies from contamination.

Maintain adequate stocks of spares on hand to replace parts which wear out more quickly in this environment.

frequently clean all moving parts to reduce the abrasive effect due to accumulated sand.

Wind and sand updraft

High and violent winds are common to desert areas. Aircraft on the ground should be secured with tiedowns. The updraft of sand and dust may obscure the entire landing area, especially when large numbers of helicopters are landing in areas covered by loose sand.

Sand and dust problems can be minimized by

Selection of landing zones and approaches to exploit the sand-free areas that can be found in most deserts.

Time landing to permit sand to subside or be blown from the landing zone between touchdowns

Use small separated landing sites in proximity to the objective.

Navigation

Lack of terrain features and poor reference points make navigation difficult.

Security

Scant vegetation and lack of terrain features increase the problem of concealment. Emphasis is placed on the use of camouflage paint and nets. Aircraft in flight are easily spotted from the air and successful evasive action is more difficult because of the lack of protecting terrain. Security of landing fields from enemy ground action is a major problem.

Radio communications

The desert provides a poor electrical ground decreasing the efficiency of standard military whip antennas.

Sand and dust often enter equipment.

TEMPERATURE, ALTITUDE, AND DENSITY

Standard conditions at sea level are:	
Atmospheric pressure	29.92 inches Hg
Temperature	59°F (15°C)
Standard conditions at any higher altitude are based on:	
Atmospheric pressure (reduced to sea level)	29.92 inches Hg
Temperature	59°F (15°C) minus 3.5°F (20°C) per 1,000 feet elevation.

Factors affecting density altitude are:

Altitude
Atmospheric Pressure
Temperature
Moisture content of the air

Altitude

The greater the elevation of an airport or landing area, the less the atmospheric pressure and the less dense the air.

Atmospheric pressure

The lower the pressure at a given elevation, the less dense the air; the less dense the air, the higher the density altitude.

Temperature

Even when elevation and pressure remain constant, great changes in air density will be caused by temperature changes.

Moisture

The higher the temperature the greater amount of moisture the air can hold. Therefore, as the moisture content of the air increases, air becomes less dense; density altitude is increased.

	FACTORS AFFECTING DENSITY ALTITUDE			
		AIR DENSITY	DENSITY ALTITUDE	HELICOPTER PERFORMANCE
FACTORS	INCREASED ALTITUDE	DECREASED	INCREASED	DECREASED
	DECREASED PRESSURE	DECREASED	INCREASED	DECREASED
	INCREASED TEMPERATURE	DECREASED	INCREASED	DECREASED
	INCREASED MOISTURE	DECREASED	INCREASED	DECREASED

High density and low density altitude conditions

High density altitude refers to thin air and decreased helicopter performance

low density altitude refers to dense air

Hovering flight

High density altitudes reduce the hovering capabilities of the helicopter.

An increase in temperature decreases hovering capability.

An increase in the amount of moisture in the air decreases the hovering ceiling.

Takeoff

For any given gross weight, the higher the density altitude at point of departure, the more power that is required to make a vertical takeoff to a hover.

Under certain gross weight and density altitude conditions, a helicopter may not have sufficient power to lift off vertically.

Landing

Because a pilot can hover at his takeoff point with a certain

gross wight, it does not mean that he can hover at his destination.

The following factors need to be considered to predict whether sufficient power to hover at a destination:

Knowledge of temperature, expended fuel, relative humidity, and wind conditions at the destination,

Use of charts in the helicopter flight manual, and

Making certain power checks in flight prior to attempting to land

The heavier the gross wight, the lower the hovering ceiling.

The most favorable conditions for helicopter performance are the combination of a low-density altitude, light gross wight, and moderate to strong wind.

The most adverse conditions for helicopter performance are the combination of a high-density altitude, heavy gross wight, and calm or no wind.

HOT WEATHER FLYING TECHNIQUES

Preparation for flight

Check for presence of sand and dust in control hinges and actuating linkages.

Engine start, warmup, and ground tests

Engine start and ground operation should be accomplished from a clean, hard surface.

Every effort should be made to minimize the sand from being blown up around the main rotor and engines.

Taxiing instructions

get the helicopter airborne as quickly as possible in order to minimize sand and dust intake by the engines and the danger of a 'whiteout'.

Takeoff

A running takeoff is preferred for a wheel-type helicopter; otherwise, a maximum performance takeoff is recommended.

During flight and descent

Avoid flying through sand ar dust storms.

Landing

The best procedure to minimize blowing sand and dust is a running landing. If the terrain does not permit running landing, an approach to touchdown should be made.

CAUTION If operation in sand cannot be avoided, landing should be made using an approach angle that is greater than the angle used for normal approaches if a running landing is not possible. The approach angle should be compatible with available power. If a running landing can be made, the touchdown roll should be kept to a minimum to preclude the possibility of overloading the landing gear. All doors and windows should be kept closed during landings and takeoffs to help prevent sand from entering the cockpit and cargo area. These procedures will lessen sand clouds and insure greater visibility. Hovering and prolonged operation in sand should be avoided because unpredictable foreign objects damage can result.

Stopping engines

The engine should be shut down as soon as practical after landing to minimize the ingestion of sand and dust.

Before leaving the helicopter

Install all protective covers and shields and leave windows open to ventilate the helicopter, except when sand and dust are blowing.

MAINTENANCE CONSIDERATION IN THE DESERT

Engine operation

Operate engines as little as possible, and for piston engines at low speeds when in use. After shut down, install appropriate covers for the aircraft.

Maintenance sites

Select maintenance sites on the hardest ground available free of loose gravel and sand. If this is not possible, test engines over rock-filled pits or over canvas-covered areas.

Oil change

Change frequently to minimize internal engine wear.

Fuel contamination

When transferring fuel, filters and screens should always be used.

Securing aircraft

Winds are sudden, violent, and frequent in the desert. All aircraft must always be securely tied down.

Greenhouse effect

Even during a typical north temperature zone summer and with the cockpit partially open, the greenhouse effect will cause severe thermal stress within the cockpit during prolonged ground standby. Thermal stress can be reduced by maximizing forced cooling by appropriate location of the aircraft to catch the prevailing wind and opening the cockpit to air.

INSPECTIONS - Besides the preflight and daily inspections, check the following:

Brake system

During summer do not set the brakes during the cool part of the day or when the temperature is expected to rise. This may cause rupture of brake lines and damage parts due to expansion of fluids during changes in temperature. Wheel chocks should always be used. Setting the brakes during times of high temperature could result in the brakes releasing when brake fluid cools and contracts.

Protection from sun

Cover clear plastic such as wind screens, helicopter bubbles with canvas, salvage sheets, condemned parachute canopies, or whatever will keep the sun off.

SURVIVAL

Generally, the best advice is to stay with the aircraft.

If travel is necessary, follow the easiest route possible by avoiding loose sand and rough terrain and by following trails. In sand dune area, follow the hard floor valley between the dunes or travel on the dune ridge.

During sandstorm, take shelter. Don't travel with bad visibility. Lie on side with back to the wind and if possible sleep through storm. Don't forget to mark upon travel direction

Multiply estimation of distance by three, since the absence of predominant features makes an underestimate likely.

Take care of your feet. Keep sand and insects out of your shoes and socks by removing them while resting. Caution must be taken because your feet may swell making it difficult to put boots back on.

Always travel at night and take all the water you can.

Procedures for desert operation

If you do not carry parachutes, make certain you are carrying a canvas or other suitable shelter material.

first aid

Medical aid to crash victims is the first concern, then get them in shade.

Drink plenty of water

Drink only small amounts at a time to avoid stomach cramps. Each person will require about eight or more canteens of water daily.

Use extra salt with food and water

Eat your heaviest meal during the cool of the day

Water

The body requires a minimum of 1 gallon each day. Keep clothing on to keep heat out of your body.

Location of water is sometimes found under likely brush heaps or sheltered rocks in semi-arid brush country.

Locate drinking areas frequented by birds.

Places which are visibly damp or where animals have scratched are reliable places to dig for water.

Avoid taking large gulps with drinking water. A small pebble in your mouth may help keep your lips moist.

Food

Look for animals at waterholes, in grassy canyons, low-lying areas, or dry river beds. Animals are most commonly seen at dusk or early morning. The smaller animals are your best and most reliable source of food.

Shelter

Seek shelter from the sun. If you stay with the aircraft, don't use the inside of it in the daytime; it will be to hot. Get under the wing or rotor blade. Make a shelter of your parachute or canvas if needed. The layers of cloth separated by an airspace of several inches makes a cooler shelter than a single thickness.

Firemaking

Whenever you find plant growth, use all twigs, leaves, stems, and underground roots for burning. Stems of palm lease and similar wood serve as fuel in or near an oasis. Dried camel dung is the standard fuel where wood fibers are lacking.

Signaling

You can make a good improvised flare from a tin can filled with sand soaked with fuel. To make dense smoke daytime signals, add oil and pieces of rubber. At night, burn fuel or use other material that produce a bright flame. The mirror is another device for desert signaling or a brightly polished piece of metal.

Section 4 - Desert Operations

The arctic, tropic, and desert areas of the world all have one thing in common: conditions of extreme environment. These environments impose severe stresses on men, material, and materiel. The causative factors producing these stresses are different for each of these environments, but the end result is frequently the same--failure of materiel to function as designed. The prime factors imposing environmental stresses in the desert are the thermal stresses caused by solar radiation and ambient temperatures and the physical and mechanical stresses caused by blowing sand and dust.

4.1 Heat Stress. Generally, hot-dry climates do not cause rapid deterioration of mechanical equipment. However, certain elastomers, textiles, leathers, chemicals, and plastics are susceptible to accelerated deterioration when subjected to high temperatures and intense solar radiation over a period of time.

The temperature a material will attain under direct solar radiation depends on its heat capacity, thermal conductivity, and reflective characteristic. Table 5 presents the temperatures of some materials exposed to direct solar radiation at Yuma.[15]

Table 5
(Measurements recorded at stated ambient conditions)

	Temperature
Ambient Air	47.5°C (108°F)
Ground Temperature	70.0°C (144°F)
Surface of a 105 mm HE round	71.2°C (146°F)
(propellant inside)	62.5°C (132°F)
175 mm round standing on end	65.6°C (137°F)
Steel rocket container painted blue	76.2°C (154°F)
Steel rocket container painted white	59.4°C (127°F)
Wooden box	57.5°C (124°F)
M60 tank exterior surface	73.7°C (150°F)

In all cases the temperatures of material exposed to direct solar radiation exceeded ambient. However, a tarpaulin shade raised seven inches above a round to allow air movement prevented temperatures from going higher than ambient. The intense solar radiation, besides causing high thermal stresses in materials, also contributes to high ground temperatures. Midday temperatures greater than 60°C (140°F) occur on both sand and desert pavement surfaces. The absolute maximum hourly temperatures recorded were 64.4°C (148°F) on sandy soil and 65.6°C (150°F) on desert pavement. The temperature extremes in the soil lag behind the extremes at the surface so much that the highest temperatures at 25-centimeters depth occurs near midnight. Therefore, as the surface of the desert sand cools down at night, subsurface temperatures are still high. The extreme

ground temperatures experienced in the desert can have a significant effect on buried mines. Temperatures of mines buried in desert soil increased to 58.9°C (138°F). This high temperature can cause changes in chemical properties of the explosive resulting in item malfunction.

Another facet of the solar radiation problem is that of high temperatures during storage. Studies have shown that the standing boxcars and the tarpaulin-covered storage modes were situations favoring maximum heat accumulation. The air near the top surface of the boxcar reached a temperature of 66.7°C, (152°F). Cartons stored in the boxcar achieved a maximum temperature of 44.4°C (112°F) for the bottom carton. The load inside the boxcar retained temperatures in excess of 37.8°C (100°F) for over 14 hours. Materials subject to chemical reaction, such as propellants and explosives, may be markedly affected by extended storage in such heated boxcars.

4.2 Mechanical Stress. The characteristics of dust environment are of interest because of the potential for this condition to cause rapid failure of many types of Army equipment. The Advent of faster vehicles, helicopters, and ground launched missiles intensify the dust problem. The sand and dust phenomena are not only associated with desert areas but also with temperate and tropic areas as well. Generally all areas have dry periods, when sand and dust play havoc with military equipment. The dust environment is usually a result of vehicular or personnel activity on the surface. Minor dust conditions can be a result of climatic conditions, however, the frequency is negligible when compared to man-made dust clouds.

4.2.1 Particle Size and Distribution. The size of a dust particle (expressed in microns) is usually understood to be the effective diameter of the dust particle since dust particles do not have a definite shape. Particle size bears directly on dust formation and airborne dust movements.

Particle size distribution is represented as the percent of a dust sample smaller than a given dust particle diameter. The size distribution is relatively indicative of the composition of the surface soil material since particles of least density and size will become available to the dust plume under moderate conditions. When a surface soil is composed of two or more basic soil materials, the particle size distribution will indicate this distribution with a double distribution curve. For a clay-quartz soil the distribution below approximately 30 microns is indicative of clay particles with those over 30 microns constituting quartz particles. Table 6 shows the distribution and compostion of dust particles from YPG vehicle test courses. The values are averages from several test samples obtained from different courses.

Table 6
Particle Size Distribution YPG Dust Course

Particle Size (microns)	Percent by Weight	Composition	
0 - 10	4.33	non-abrasive (82%) clay, gypsum, carbonate	abrasive (18%) quartz
11 - 20	2.88		
21 - 40	3.47		
41 - 74	3.82	non-abrasive (31%) clay, gypsum, carbonate	abrasive (69%) quartz
75 - 149	21.28		
150 - 250	22.85		
over 250	41.37		

As the table shows, abrasive content of the dust increases with particle size. YPG vehicle test courses are composed primarily of larger size dust particles.

4.2.2 Dust Concentration. One of the most important aspects of dust environment is concentration. The dust concentration measured near or directly on a moving vehicle is primarily a function of terrain, vehicle type, vehicle speed, and climatic conditions. It is usually measured as a weight of particles per unit volume. The methods and techniques employed in obtaining and measuring dust concentrations are important in the accuracy of concentration data. Several factors that influence concentration data include sampling period, location of samples, type of filter, and climatic data.

Only the surface soil layer is responsible for the dust environment. Any mechanical or aerodynamic force which causes this surface layer of soil to be agitated or moved is a dust generating mechanism. As a result, dust concentrations are not constant but vary over time. Peak concentration occurs shortly after a vehicle passes over the soil, and depending on particle size distribution, the rate at which dust concentration diminishes is a function of the square of the particle diameter. Relatively large particles descend much faster than smaller particles: 40-74 microns at one foot per second; 150 microns in 3 feet per second and 5 microns at 0.01 feet per second. This wide variation in dust settling rate is highly important in dust sampling. Dust concentrations for various levels of activity are shown in Table 7.

Table 7
Dust Concentrations to which Armored Personnel are Exposed

OPERATIONS	DUST CONCENTRATION BY WEIGHT (grams/cu. ft.)
MINIMUM ACTIVITY	
Dust Storm	.015 - .30
Airborne dust from infantry camp; some from a road grader	.0003
Motor pool of a medical battalion; slow traffic	.0004
Bivouac area, Sunday afternoon; fresh breeze	.001
Div. Sug. Tent, Hdqrs., camp area	.001
Air base; planes taking off clean runway	.001
Motor pool; ambulance driving in loose sand	.001
Infantry training on regt. parade ground	.001
Ordnance unloading depot, only 3 vehicles moving	.001
Army truck road, dust raised by staff car	.001
Regimental area of camp, normal traffic	.001
Gas dump, no vehicular movement, light to no breeze	.001
Railhead with light traffic, no convoy movements	.001
Repeated passage of ¼ ton truck on tank trail	.001
Railhead with little traffic	.001
Hdqrs. camp, light traffic, fresh breeze	.001
Ordnance unloading depot; heavy wind storm; no traffic	.001
MODERATE ACTIVITY	
Infantry column, 4 companies ahead of sampler	.002
In convoy behind half-track	.002
Asst. driver's seat; light tank midway of column of tanks	.002
Evacuation hospital area; sandy surface, fresh breeze	.002
Corner tank battalion motor pool; 16 tanks and 1 truck moved	.002
Entrance to railhead; almost continuous truck traffic	.002
Troop drilling--no traffic	.002

HIGH ACTIVITY	
Maneuver road; dust raised by staff car	.003
Convoy of cargo trucks spaced 100 yards	.003
From ¼ ton truck and wind-blown dust	.004
Deliberate dust disturbance by ¼ ton truck	.004
Convoy of trucks and towed 75 mm guns	.005
Repeated passage of ¼ ton truck through pulverized silt bed	.006
Alongisde moving tank column	.037
Inside tank following another 150 yards	.009
Convoy of trucks passing by	.010
Following ¼ ton truck	.018
Thirty feet behind half track; loose sand	.029

SECTION VI. MISCELLANEOUS

SECTION VI. MISCELLANEOUS

MAPS OF SOUTHWEST ASIA

Fig. 1. July mean daily maximum temperature.

2. Absolute maximum temperature.

3. Hourly temperature frequencies greater than 110°F. (July)

4. Summer dewpoints.

5. Areas favorable to microbiological deterioration.

6. Probability of equipment difficulty.

7. Gasoline storage life.

8. Long-term food storage life areas.

9. Short-term food storage life areas.

10. Limiting environmental conditions for sustained light, moderate, and hard work.

11. Areas of reduced performance.

12. July survival time without water.

TABLE

1. Safe keeping time for non-perishable foods in open storage.

GRAPH

1. Daily water requirements for three levels of activity.

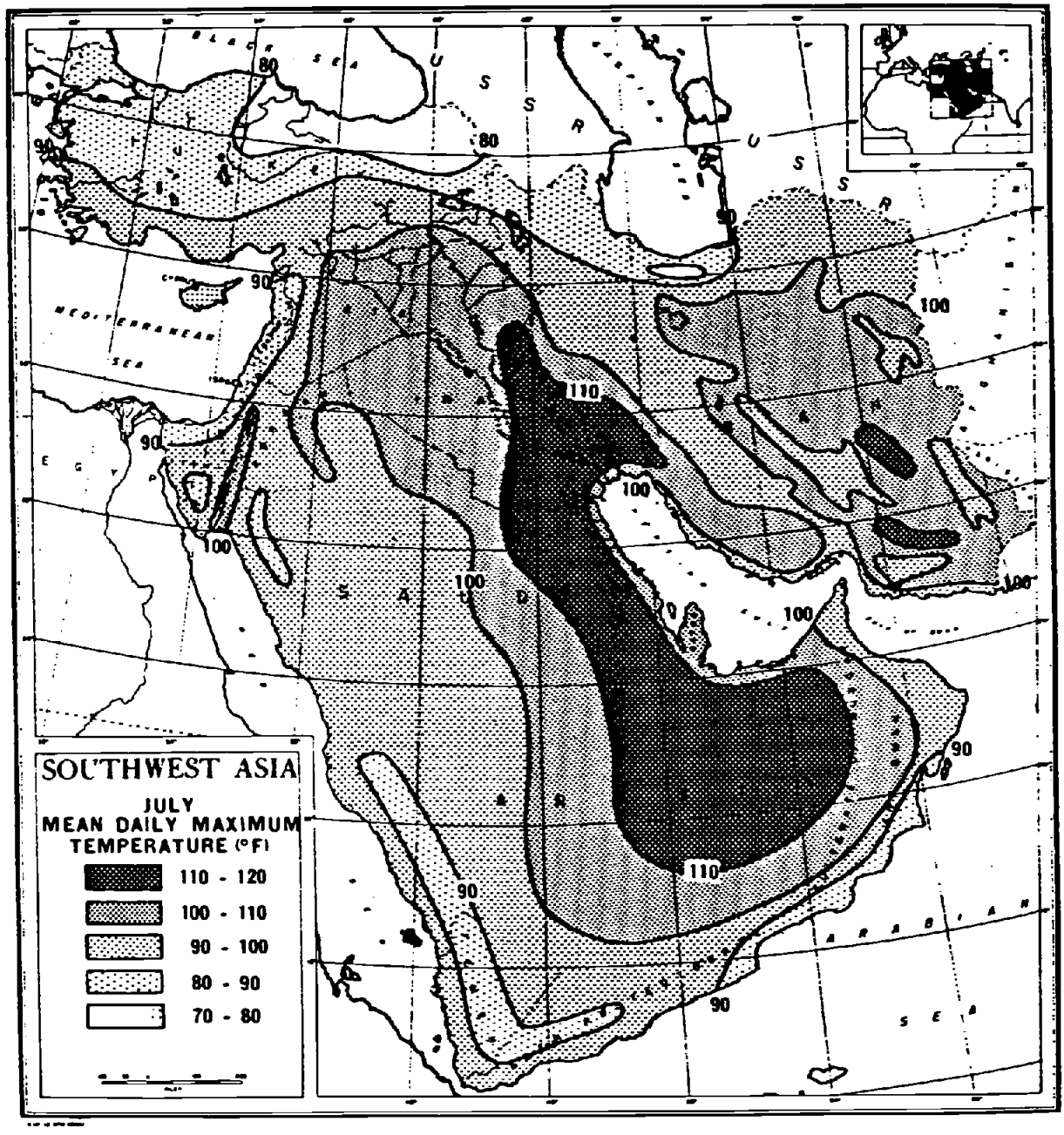


Fig. 1: The above map, based on average daily high temperatures in July, gives some idea of the high temperatures likely to be reached during the day. Because the figure is an average, however, approximately half the days will have higher temperatures, and the other half will not be so hot. The map indicates that over a vast area many days in July will have temperatures above 90F; in a smaller but no less important area, temperatures above 100F are common.

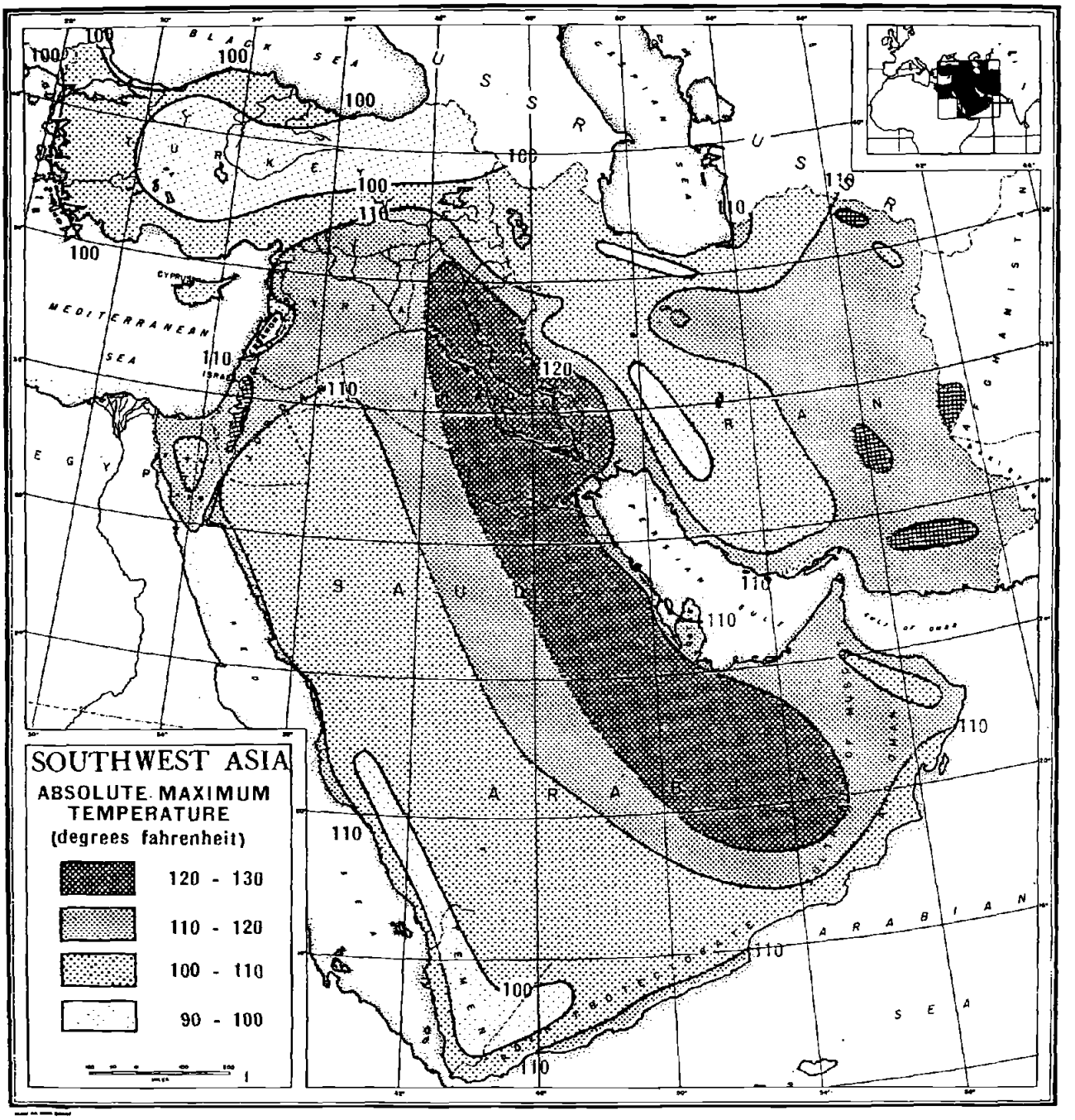


Fig. 2: Absolute maximum temperature figures are of limited practical value, but this map indicates in a general way the extremes likely to be reached. It is of interest that the extreme high temperatures are likely to occur at least slightly inland from the coast.

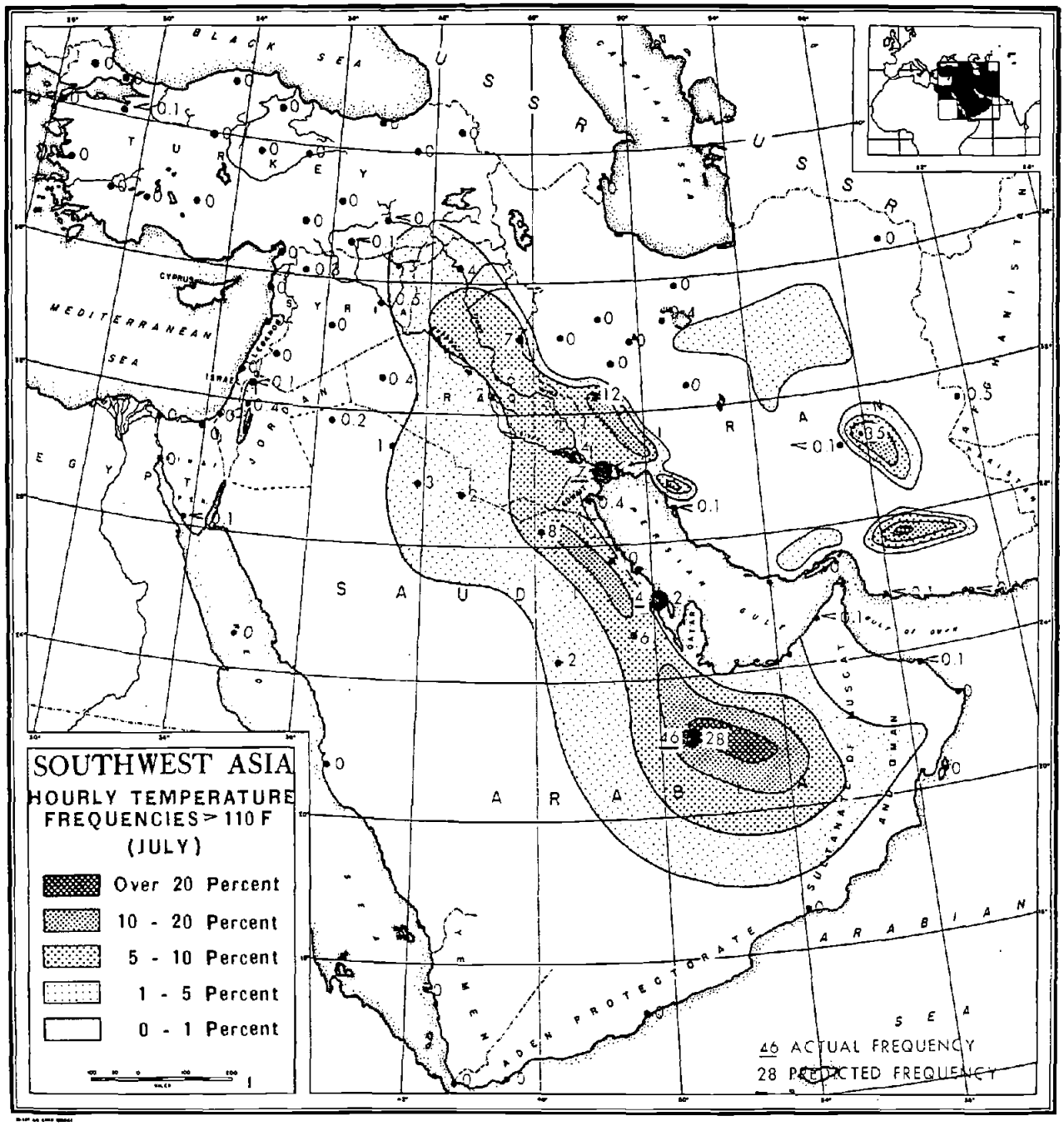


Fig. 3: Both personnel and equipment are affected adversely by extremely high temperatures. The reader must be aware that the percentages shown are in relation to the total hours in July. If only daylight hours were considered, the top category would be raised to "over 34 percent." If only the five hours per day of maximum heat were considered, the top category would be increased still further to "over 96 percent."

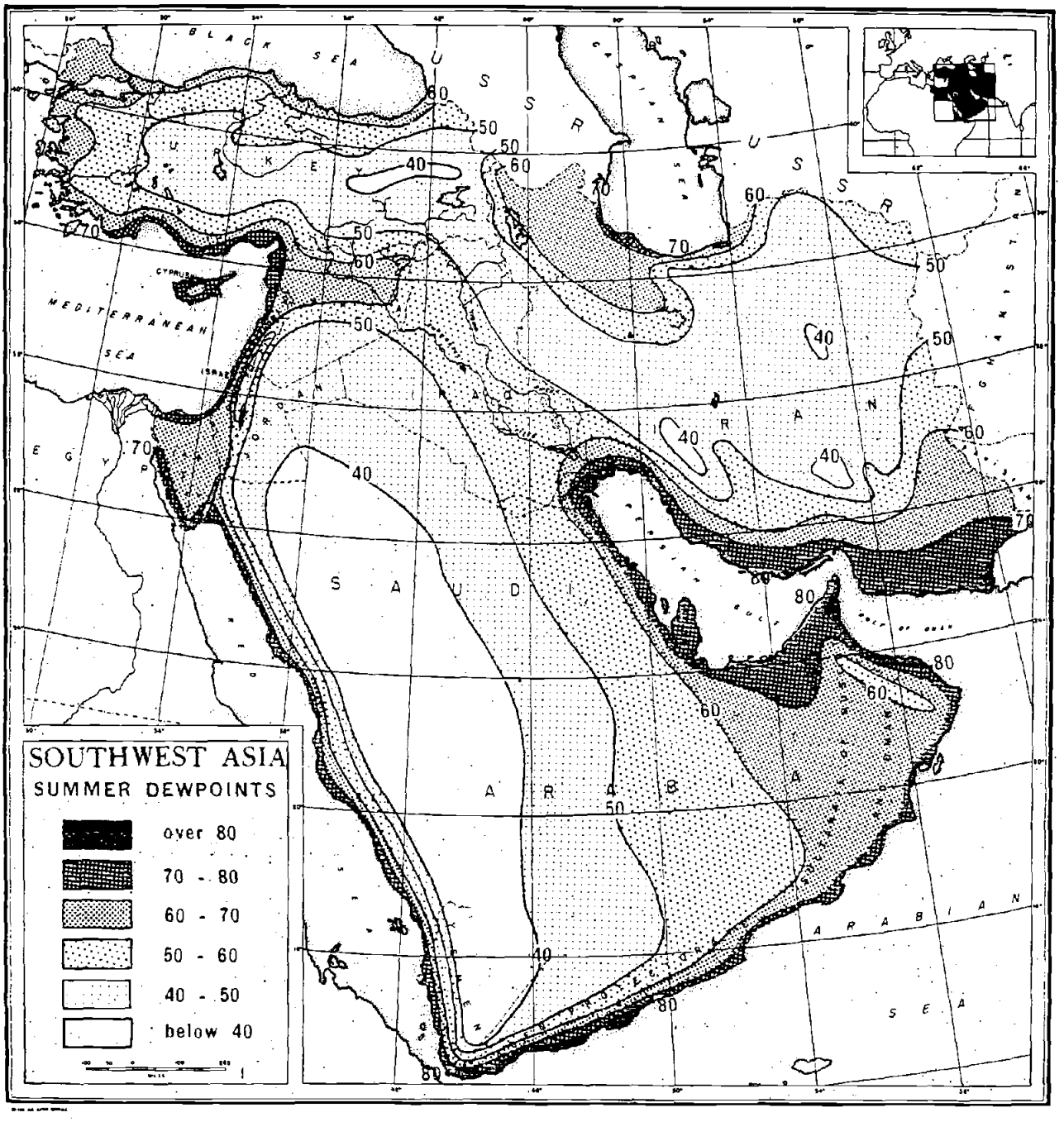


Fig. 4 : Mean monthly dewpoints are shown for the summer month in which they are highest. Dewpoints near the coasts are high throughout the region and are excessive (as high as anywhere in the world) on the Persian Gulf and Red Sea coasts. Vapor pressure data (directly convertible to dewpoints) were available for some stations, but for many places mean temperatures and relative humidity data were used to obtain a good estimate of the mean dewpoint.

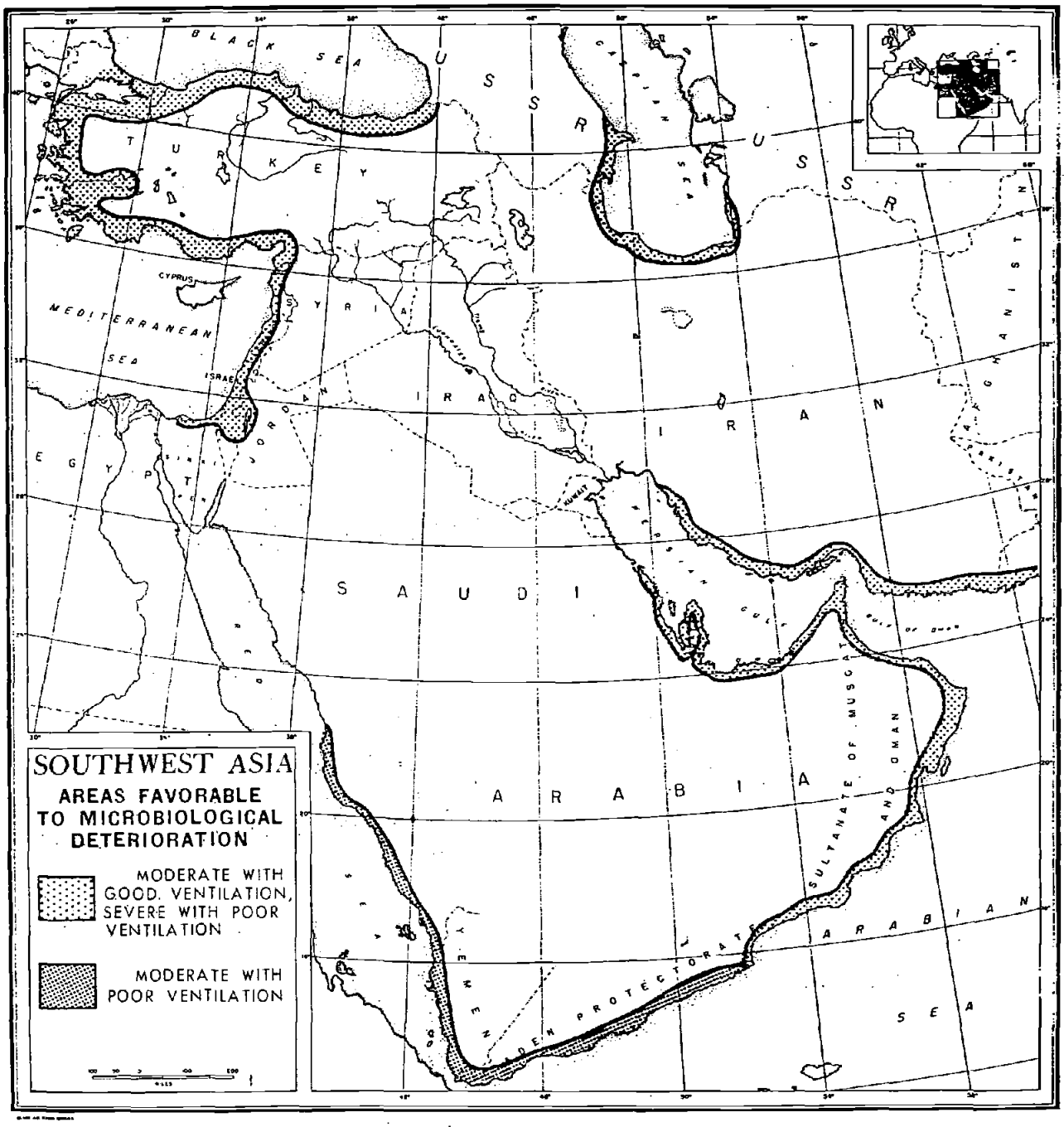


Fig. 5: The areas of Southwest Asia favorable for microbiological deterioration are found only along the coasts; in most other areas the humidity is too low. This map of conditions favorable for microbiological activity should in no way be construed to suggest that such activity is confined to the areas shown; rather, it shows the areas that are especially favorable.

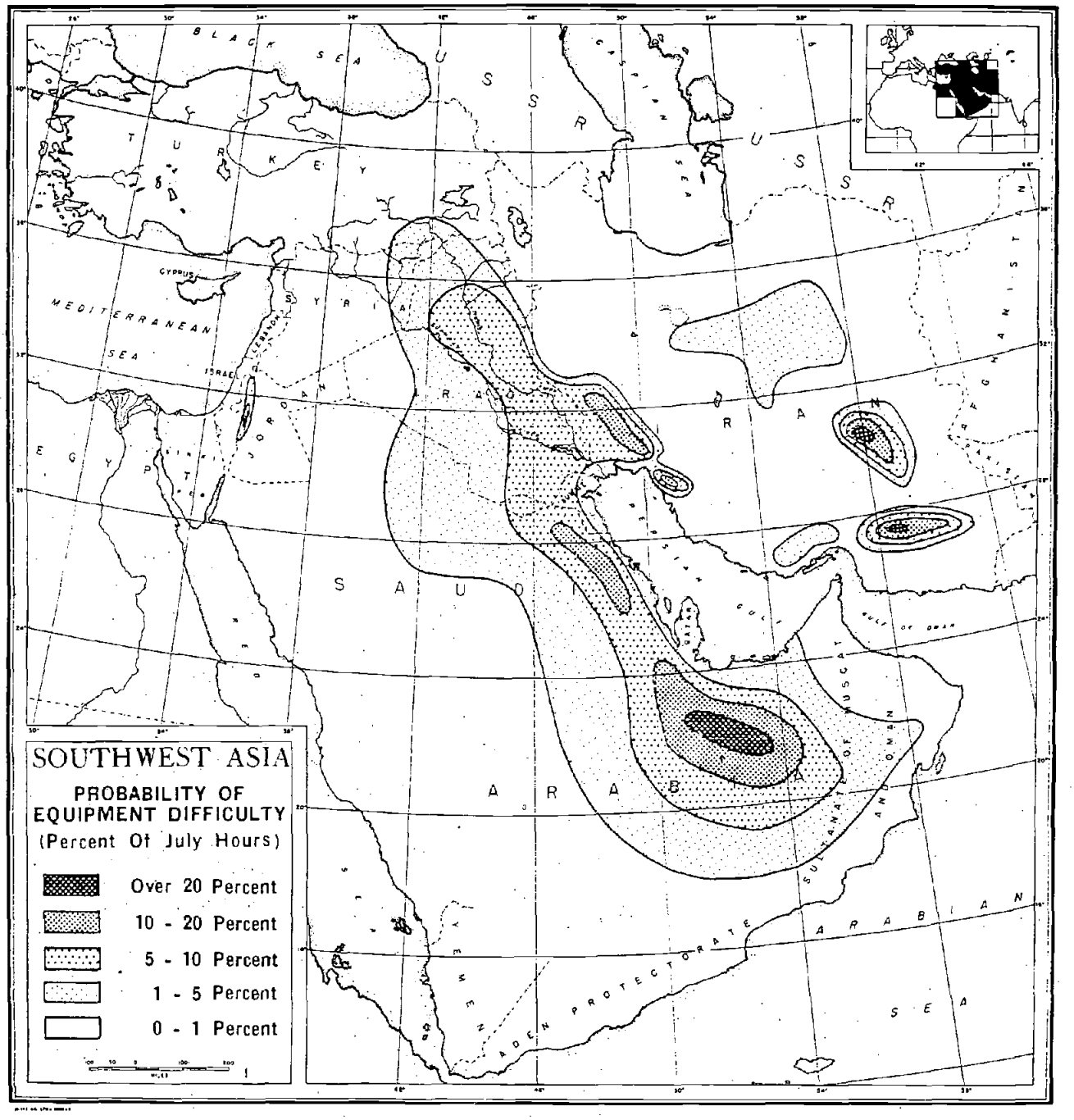


Fig. 6: This map shows the percent of July hours during which the Mobile Bakery; Refrigerator, 25 cu. ft.; and Rough Terrain Fork Lift Truck may be ineffective. These three items begin to fail at temperatures of about 110F.

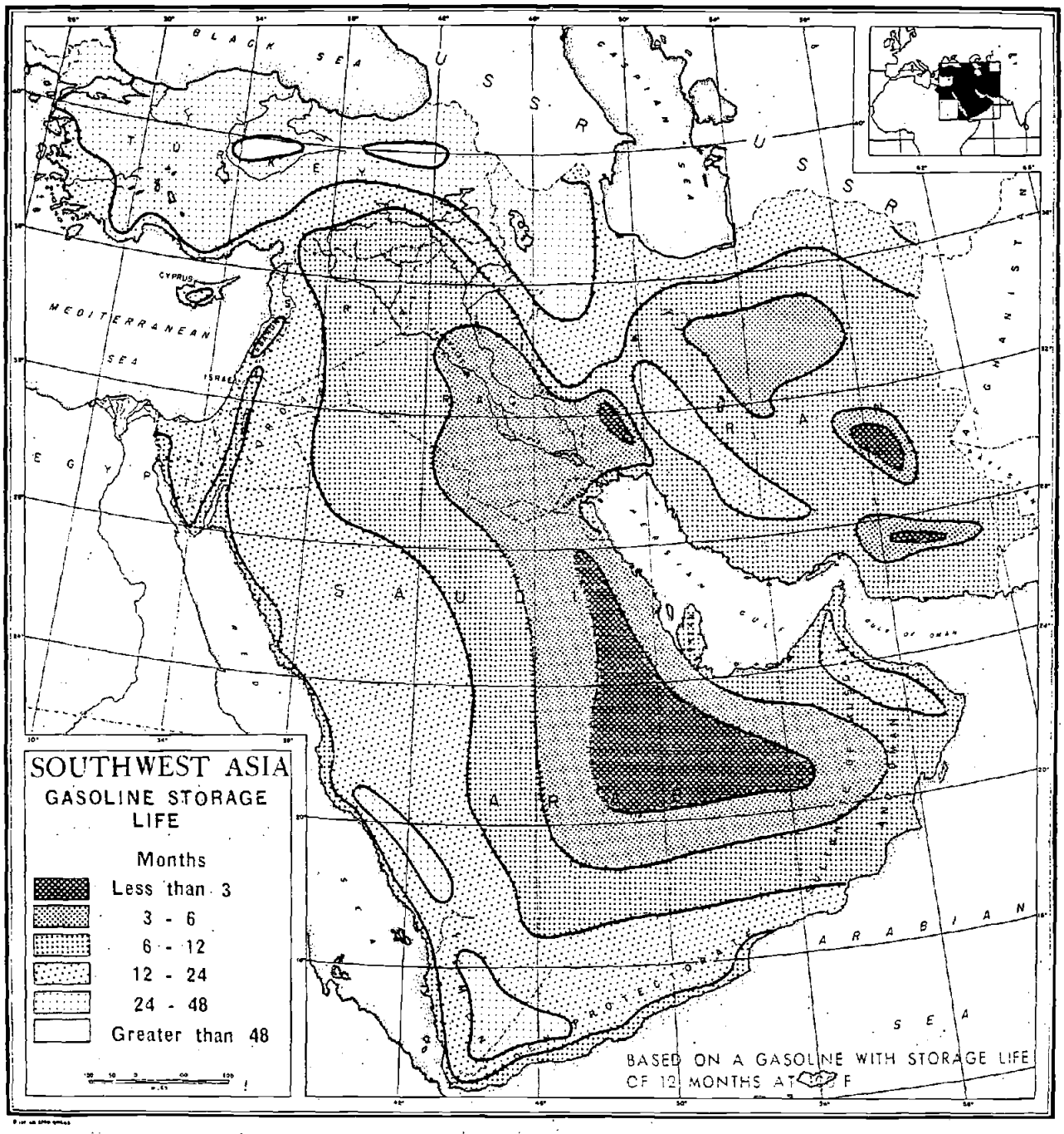


Fig. 7 : The above map, as indicated, is made for a common type of gasoline, which has a storage life of 12 months at 100F.

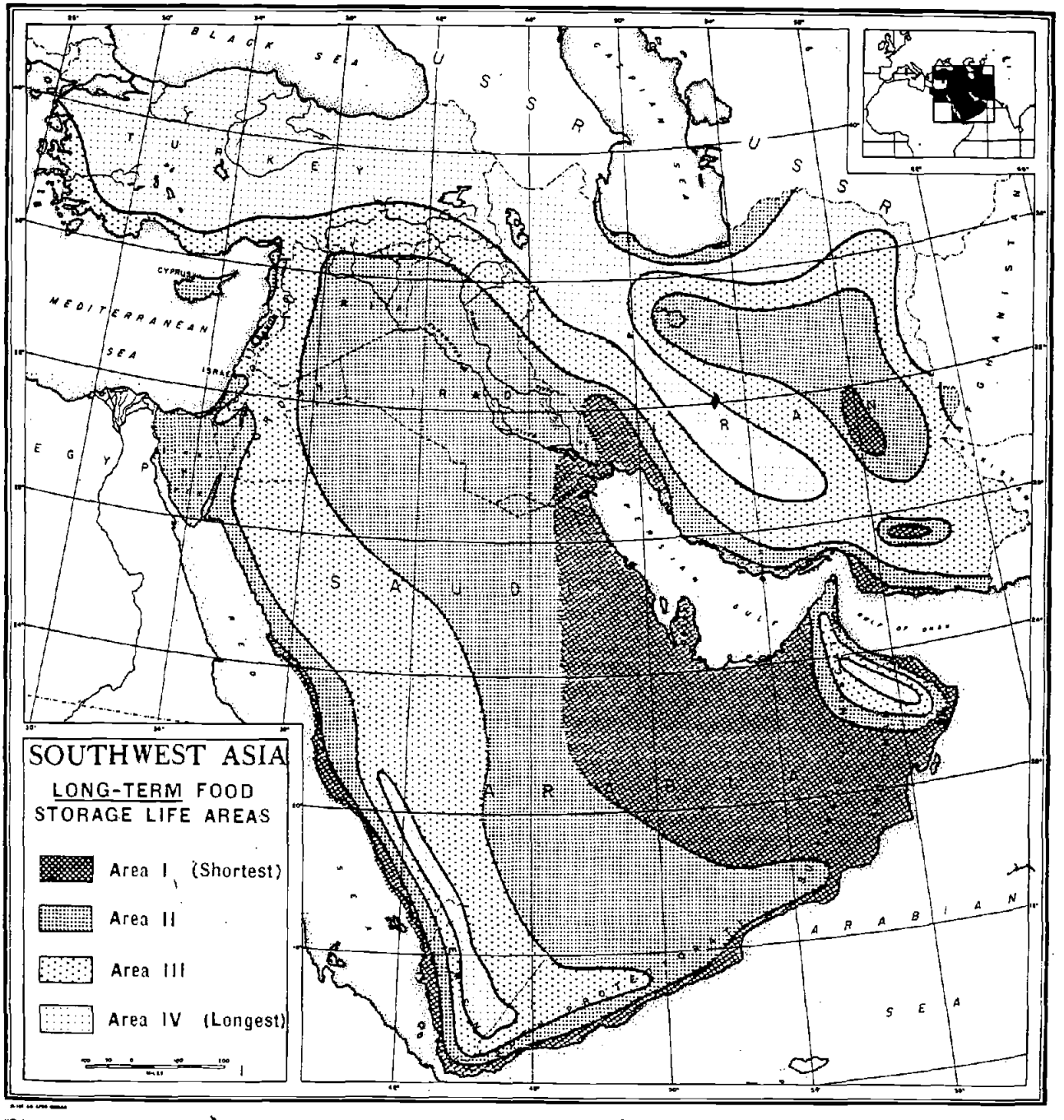


Fig. 8 : Long-term for this map is more than 6 months.

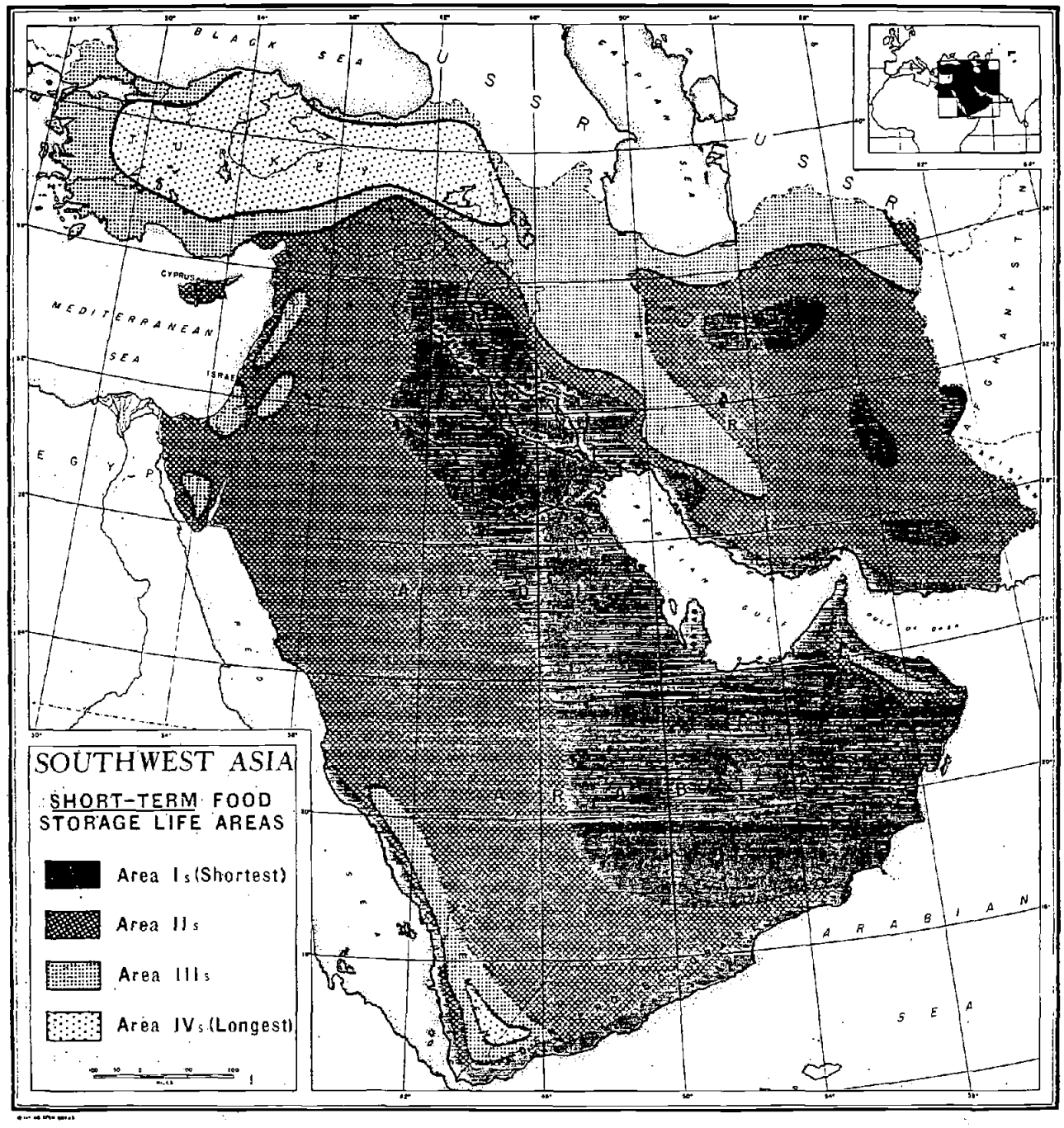


Fig. 9 : Short-term food storage is less than 6 months.

TABLE 1

SAFE KEEPING TIME FOR NON-PERISHABLE FOODS IN OPEN STORAGE*

	PRODUCT	PACKAGING	SAFE STORAGE TIME IN MONTHS BY AREA				
			Long Term**		I	II	III	IV
			Short Term***	I_s	II_s	III_s	IV_s	
1.	BEVERAGES:							
	Coffee, roasted, ground	Can, vacuum-packed		4	5	6	7	8
	Tea, soluble product	Can			24	30	36	43
2.	CEREALS AND CEREAL PRODUCTS:							
	Cereals, breakfast, prepared	Carton w/inner bag			12	15	18	23
	Cookies and Crackers (biscuits)	Special moisture-proof		4	6	8	12	16
	Flour, wheat, bleached	Cotton and multi-wall bag		1	3	5	9	13
	Macaroni, spaghetti, vermicelli	Corrugated fiberboard carton			10	15	18	23
	Oversea PX items	Special moisture-proof		4	6	8	12	16
	Prepared mixes (bread, cake, doughnut, pancake)	Can			12	17	24	34
3.	DAIRY FOODS, FATS, AND OILS:							
	Ice Cream mixes	Can		2	3	4	7	10
	Milk, dry, whole	Can		3	5	7	10	12
	Oleomargarine	Can		< 1	3	10	24	34
	Eggs, whole, dehydrated	Can			12	17	24	34
4.	FOOD SPECIALTY PREPARATIONS:							
	Chocolate, cooking, unsweetened	Paper wrapped		2	3	4	6	10
5.	FRUITS:							
	Non-acid fruits	Can		6	9	14	20	29
	Acid fruits (citrus, berries, sour cherries)	Can		1	2	3	6	11
	Dried fruits, light	Carton		2	3	4	7	11
6.	MEAT, MEAT PRODUCTS, AND SEAFOOD:							
	Beef items	Can			24	30	36	43
7.	RATIONS, OPERATIONAL, PACKAGED:							
	Ration, Individual, Combat	Carton****			12	17	24	34
	Ration, Small Detachment, 5-in-1	Carton****		6	9	12	18	24
8.	SOUPS:							
	Soup, bean or pea, precooked, dehydrated	Can		5	7	8	12	16
9.	SPREADS:							
	Apple butter, Jams, Jellies, and Marmalade	Can			10	13	18	24
10.	VEGETABLE ITEMS:							
	Low-acid vegetables	Can			12	20	24	31
	High-acid vegetables (tomato products and sauerkraut)	Can		4	9	13	18	25
	Dehydrated vegetables	Can		8	12	17	24	33

*Table based on data supplied by QM Food and Container Institute for the Armed Forces (d/7/23/55)
**Periods longer than 6 months
***Periods shorter than 6 months
****Individual items are packaged in cans, heat-sealed envelopes, and flexible bags

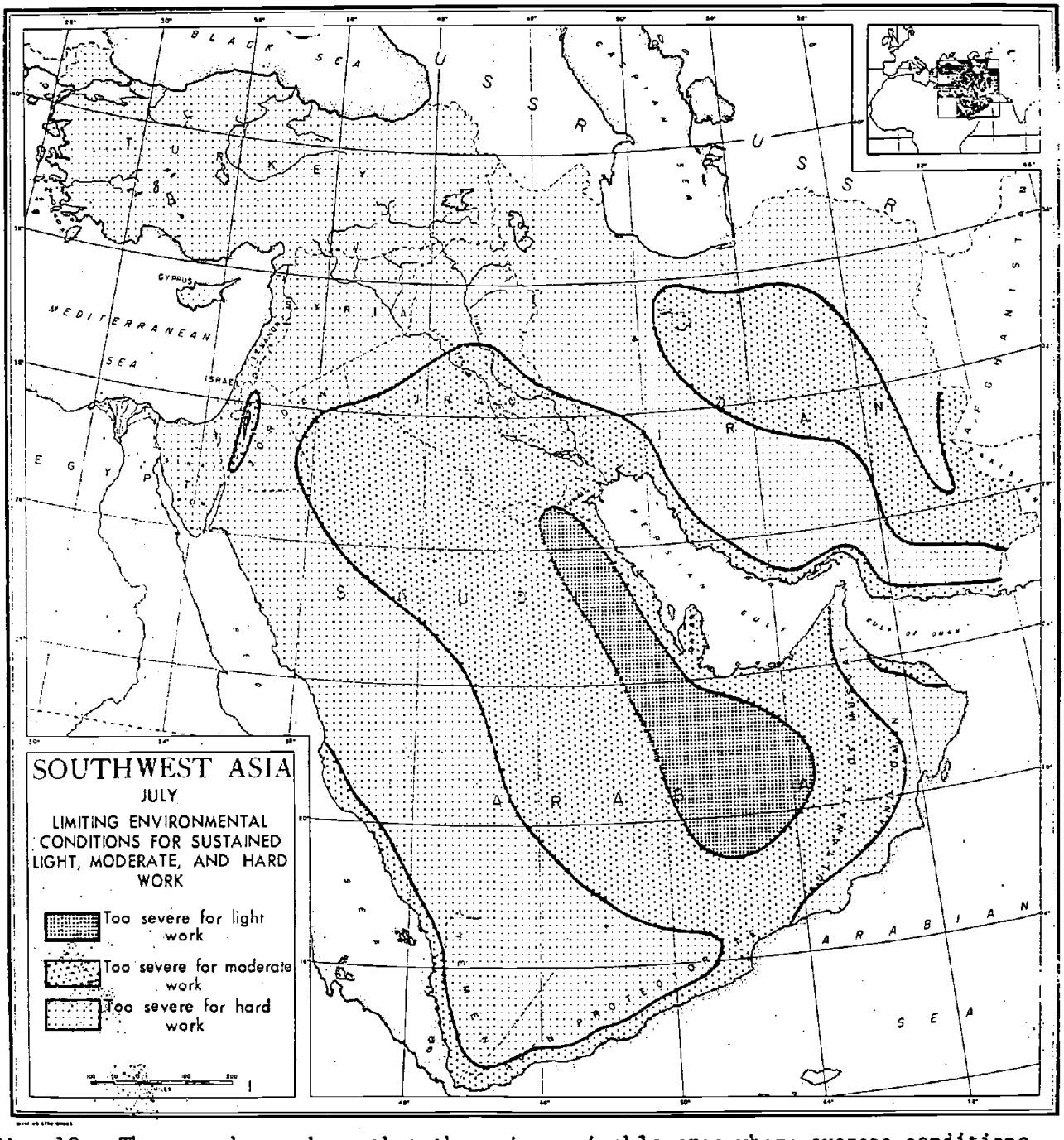


Fig. 10: The map above shows that there is a sizable area where average conditions in July are too severe even for sustained light work. This should be interpreted as meaning that approximately half the days are less severe than the average, and on the most severe days work can be done for periods somewhat shorter than 8 hours.

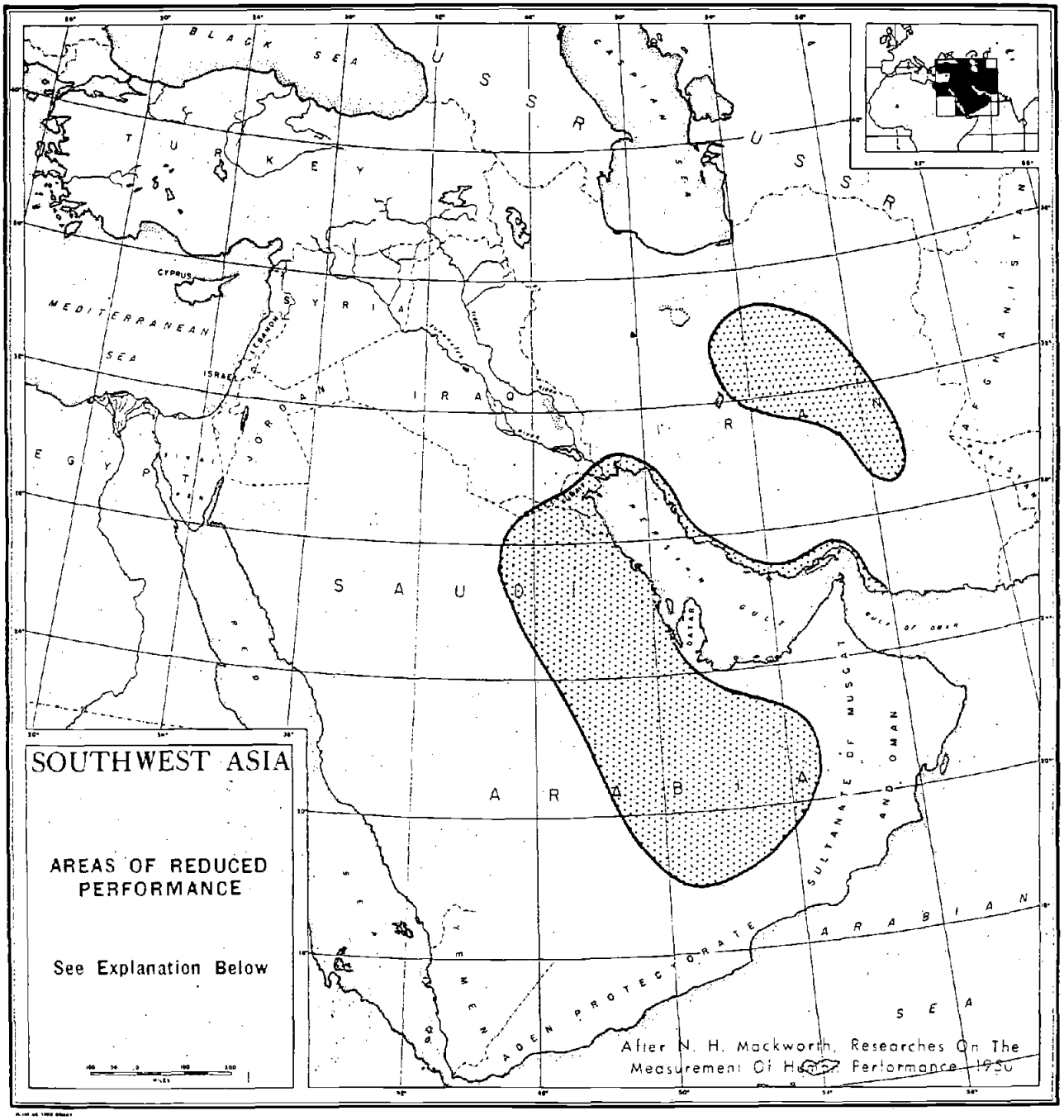


Fig. 11: This map shows areas where the performance of men doing light skilled tasks will be reduced by about 25 percent. This is not necessarily a decrease in the amount of work done, but rather an increase in number of errors. For example, a competent radio operator located in one of the stippled areas on an "average" day in July will make 25 percent more errors than he would if the temperature were 85F and the relative humidity 63 percent. If the operator, however, is highly skilled, he probably will suffer little or no performance decrement under the severe conditions.

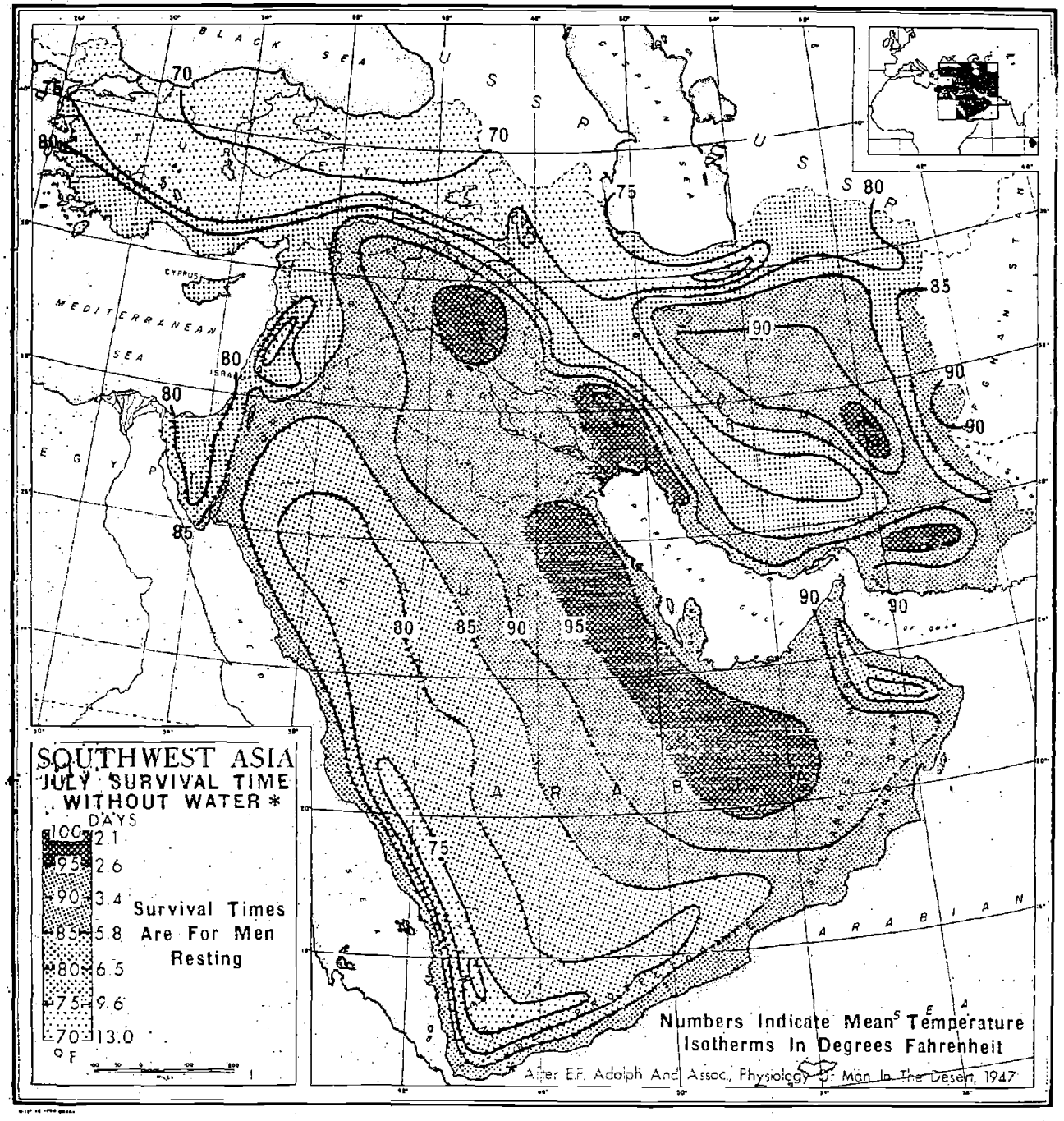
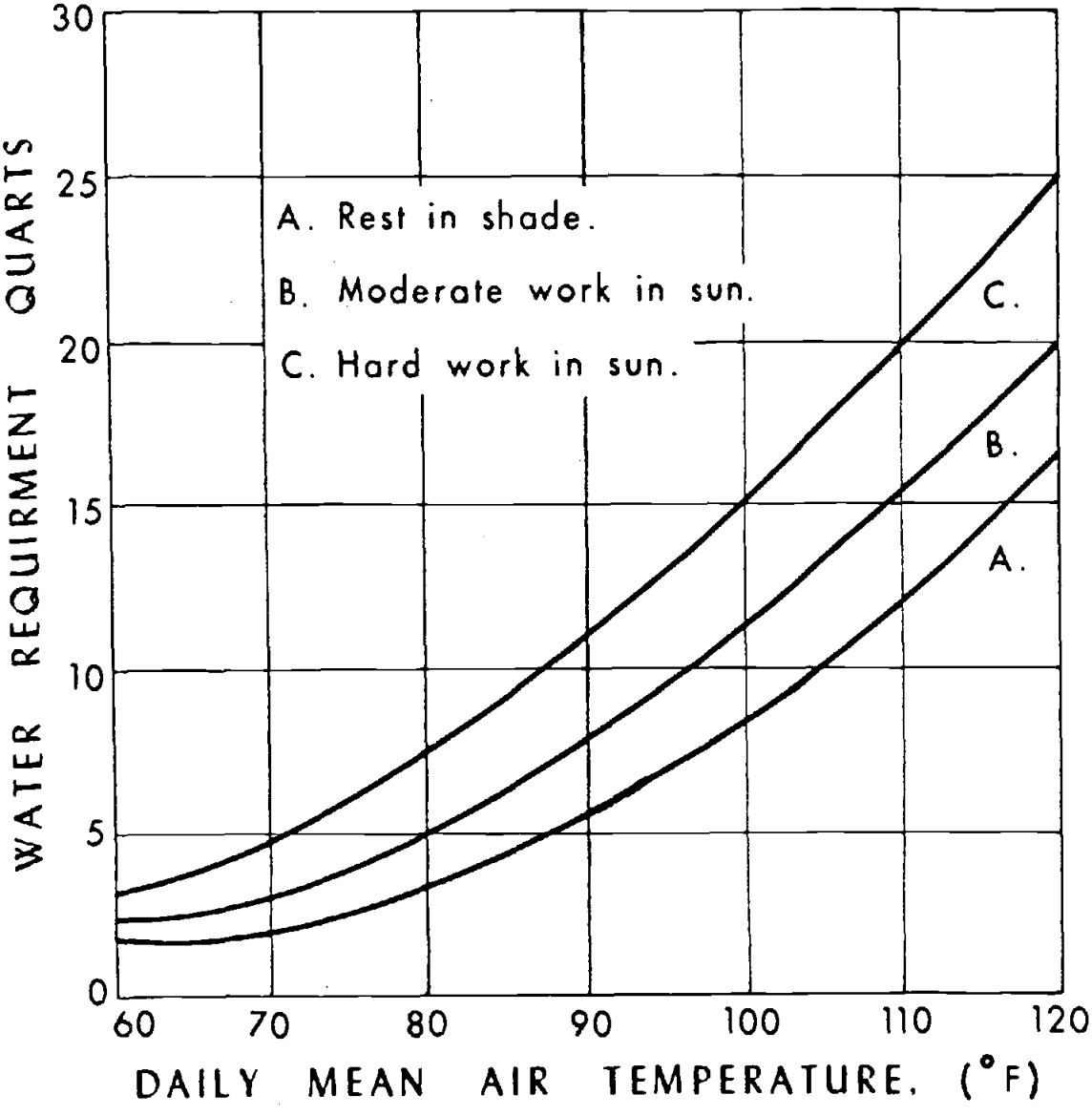


Fig. 12: This map shows the predicted survival time for resting men when drinking water is not available. Survival is not considered likely when body water loss exceeds 20 percent of body weight (about 14 quarts). Because survival time is influenced both by the air temperature and by activity level, anyone involved in a survival situation should avoid all unnecessary physical activity and seek shade in the daytime. Necessary activities should be carried out at night.

DAILY WATER REQUIREMENTS FOR THREE LEVELS OF ACTIVITY



Graph 1: This graph shows water needs, in quarts per day, for men at three activity levels in relation to the daily mean air temperature. For example, if one is doing 8 hours of <u>hard</u> work in the sun (Curve C) when the average temperature for the day is 100F (Horizontal Scale) his water requirements for the day will be approximately 15 quarts (Vertical Scale).

APPENDIX A

REFERENCES

1. This manual is only an introduction to the influence of weather and terrain on desert operations in the Mideast. This appendix lists publications with additional information. Some of these manuals provide technical information such as how to determine soil types. Other manuals and books are military histories which record the interaction of weather, terrain, equipment, and personnel. These histories help Marines to understand how the technical information can be exploited.

2. Publications with prefix control numbers (PCNs) are stocked at the Marine Corps Logistics Command, Albany, GA 31704-5001, and can be ordered through the supply system. See section 3 of chapter 3, MCO P5600.31F, Marine Corps Publications and Printing Regulations, for instructions on ordering these and other publications.

3. Publications of other Services which are not stocked at Albany, GA may be ordered by following the instructions in paragraph 3300.8 of MCO P5600.31F and in chapter 11 of MCO P4400.84C

4. Operational Handbooks are stocked at the Marine Corps Combat Development Command. They can be ordered from the Commanding General (WF12), MCCDC, Quantico, VA 22134-5001. To order by telephone, call AUTOVON 278-3610/8, commercial (703) 640-3610/8.

Marine Corps Publications

FMFM 7-11H	Field Behavior of NBC Agents PCN: 13971180000
FMFRP 12-3	Artillery in the Desert PCN: 14012030000
FMFRP 12-4	Battlefields of the World War PCN: 14012040000
FMFRP 12-5	Combat Support in Korea PCN: 14012050000
FMFRP 12-6	Commentary on Infantry Operations and Weapons Usage in Korea PCN: 14012050000
FMFRP 12-8	Topography and Strategy in the War PCN: 14012080000
FMFRP 12-16	Front-Line Intelligence PCN: 14012160000
FMFRP 12-20	Naval Reconnaissance PCN: 14012200000
OH 0-3A	Operational Effects of Terrain and Weather

OH 0-51 Small Unit Leader's Guide to Weather and Terrain. This manual discusses the basics of terrain and weather; e.g., types of terrain features, observation, importance of high ground, fields of fire, terrain considerations when establishing boundaries, reverse slope defense, and sources of information on terrain and weather.

OH 0-52 Remote Sensing Field Guide, Desert: A Guide to Analysing Desert Landforms. This discusses analyzing desert landforms if one is remote from them; e.g., is studying a sand dune in an aerial photograph.

OH 0-53 Afoot in the Desert. A guide to survival in desert regions.

OH 0-54 The Persian Gulf Region, A Climatological Study.

OH 0-55 Desert Water Supply. A 1982 study.

OH 0-56 Southwest Asia: Environment and Its Relationship to Military Activities.

OH 0-57 A Study of Windborne Sand and Dust in Desert Areas.

OH 0-58 Problems in Desert Warfare.

OH 0-60 General Design and Construction Criteria for Kuwait. This is a 1968 report prepared by the Corps of Engineers.

Other Publications

FM 5-30 Engineer Intelligence PCN: 32000516000

FM 5-36 Route Reconnaissance and Classification PCN: 32000524000

FM 5-100 Engineer Combat Operations PCN: 32000525000

FM 5-101 Mobility PCN: 32000525100

FM 5-102 Countermobility PCN: 32000525200

FM 5-103 Survivability PCN: 32000525300

FM 5-104 General Engineering PCN: 32000525400

FM 5-335 Drainage PCN: 32000603300

FM 5-530 Materials Testing PCN: 32000604000

FM 5-541	Military Soils Engineering PCN: 32006050000
FM 21-26	Map Reading PCN: 32002124000
FM 21-31	Topographic Symbols PCN: 32002128000
FM 21-75	Combat Skills of the Soldier PCN: 32002140000
FM 21-76	Survival PCN: 32002142000
FM 34-3	Intelligence Analysis PCN: 320033090000
FM 34-81	Weather Support for Army Tactical Operations
FM 34-130	Intelligence Preparation of the Battlefield PCN: Not yet assigned.
FM 90-3	Desert Operations PCN: 32008300000 The basic desert manual
FM 90-6	Mountain Operations PCN: 32008340000
FM 90-13	River Crossing Operations PCN: 32008375000
FM 101-5-1	Operational Terms and Symbols PCN: 32010112200
TM 5-545	Geology PCN: 34600155000
DA PAM 20-236	Night Combat PCN: 30500691700