Study Guide:
Search and Rescue
Field Certification

New Mexico
Department of Public Safety
Search and Rescue

March 1, 2016 Standards
Policy Advisory Committee on Education (PACE)

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Introduction

New Mexico has one of the few Search and Rescue (SAR) programs organized at the State level. The State passed the NM SAR Act (NMSA 1978, 24-15A-1 to 24-15A-6, et seq.) in 1978, and the NM SAR Plan was developed to implement the Act. The Field Certification process is a result of a requirement in both the SAR Act and Plan. These requirements pertain to all kinds of SAR teams found in the State:

- Foot teams, all kinds, including canine teams;
- Vehicle teams, including all-terrain vehicles, snowmobiles, four wheel drive vehicles, and mountain bikes;
- Horse teams;
- Technical rescue teams; and
- Cave rescue teams.

FIELD CERTIFICATION

The Policy Advisory Committee on Education (PACE) was chartered in 1969 to develop a set of Field Certification standards for New Mexico SAR volunteers. The actual Certification process and requirements have been revised slightly over the years, and this *Study Guide* and written test on that material were extensively revised in 2006.

The Certification consists of four parts:

1. Successful completion of the following Federal Emergency Management Administration's IS-100.b – (ICS 100) Introduction to Incident Command System and IS-200.b – (ICS 200) ICS for Single Resources and Initial Action Incidents
2. A gear and clothing check
3. A compass field test
4. A written test on the material in this *Study Guide.*

The study materials for Certification, as well as the NM State SAR Act and Plan, are available from the New Mexico SAR Resource Officer (505-841-9297). They are also provided on the Field Certification section of the New Mexico Search and Rescue Council (NMSARC) website, currently at www.nmsarc.org. (That website also contains SAR Guidelines developed by the NMSARC for specialty teams and functional disciplines, such as technical rescue, ATV and snowmobile, and ski and snowshoe. Developed by experts in these fields, these are simply guidelines and not requirements. Other Guidelines are under development.)

Complete the IS-100.b and IS-200.b requirements for Field Certification online and bring your proof of completion to the test. Please note that we do not need a copy of your proof of completion, we only have to look at it.

This *Study Guide* provides an introduction to key elements of search and rescue work and strives to ensure you are prepared to undertake that work safely.

- The gear and clothing lists were developed from SAR standards across the country – they are the minimum equipment required for survival in the field for at least 24 hours. While your team may require additional gear and/or clothing, the minimum equipment in this *Study Guide* ensures the search mission Incident Commander that you are safely ready to enter the field.
- The other information in the *Study Guide* gives you the basic knowledge and skills to complete your assignment. You and your team should train on these basic and other more advanced skills.

Note that the *Study Guide* covers only the most basic and general medical information (signs and symptoms) and treatment (e.g., for heat illnesses, get the patient into the shade). It also stresses getting ill or injured people to medical assistance as soon as possible. Of course, having trained and/or licensed medical personnel on your team will allow advanced first aid to be performed.

CERTIFICATION PROCESS

The Certification process consists of the following steps:

Prepare yourself for the Certification test

- Prepare your gear and clothing per the lists in this *Study Guide*.
- Practice using your compass.
- Study the material in this *Study Guide*.

Bring materials with you to the Certification session

- IS-100.b and IS-200.b Certificates
- Gear and clothing (as listed in this *Study Guide*),
- Two writing utensils.

At the test site

- Once at the test site, acquire and complete the upper portion of the SAR Certification Record form and the *Study Guide* Written Test Answer Sheet/Gear and Clothing Checklist form.
- Listen to the Evaluators' instructions.

Complete the four parts of the Certification test

1. Present proof of IS-100.b and IS-200.b completion

2. Gear and clothing check

- Display your gear and clothing for the Evaluator; you must show all the required gear and clothing. (See *Chapter 1: Gear and Clothing* for the appropriate lists.)
- A passing grade is 100%.
- Failure to pass this portion ends your participation in this Certification session.

3. Compass field test

- You will be asked to give a true and/or magnetic bearing on one or two landmarks. (To prepare yourself, see *Chapter 5: Map and Compass.)*
- A passing grade is 100%.
- Failure to pass this portion ends your participation in this Certification session.

4. SAR Field Certification (*Study Guide*) written test

- This test – which is **not** open book – has five sections:
  - Gear and Clothing
  - Communications
  - Safety in Search and Rescue
  - Search Techniques
  - Map and Compass.
- When you've finished all sections, bring the answer sheet and test booklet to the grading table.
- Passing grade for each section is 70%.
- Failing two or more sections of this test ends your participation in this Certification session. However, if you fail only one section, you may immediately take another test on that particular section. A passing grade for this makeup exam is 70% and failure to pass it ends your participation in this Certification session.

Accept congratulations and receive your patch

- Turn in your completed SAR Certification Record form, all answer sheets/checklists, and tests, if you have not done so already.

- If you have successfully passed all three parts of the Certification test, receive your patch. To obtain a SAR Identification Card, visit http://www.dps.state.nm.us/index.php/search-rescue/search-rescue-id-request/.

Resolve any issues you may have

During your testing session, you may have a complaint or dispute. The Evaluators will make every attempt to resolve it at the test site. But, if your issue is not handled to your satisfaction, please feel free to contact the New Mexico SAR Resource Officer at 505-827-9228.

ARRANGING FOR A CERTIFICATION SESSION

One Certification session will be held each year at the New Mexico Search and Rescue Council's annual SAR conference. Any person who wishes to be responsible for arranging a time, place and date for an evaluation session must coordinate first with a Lead Evaluator (a Type I, II, III or IV Field Coordinator) in their district, then with the SAR Resource Officer (Robert.Rodgers@state.nm.us) and the PACE Chairman (FMulholl@cybermesa.com). After receiving approval from the SAR Resource Officer and PACE Chairman, the Session Coordinator may then advertise the session.

Chapter 1: Gear and Clothing

This Chapter covers the following topics:

1. Gear and Clothing – Introduction
2. Gear and Clothing Lists
3. Clothing
4. Gear
5. Gear – Not Required

1. GEAR AND CLOTHING - INTRODUCTION

Scenario: During a search in New Mexico, a searcher may be asked to hike up to ten miles on a search lasting one operational period (up to 12 hours) in an unfamiliar area on flat or in mountainous terrain, at temperatures between 10 and 110 °F, at an altitude between 3,000 and 10,000 feet. This means that, a searcher must be prepared for anything!

Many factors affect your decision about what gear to carry and what clothing to wear on a specific mission. These include weather (current, predicted, and possible), terrain, the number and possible condition of subjects, the length of time you may be in the field, and what you need for your own comfort and safety. The limits to what you can carry are how much your pack will hold, the weight you can safely and comfortably carry, and common sense.

The minimum survival gear required for search and rescue missions is spelled out in the gear and clothing lists below. Each person on a search team should carry all of the gear on the list. In addition, the team should share the weight of items such as radios, stoves and fuel, cook kits (or at least cups that can be heated), medical supplies, and shelter (see the last section of this Chapter). Remember, always know how to use your gear and equipment before you go out into the field.

Most search areas are isolated, so you must supply your own equipment, food, and water, especially at the beginning of a mission. As a mission lengthens, some supplies may be brought out to teams that have stayed out in the field, if necessary. If in doubt about whether to bring specific equipment, bring it to Incident Base and decide there what you need to take into the field.

Each searcher must carry personal drinking water. All water from streams, rivers, or lakes in New Mexico most likely carry Giardia, a micro-organism you do not want in your system. Giardia causes diarrhea, stomach cramps, nausea, and other gastro-intestinal symptoms. These symptoms can lead to dehydration and weight loss. (Should you have to use water from these sources, purify it with iodine or use an appropriate filter. Also, water may be boiled for 30 seconds per thousand feet of elevation above sea level.)

Remember, weather changes quickly, and you need to be prepared to protect yourself from almost anything. A search route may not end up as planned – you could be diverted to another area because of clues, to help with an evacuation, or to support another team. What appears in Incident Base to be a straightforward route requiring four hours to cover can turn into an overnight trek at a moment's notice. Be prepared!

2. GEAR AND CLOTHING LISTS

These lists are intended to cover only the basic survival equipment needed to respond to SAR missions. Detailed descriptions of all items follow in Section 3. (Unless otherwise noted, you should bring all these items with you to the Certification session.)

Clothing

- Sturdy hiking boots
- Sturdy work gloves
- Head cover(s)
- Gloves and/or mittens
- Socks (and extras)
- Layer Clothing
    - Inner layer (basic underwear, long underwear – bottoms and tops)
    - Middle layer(s) for warmth (bottoms and tops)
    - Outer layer for wind and water protection (bottoms and top with hood)

Note: Although cotton and cotton-blend clothing may be included in a summertime pack, each candidate for Certification must also have non-cotton/cotton blend clothing inner layers as described in this Chapter.

Gear

- Pack or container to carry/hold the required gear and clothing
- Eye protection
- Food for 24 hours
- Water (2 quarts minimum) [1]
- Knife
- Fire starter
- Compass with 5 degree accuracy
- Map of search area[2]
- Whistle
- Signal mirror[3]
- Light source (flashlight or headlamp, plus extra batteries and replacement bulbs)
- Personal first aid kit
- Space blanket
- Pencil or pen and paper
- 20 ft of 1 inch tubular webbing or 20 ft of 8mm climbing/rescue cord (kernmantle construction)

[1] *Only the water containers need to brought to the Certification session*
[2] *A map does not have to be brought to the Certification session*
[3] *Glass or mil-spec plastic with mesh around sighting hole*

3. CLOTHING

Sturdy Hiking Boots

Hiking boots are designed for walking long distances over rough terrain. Work boots or cowboy boots are not suitable. Even horseback riders wearing boots with heels need to have another appropriate hiking pair in their saddlebags, just in case. Searchers in vehicles and those flying in aircraft during a mission should also be prepared for an unexpected hike.

Considerations when choosing hiking boots include comfort and fit, ankle support, and sole thickness. Boots should be waterproof as well. (Remember, try on boots with the socks you will wear on a mission.) Leather boots will keep out cactus spines that the lightweight uppers, such as Gore-Tex or Cordura on many popular (and expensive) hiking boots, will not. A sturdy leather boot will also protect your feet from the sharp rocks found in desert areas and lava fields.

Hiking boots are required for certification but on SAR missions, the appropriate footwear needs to be considered for the assignment. Appropriate footwear should in all cases protect the wearer from the environment and be suited for the task at hand. An example would be climbing shoes. Climbing shoes are not designed for hiking, but are suitable for climbing on rocks when such an event needs to occur.

Flip-flops, sandals, 5 toe shoes and other open toe footwear are not permissible for certification or to be used by personnel on SAR incidents. If you are working at the Incident Base, you choice of footwear may seem feasible for operating at the IB, but are you prepared to work in the field if the need arises? You also need to consider the image portrayed to the public by you and other SAR responders. Dress professionally and start with the choice of footwear.

Sturdy Work Gloves

Leather or leather palmed gloves are recommended for protection when traversing steep or brushy terrain, for assisting with a rope rescue, or when carrying a litter. These work gloves are not a substitute for the gloves required for warmth.

Head Cover(s)

As the saying goes, “If your hands or feet are cold, put on your hat”; because most body heat is lost through the head. Be sure your hat protects all of your head (no ‘visors’) and can shade your face, ears, and neck from the sun. Hard hats are vital when doing any rock work, when performing a cave rescue, or any time you are around a helicopter. Wool and synthetics work best in cold weather.

Gloves and/or Mittens

Hands typically will be warmer in mittens than in gloves because the bare fingers keep each other warm. Layers often work well to keep your hands warm and dry. Wool and synthetics, possibly with a wind/waterproof shell, work best.

Socks

Cotton socks are not suitable for hiking, even in the summer. They are more likely to cause blisters and they conduct heat out of your feet when wet – a possibly serious situation if you must spend a cold night

out. Wool is very comfortable, gives good cushioning, stays warm when wet, and dries quickly. Polypropylene works well, but it is better as a thin inner sock than as a thick outer.

An ideal hiking sock combination is one inner pair of thin nylon, polypropylene, silk, or wool, and one outer pair of medium weight wool (hiking sock thickness). A second set of clean dry socks in your pack (in a plastic bag to keep them dry) is required.

Layers

Layering is a basic principle used for search and rescue clothing. It gives you the flexibility to adapt to changing weather and differing activity levels by allowing you to remove or add clothing. It is best to have many layers to mix and match to get just the right comfort level in different conditions, especially when hiking.

The trick is to keep warm enough without sweating and getting wet from the inside out. The layers include an inner layer (basic underwear and long underwear), warm middle layers, and an outer layer for wind/water protection.

Anywhere in New Mexico, at any time of year, you may need to protect yourself from hypothermia, a serious decrease in body temperature at which normal muscular and cerebral functions become impaired. (See a more detailed explanation of hypothermia in *Chapter 3: Safety in Search and Rescue*.) Even though you may be part of a four-wheel drive or horse team and believe that you will never be on foot, unexpected things happen. This Certification Program is based on the principle that all searchers must be prepared for the unexpected.

To pass the gear and clothing check section of this Certification, you must:

- Have silk, synthetics, wool or other non-cotton/cotton blend for the inner layer (next to your skin),
- A middle layer to maintain warmth, and
- A breathable wind/water protective outer layer.

You may have cotton/cotton blend in your pack, but you must be able to replace it with dry clothing if it gets wet.

Inner layer

Wool is a wonderful material for the inner layer. It keeps its warmth when wet, is durable (especially in a blend with a little nylon, which also foils moths), and is relatively inexpensive. Polypropylene (polypro), Capilene, Thermax, Polartec 100, and others are called 'hydrophobic' materials (water-hating). They are almost as warm as wool, wick perspiration away from the body better than wool, and dry quickly. Polyester works also and is inexpensive. Silk, while expensive and significantly less warm than wool, both wet and dry, is acceptable, and is often used as a layer under wool.

If these materials are not used as an inner layer (including using these materials for your basic underwear) you could find yourself in a life threatening situation if you get wet and the temperature drops.

Remember, wet cotton/cotton blend clothing (even just damp from perspiration) must be removed before any dry layers are added. Otherwise, the inner layer can set up a hypothermia situation that endangers you and the whole team. If it is cold enough to need long underwear, it is too dangerous to be wearing cotton/cotton blends next to your skin. You can purchase Cool-Max, polypro, and silk t-

shirts which are comparable in coolness to cotton/cotton blend t-shirts, but which do not need to be removed when layers are added.

Middle layer

The middle layer (for warmth) can be wool, polar fleece, and other synthetics. Acrylic knits (e.g., Orlon) are inferior but acceptable. Down loses its loft when wet and is then useless to provide warmth, so do not depend on just a down parka to keep you warm. You should have several middle layers (only one is required for this Certification) of different weights, instead of one very warm layer; this allows for even more layering as the temperature and your activity level changes.

Outer layer

The outer layer should be appropriate to the weather. A hooded, unlined (so you can use it in the summer) shell with lots of large, weather-proof outer pockets, some inner pockets, and a full two-way zipper with a weather flap is the most versatile. The shell should be loose fitting for freedom of movement and should extend down past the hips. Zippered vents under the arms are useful for ventilation. Wind, waterproof, and breathable pants are best for full protection against the wind and weather. Ideally the pants should have a two-way full-length zipper down the outside of the legs or at least a zipper part way up the leg.

A waterproof rain covering that is not breathable (a poncho, for example, of coated nylon) will keep perspiration in, causing you to get wet from the inside, so carefully consider ventilation. A good addition to a poncho for leg coverage is rain chaps. A poncho is usually large enough to cover your pack. This type of rain gear can also be used as a temporary emergency shelter if forced to seek shelter for a short while.

Breathable fabrics, such as Gore-Tex, are designed to let perspiration evaporate while keeping rain out. The good quality garments are expensive. Wash them exactly as the manufacturer suggests, or you could lose the waterproofing.

Whatever you use for the outer layer, a hood attached to your jacket/shell is required to keep your head warm and dry. If you wear a helmet frequently, the hood should be large enough to go over the helmet.

Clothing in Hot/Arid Climates

Most reference materials on proper clothing for search and rescue missions concentrate on staying warm in wet, cold, or windy conditions, thus avoiding hypothermia. However, in many areas of New Mexico, we need to consider the proper clothing to wear in the field when the temperature hovers near 100 degrees and the primary concern of searchers should be avoiding hyperthermia (overheating), which can be deadly.

The very factors that make cotton/cotton blend clothing dangerous in the cold can make it an appropriate choice for hot climates. Its breathability is an asset in these conditions. Cotton will absorb moisture from perspiration quickly and wicks moisture from damp or wet areas to dry areas. Cotton dries slowly because the fibers get completely saturated and can aid the cooling of the body by evaporation. Cotton's heat conduction when wet nearly equals complete immersion in water.

In hot environments, wear loose fitting clothing to allow air circulation, which will promote cooling. Light colored clothing will reflect heat and help maintain temperature balance. Long sleeves and pants not only help protect you from sunburn, heat gain and water loss, but also protect from some vegetation (cactus, catclaw and mesquite), wind-borne sand and the inevitable contact with abrasive rock. Resist

the urge to remove clothing in severe heat; clothing reduces the evaporation rate and helps to slow the body's water loss.

Shorts are not appropriate on any search mission, whether you are in base camp or in the field. A dense cloth, such as denim, will protect against cactus and abrasive rock better than a thinner or more pliable cloth.

Do not, however, ignore the potential for quick weather changes in the desert southwest. Monsoon rainstorms can bring rapid and significant drops in temperature, as does nightfall. Be sure that the extra clothing in your pack will handle these situations. Lighter weight versions of cold weather clothing (wool, polar fleece, etc.) are a great choice.

4. GEAR

Pack or Other Container

All searchers need something in which to carry their gear and clothing. For example, searchers on horseback should have emergency gear on their person (in a fanny pack, in clothing pockets, etc.) in case the horse runs off with their saddlebags. It is also important to carry emergency gear on your body if you are in a helicopter (e.g., as an observer or being transported to your assignment). A vehicle driver or passenger should have a duffel bag or similar container which could be easily carried if a walkout were necessary. Hiking ground-pounders need a backpack.

Backpacks may have internal or external frames. Your pack needs to be large enough to carry all required gear and clothing and any additional equipment you may need to help you care for yourself, your teammates, or the subject(s), if necessary. Save room for gear that will be shared among the team (shelters, fuel and stove, etc.).

The pack must be comfortable to carry when well loaded. If it just hangs on your shoulders, it will not be comfortable after a few hours. Most of the larger capacity models have well-designed suspension systems that distribute the weight down your back, over the hip, and across the chest with a sternum strap.

Whatever pack you carry, consider a padded hip belt and a sternum strap. If your pack lacks either of these, they can be purchased separately and put on your pack. Experiment to make sure it is comfortable when fully loaded. The fancier packs have many possibilities for adjustment and you may want to fiddle until you make it comfortable for you – especially making sure that the weight does not hang mainly from your shoulders but is taken on the structure of the pelvis.

Eye Protection

Ideally, some form of eye protection should be worn at all times (day and night), especially when navigating through brush or trees and when blowing snow and/or sand is present. Sunglasses affording UV protection are needed in sun and many snow conditions. Also, goggles are needed when working around helicopters.

Food for 24 Hours

Food requirements vary from person to person. Everyone’s metabolism is different. What kind of food you carry will depend on your tastes. Some people can do well with several Powerbars in a 24 hour period, but others need ‘real’ food. Medical conditions, such as diabetes, also play a role in how much and what kind of food you need.

You need to know your own body's requirements, learned from experience. On average, males aged 19 through 50 will need about 2300 calories per day if doing light day-to-day activities, but will need 3000 to 4000 calories per day if doing three to five hours of vigorous exercise in addition to the day-to-day activities. Foods high in sugar should not make up the bulk of your food supply. Food should have a ratio of 30% fat (with 10% or less of the fat being saturated and trans fat) to 40% - 60% carbohydrates to 10% - 30% protein. When exercising, you may lean towards the 60% carbohydrates and 10% protein.

Eat often while searching. Don't let your energy level fall. Carry plenty of food that tastes good, is nutritionally good for you, is lightweight, and will not spoil.

Water

Two quarts of water for a 24 hour period is the minimum required for this Certification. (For the Certification test, you do not have to bring the actual water, just having the containers will do.) As with the food requirement; you need to be familiar with your body's water requirements, both at rest and when exercising. Some people perspire more than others and therefore need more water.

On average, doing day-to-day activities, you lose about 48 ounces of water through urine production and another 24 ounces through perspiration and respiration. Some fluid is replaced from eating (e.g., from fruits and vegetables) and from drinking beverages other than water (avoiding alcoholic and caffeinated beverages). The rest of the lost fluid should be replaced by drinking water.

Obviously, exercising increases fluid loses. For example, you can lose an additional 24 ounces of fluid while running five miles and 33 ounces during a one hour bike ride. Two quarts of water will not be enough in very hot and dry conditions. Hard exertion in these conditions can cost upwards of two quarts of water in one hour. Seriously consider carrying as much water as is practical. We recommend you carry one or two gallons if you are searching for two to four hours in hot/dry weather. Drink often while you are searching. Do **not** wait till you are thirsty. (Also see *Chapter 3: Safety in Search and Rescue*.)

Knife

A knife can be useful in many situations, from using the knife while eating to cutting rope/cord to assist in making an emergency shelter. A standard folding knife with a three or four inch blade will suffice for the Certification. Many searchers carry a multi-tool (e.g., Leatherman-brand tool).

Fire Starter

The simplest fire starter is a match. Some searchers carry butane lighters. Others have the 'flint and steel' type fire starters. Having some sort of kindling (e.g. wax impregnated cardboard or pieces of fireplace log starter) will enhance your ability to start a fire quickly. Of course, keeping your fire starter and kindling dry is essential.

Compass

A compass with 5° accuracy is required, and one with a sighting mirror is recommended. (For a discussion on compass use, see *Chapter 5: Map and Compass*.)

Map of Search Area

Avoid going into the field without a map of your search area. For more on what maps we use and how to work with maps, see *Chapter 5: Map and Compass*. (A map does not have to be brought with you to the Certification session.)

Whistle

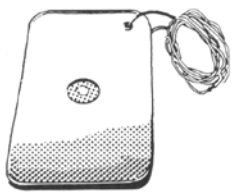
A whistle is used as a signaling device. It can be used as a signal in an emergency situation or can be used as a sound attraction device while searching. A good quality, sturdy, loud whistle is recommended. Metal whistles should be avoided as their use in cold, winter conditions is problematical.

Signal Mirror

The military style signal mirror is the most basic and best all-around signaling device. Compact and simple to operate, it has been used successfully for many rescues. This type of mirror is required for Certification. While any shiny object can and has been successfully used for signaling, a mirror especially designed for signaling and sighting is generally brighter and much easier to aim.

In normal sunlight, the flash from a 2-inch by 3-inch signal mirror can be seen easily for ten miles while the flash from a 3-inch by 5-inch mirror will be visible up to 30 miles, depending upon atmospheric conditions. A mirror will work on bright overcast days and with moonlight, though with much-reduced range.

The 2-inch by 3-inch size (standard, small military specification size) works adequately, and the convenient size and weight is an asset for ground-pounders.



To use a signal mirror, reflect sunlight from the mirror onto a nearby surface (your hand, a tree, etc.). Slowly bring the mirror to eye level and look through the sighting hole. You will see a bright spot – called the fireball – within the surrounding mesh. This is the aim indicator. Hold the mirror close to your eye and slowly turn it so that the fireball is on the target. Manipulate the mirror up and down rapidly to flash the target.

Once the target indicates your flash has been spotted and turns toward you, do not keep the mirror on it continuously, because the flash can be blinding. Continue flashing periodically until the target arrives and indicates you have been visually located.

Light Source

At least one source of light is required. A headlamp or flashlight, with extra batteries and bulbs, will satisfy this requirement. When working in a cave, three sources of light may be required.

Personal First Aid Kit

Every searcher needs to carry a personal first aid kit. This kit contains the medications you normally take and simple first aid supplies (Band-Aids, blister prevention pads, tape, gauze pads, etc.). This kit is not meant to be used for subject care. Your team may elect to carry a separate, larger first aid kit for this purpose.

Space Blanket

A silvered Mylar plastic space (or emergency) blanket can be very useful if you have to stay out overnight unexpectedly. Occasionally the heavier type of space blanket can be used as an emergency shelter during a change of weather or as protection from the sun. This space blanket is meant for the searcher, but it can be used for the subject if necessary. Make sure you check your space blankets a few times a year and replace them if needed.

Pen or Pencil and Paper

The pen/pencil and paper has many uses. Some examples are: making notes during your team briefing; leaving a note for the subject if you find a camp; or making a list of clues and their location. Remember that the ink in a pen may freeze in the colder months, so have a pencil as a backup.

20 feet of 1-inch Tubular Webbing or 20 feet of 8mm kernmantle cord

The webbing can be used when assisting in a litter evacuation of an injured subject or for making an emergency seat harness. It can also be used when making an emergency shelter or securing items to your backpack, among other uses. Make sure your webbing is tubular for strength. To determine if webbing is tubular, squeeze the tubbing between two fingers at the edges. It should form a "tube" when squeezed with no seam.

The 8mm cord can be used for almost all the same applications as webbing, but does not fray as easily as webbing might. Cordage has an inner core that is covered by a protective layer called the sheath. The strength of cordage is from the inner layer so if the outer protective layer is frayed, the strength of the cordage is not lost, unlike webbing which loses some of its strength when frayed. Tensile strength of some cordage may be less than some webbings available but will perform quite well for non-technical SAR usage.

5. GEAR – NOT REQUIRED

Some gear is not required for survival, but would be good to have with you in the field, or at least, with your team. A few of these items are:

- Radio and spare batteries – a minimum of one radio per team, two would be better. (This item is not required for survival, but is required before you will be allowed into the field. You may have your own radio or may use team-owned radios.)
- Watch – used for taking vital signs, arriving at a rendezvous on time, estimating your distance, for radio check-in times, and knowing when to return to Incident Base.
- Larger first aid kit (one per team) – used to assist your team members and/or the subject.
- Sunscreen and lip balm with sunscreen – protect skin and lips from UV rays.
- Bandana – used for a bandage, a cool cloth on the forehead, sun protection for the back of the neck, and face protection in blowing sand.
- Shelter (tent, bivvy sack, or tarp) – used for protection from the environment.
- Lightweight snow shovel – used to make a snow shelter.
- Stove and fuel (one per team) – used to make warm/hot food or drinks.
- Trail tape – used for marking clues and search areas.
- Sleeping bag and pad – used to keep warm and comfortable if staying in the field overnight; pad is used for insulation from ground temperature and moisture.
- GPS receiving unit with spare batteries – used for transmitting locations to Incident Base (such as for you, the subject, clues), used for navigation.
- Toiletries – toilet paper and other personal items.
- Identification – may be needed when approached on a search by citizens or Law Enforcement (a team ID and driver's license would be best).
- Gaiters – protects lower legs from brush, cactus, and moisture.
- Pack rain cover – protects the gear in your pack from moisture.

You and your team should develop a team-required gear list. Include the required Field Certification gear and clothing and add items from the list above and others as you see fit. Do gear and clothing checks once or twice a year (possibly at the beginning of fall/winter and spring/summer) to ensure that you and your team members have all the required gear.

Chapter 2: Communications

This Chapter covers the following topics:

1. Introduction
2. Field Communications
3. Using Two-way Radios
4. Special Situations
5. Summary

1. INTRODUCTION

Nothing is quite as critical to a search and rescue operation as good communications. Without communications, we would be unaware that someone was in trouble in the first place. We would be unable to get our teams together to respond. And, without communications, we could not coordinate the mission or direct the responders, and we couldn't call home our teams at the conclusion of the mission.

Despite all the modern advances in telephone and radio equipment, by far the most efficient communication method is face-to-face. Not only is the verbal message conveyed, but the non-verbal message is sent as well. The look of anxiety, doubt, or puzzlement on a person's face speaks volumes. The shifting of eyes can communicate that the person is concealing information or lying. Crossed arms or fidgeting hands can provide clues to a person's state of mind. Eyes looking off in the distance or frequent shifting of the feet can indicate the person is distracted and not paying full attention.

Much of this information is not processed at a conscious level, but the subconscious mind is taking note and providing us with a gut reaction. This silent feedback is vital when interviewing the reporting party, but is totally lost in any other form of communications. (Also see *Chapter 4: Search Techniques* for discussions about fact-finding, investigation and field briefings.)

Whenever possible, interviews about a lost subject should be conducted face-to-face. People have many different reasons for concealing information. This is much more likely to be detected if the report is taken in person. Taking such reports over the phone can result in wasting valuable time because you were given incomplete or inaccurate information. Additionally, this personal interaction is two-way and the interviewer's expression can convey empathy, calm the subject, and draw out additional information.

Many people also feel more comfortable talking face-to-face rather than to a disembodied voice on a telephone or radio. Unfortunately, the initial communication on a mission is usually on the telephone (initial call from the State Police, the call-out made by the Incident Commander, etc.).

Before going into the field, you and your team should be briefed face-to-face. Once again, the non-verbal communications are important in determining whether you are really paying attention and understanding your assignment.

2. FIELD COMMUNICATIONS

Unfortunately, when dealing with many people scattered over a large area as in a search, face-to-face communication is not always practical. Other less efficient means must be used. These means can range from the high-tech, such as cell phones, satellite phones, and radios to the low-tech, such as leaving notes, sending runners, using a signal mirror, blowing a whistle, or flashing lights.

Cellular Phones

While cell phones have gained wide acceptance for communication in most areas, they are of limited value in search and rescue. Cell phones require the use of relatively closely spaced cellular towers to provide continuous coverage. These towers and their associated equipment are quite expensive. For this reason, they are placed only in areas that will see a lot of cell phone usage, such as in cities and along major highways. Coverage in remote areas where a search is likely to occur is spotty at best. If cell phone communications are necessary, try going uphill so that you may be within line-of-sight of a cell tower.

If you are involved in a large, long-term incident and cellular coverage is critical, a Cellular On Wheels (COW) unit may be requested by the Incident Commander (IC). These units are trailer mounted cell sites designed to provide short term cell phone coverage to a specific area. Many cell companies have COWs available as a public service for emergencies and large special events; however, most searches are not large enough or long term enough to justify using a COW.

Satellite Phones

While relatively expensive to use, satellite phones can provide coverage to areas not served by cell phones. However, these phones also have limitations. They must have a clear field of view to a relatively large area of sky. They are not useful from the bottoms of deep, narrow canyons or in areas with dense tree canopy.

Satellite phones are available from the State and can be requested by the IC. Some specialized SAR communication teams and other agencies (like the Forest Service or the National Park Service) may also have access to satellite phones.

Radios

The vast majority of communications within an incident occur on two-way radios. Depending on the incident, these communications may be conducted over the state SAR radio frequencies, amateur radio frequencies, Family Radio Service (FRS) and General Mobile Radio Service (GMRS) frequencies, agency radio frequencies, individual team frequencies, or others.

When you are contacted for a mission, ask what frequency can be used to contact Incident Base – before you respond to the mission. That way, you can get updates and check-in instructions before your arrival, as well as communicate any difficulties you may be having in reporting to Incident Base.

When you arrive at Incident Base, find out what type communications and associated radio frequencies are being used. This information is listed in the mission Communications Plan, and will be provided at your team briefing along with your field team's number or call-sign. Do not go into the field without this information.

State SAR frequencies

The very high frequencies (VHF) of 155.160, 151.370, and 159.285 Megahertz as well as the ultra-high frequencies (UHF) of 460.250 and 465.250 are authorized for SAR missions and training throughout New Mexico. One of these frequencies (usually 155.160) is commonly used as the call-in frequency for those responding to an incident as well as the frequency used by search teams to call Incident Base from the field (called the mission frequency). The other frequencies may be used for base camp communication, special search operations (like a rope rescue), or for use in cross-banding and repeater use.

Amateur radio

The amateur (or Ham) radio system frequently provides the most reliable communications from Incident Base to teams in the field or back to civilization. Amateurs have set up radio repeaters on high points throughout the state that are capable of providing communications over wide areas and into many remote spots not open to cellular communications.

Use of these radios requires a federal government issued license, obtainable only after passing a licensing exam. These exams are offered frequently by Ham radio organizations throughout the state and at the NMESC annual SAR conference. Many SAR team members have obtained Ham licenses to improve mission communications; it's advisable that more do so.

To improve communications in remote areas, we recommend that a licensed Ham radio operator go out with each team. This greatly improves the chances that a team will be able to communicate with Incident Base. If a life-threatening situation develops, a non-Ham licensed person can use the amateur radio system to obtain help.

Family Radio Service

FRS radios are small, inexpensive, low power radios that provide short-range communications on UHF. These radios require no license and have a range of about two miles under ideal conditions (perfectly flat terrain with no vegetation visible for miles). They are sometimes used for the command net radios at Incident Base during a mission.

But the range of these radios is reduced in rugged, uneven terrain or in conifer forests. Therefore, they should not be relied upon for long-range, critical, or mission communications due to their very limited range.

General Mobile Radio Service

GMRS radios are much like FRS radios, but are capable of higher power. These radios may be operated on FRS frequencies (thus allowing for intercommunications) or on additional frequencies. Their range under ideal conditions is around five miles. Like the FRS radios, the range of these radios is reduced in rugged terrain or in forests. A no-test license from the federal government is required to operate these radios.

Agency radios

The Forest Service and Park Service, as well as some other agencies, have their own radios and frequencies. When these agencies assist on a SAR mission, their field teams often use their own agency radios and frequencies. If this happens, be sure to keep an agency representative with a radio at Incident Base, or get written approval to use their frequency and put an agency radio in the communication unit.

Team frequencies

Many search teams have their own assigned frequencies for communications within the team. These frequencies are often used for inter-team coordination while in the field (called a tactical net).

Other frequencies

Other radio frequencies may be used by the Incident Management Team (IMT) to coordinate in-camp activities (the command net). Use of separate frequencies for these functions lessens the chances that critical information coming in from the field will be missed. Command nets frequently use the low-power, UHF; FRS radios (see also the section, above, about the State SAR frequencies).

3. USING TWO-WAY RADIOS

General Practices

A two-way radio can be a valuable communications tool, or it can be useless weight in your already heavy pack. The most worthless radio is the one that is turned off. The idea of carrying a radio and turning it on only in case of an emergency defeats half the usefulness of the equipment.

That said, you do not have to have all the radios on a team turned on (unless you are separated by some distance). If one or more radios must be turned off to conserve batteries, ensure Incident Base knows. Please note that turning off all radios on a team should be done only in extreme circumstances and only with permission from the IMT.

If you miss a check-in time, check in as soon as is practical. If Incident Base does not respond on your regular check-in, try to reach them with one of your team's other radios. If you cannot reach Incident Base on any radio – get to a better, possibly higher, location and try again. If you still cannot reach anyone, return to the last location where you had good radio communication, or to Incident Base, if necessary. Do not stay in the field if you have no communication with the outside world.

There may be time that you may be instructed to set your radio to a different frequency for inter-team communications. When the team leader decides to operate in this manner, it is highly recommended that at least one radio stay on the frequency specified for operations so communications with the Incident Base is not lost. If your radio cannot be tuned to the desired frequency, ensure you notify the team leader.

A radio is a two-way communications tool. You must be able to receive incoming messages as well. Therefore, keep the volume turned up enough to hear. For example, what happens if severe weather is rolling in and the IMT is trying to get word out to the field? Will you hear the call?

When you speak, speak at an angle across the microphone in your radio, with your lips one or two inches from the microphone.

Checking your radio

Make sure your radio is working and know how to operate it before you leave Incident Base. Always take fresh extra radio batteries with you. To check your radio:

1. Turn on the radio.
2. Set the listening level (volume). To do this, turn the squelch knob until the radio emits a constant static roar. Then adjust the volume to a comfortable listening level. (If your radio has no squelch

control, check to see if it has a monitor button. Press and hold the monitor button to open the squelch and then adjust the volume.)
3. Rotate the squelch control until it just silences the roar from the speaker. (The squelch control adjusts the sensitivity of the receiver. Setting the control to this position sets the radio to the most sensitive receive setting that does not constantly make noise.)
4. If the radio has a low/high power switch, set it to high.
5. Listen to make sure no one is talking on the channel.
6. Press and hold the transmit button for two to three seconds, observing whether or not the radio transmits for the full time or reverts to receive. If it reverts to receive before you let up on the transmit button, either the batteries are low or you have a bad radio. Also, check the battery condition indicator, if there is one.
7. Set the power selector back to low.

Note: The following steps may require some familiarity with the particular radio you will be using. If you are not familiar with the radio, ask for help.

8. Set the radio to the desired channel or frequency.
9. Set the access tone, if one is to be used. *This is critical.* If this tone is not correctly set, either those you are calling will not be able to hear you, or you will not be able to hear them.

What to say and when

Before you press the transmit button, know what you want to say before you say it and choose your words carefully. Look to see who is around you and remember that there may be radios in vicinity of the subject's family or the media.

Remember also that many people own scanners. Are you about to say something that you don't want them to hear? This is especially critical if the subject has been found and you need to convey the subject's condition. In these situations, the 'Echo Code' can be used to describe the condition:

Echo Alpha = Subject is uninjured

Echo Bravo = Subject has minor injuries

Echo Charlie = Subject has serious injuries

Echo Delta = Subject is deceased

If there are multiple subjects, it may be stated as *"We have two echo bravos and one echo delta."* Other codes (referred to as 'death codes') may be used to convey this information. The code to be used is selected by the IC. Know what code is being used before you go into the field. If a death code is not given to you during your team briefing, *ask for it.*

Listen before talking. Do not transmit if someone is already using the frequency. If you are using an access tone, you will not hear someone who is using a different tone. Press the monitor button on your radio (if it has one) to hear all transmissions, regardless of tone.

Press the transmit button, wait two seconds, and then speak. The person you are calling may be scanning other channels or have other special features turned on in his radio. If so, it may take a while for the receiving radio to lock on to your transmission. If you are communicating through a radio repeater, this will throw in an additional delay while the repeater locks on to your transmission. Counting to two helps prevent part of your transmission from being cut off.

State whom you are calling and who you are. When functioning under the Incident Command System, personal call signs are not used. Instead, individuals are identified by their ICS position or team designator. For example, if the Operations Section Chief wished to call the leader of Strike Team 2, the exchange would be:

Operations: "*Strike Team Two* (pause), *this is Operations*"

Strike Team 2 Leader: "*Strike Team Two*" or *"This is Strike Team Two"*

Internal team communications may be conducted using last names as identifiers, when all team members know each other.

This is not to say that legal call signs are not used. All licensed transmitters must identify using their legal call signs at least once every thirty minutes.

All radio communications during a mission should be conducted using plain language. This means:

- No codes – other than the death code or echo codes – are to be used. This includes '10 codes' (e.g., *10-4* – often used by police and citizen band users) and amateur radio 'Q' codes. The only exception is when the communications are over agency frequencies and the agency requires their use.
- No jargon is to be used (such as *"Got your ears on?", "over", "clear", "come back"*, etc.).

When requesting information from Incident Base, be prepared to wait a short while so the Communications Unit personnel can pass your question along to the appropriate Incident Management Team member, get the answer for you, and return to the Communications Unit area. Be aware that all messages sent or received at Incident Base are logged along with the date, time, sender, and recipient in the communications log.

Radio etiquette

The use of scandalous, obscene, or otherwise foul or crude language over the radio is illegal and will not be tolerated during SAR missions (on or off the radio, for that matter).

Be concise. State who, what, when, where, why and how. There is no need for lengthy monologues that waste batteries. In fact, many radios have time-out timers that turn off the transmitter if it is operating too long.

If a lot of information must be conveyed by radio, break long transmissions by saying *"break"* at frequent intervals and listen in receive mode a few seconds to see if there is any emergency traffic. You may then continue with your message by stating *"Continuing."* After sending large amounts of information, ask the recipient to repeat back the important details to assure that there is no confusion.

A good way to assure that all important details are sent and received verbatim is to precede the information by stating *"Prepare to copy."* That way, the recipient can have a pencil and paper ready. When the recipient is ready, he should respond with *"Ready to copy."* At each break in the transmission, the recipient should respond with *"Copy"* when he finishes writing. When all information has been transmitted, the sender should say *"End of message."* The recipient may then respond with *"I copy as…"* and read back the message.

Don't get too wrapped up in trying to follow this protocol, however. The important thing is to state the information clearly and verify it is understood properly.

Emergency Communications

Such communications take precedence over all other communications.

If an emergency occurs during a mission, the frequency should be cleared of all non-essential traffic. This is usually done by transmitting a message such as *"All units stand by for emergency traffic."* Until the emergency is resolved, all non-essential traffic must remain off the frequency. It may switch to an alternate frequency, however. If you must interrupt a current radio transmission for emergency traffic, wait for a pause and say *"Break, break".* You will be acknowledged and you can then pass on your emergency traffic.

At the conclusion of the emergency, the frequency may be returned to routine use with a statement such as *"Emergency traffic concluded. This frequency is now returned to normal use."*

Radio Use in Aircraft

Do not use a radio in an aircraft without the pilot's knowledge and permission. Radios can interfere with aircraft communications and navigation.

Further, radios operating from flying aircraft can transmit to, and receive from, very long distances. It is extremely likely that what you say will be heard by others who were not your intended recipient. Choose your words very carefully. Also, you will quite likely hear radio communications that were not intended for you. Make sure the message you respond to was actually intended for you; you may be responding inadvertently to someone a hundred or more miles away.

A radio's increased range may be useful in relaying communications to difficult areas. While flights are expensive, using this capability is very effective and should not be ruled out in critical situations. Special air-to-ground and air-to-air radio nets may be established.

Troubleshooting

The two most common causes of communications problems are low batteries and difficult terrain.

Low batteries

If the batteries seem to be going low on your radio at an unusual rate, it may be due to a number of factors, including:

- **Talking too much.** Keep your messages brief and to the point. Transmitting uses a lot of battery power.
- **Using high power.** Many radios have high/low power switches. Always try talking with low power first. Only if communications are difficult should you switch to high power.
- **Unnecessarily high volume.** The higher you set the volume, the more rapidly the battery drains.
- **Using the scan function.** A scanning radio draws considerably more power than one set to one channel.
- **Improper display light settings.** Many radios have display lights that are on timers. Make sure they are set to be on the minimum amount necessary to do your job.
- **Age/use of your installed batteries.** Make sure you go into the field with fresh or fully charged batteries.
- **Failure to use the battery saver feature.** If your radio has such a setting, turn it on. This feature turns on your receiver at frequent intervals (normally once or twice a second) and checks for a signal. If no signal is present, the receiver turns back off, saving power. Unfortunately, when using the

feature, you will frequently miss the first word or two of received messages. This is another reason you should wait a couple of seconds before speaking when you press the transmit button on your radio. This allows radios with the battery saver feature to lock on to your signal and not miss your first words.

Finally, a word to the wise: Take plenty of spare batteries. If your radio uses disposable batteries, make sure they are alkaline, which are designed for equipment such as a radio that is to be turned on and left on for long periods. 'Heavy Duty' batteries are not alkaline and are designed for equipment that is turned on and off frequently.

Difficult terrain

When you are trying to communicate from difficult areas, there are several things you can try:

- **Move a few feet.** Sometimes, that's all that is necessary. Radio signals can bounce off prominent objects. If you are receiving signals bouncing off multiple objects, the signals can either add together to create a stronger signal or cancel each other out, depending on just where you are standing. Moving just a little can make a major difference.
- **Shield your radio from the wind.** Wind noise can obscure totally what you are saying.
- **Get out of the trees.** Foliage can absorb radio signals. This is especially noticeable on UHF, such as those used by FRS, GMRS, or amateur radios. The needles on many conifers are approximately the same length as the radio antenna and can absorb a great deal of the transmitted signal.
- **Get away from structures, especially metal buildings.** They can either absorb or reflect much of the transmitted signal. In addition, support for the stucco on some structures is chicken wire. This can also block much of the signal.
- **Move uphill.** Radios are line-of-site. You are much more likely to be heard from a mountaintop than in a valley.
- **Try using high power.** Often, this is not your best option; it drains your batteries much faster. It takes four times as much transmit power to double your range, but using high power may be necessary.
- **Face the receiving station.** Sometimes you will need to face the general direction of the station you are trying to contact to avoid your body shielding the transmitted signal.

Extending Coverage into Difficult Terrain

In addition to using aircraft, radio coverage may also be improved with the use of radio repeaters. These units are normally located on towers or mountain tops and provide communications to a large area by receiving a signal and simultaneously retransmitting it on another radio frequency.

Many local, state, and federal agencies have repeaters situated around the state, as do amateur radio operators. Do not use a repeater system without the permission of the agency or owner. Obtaining this permission is the responsibility of the IC, Logistics Section Chief, or the Communications Unit Leader.

Some SAR teams and agencies also have portable repeaters that can be set up quickly on a high point during an emergency. It is good to know who has them available in your area.

If no repeater is available, you may want to set up a human relay. Simply place someone on a hilltop with instructions to relay messages between areas. If you are sent out as a relay, go prepared to spend many hours sitting by a radio in all kinds of weather. Take all your normal field gear, extra water, something comfortable to sit on, and perhaps extra food.

Other Things to Remember

- **Match radios.** Radios must be matched to achieve the most efficient communications. Two-way communications are only as effective as the least effective radio. If you have a radio that transmits 30 watts, you are no better off than the one watt radio – you may sound very strong to him, but if you can't hear him, two-way communication is not occurring.

  (This is sometimes referred to as alligators and elephants. Your radio may have a mighty mouth but tiny ears, or fantastic ears, but a tiny mouth. Alligators talk best to alligators and elephants talk best to elephants. Distant alligators rarely have much success communicating with elephants.)

- **Use the squelch control.** When trying to receive very weak signals, it sometimes helps to turn the squelch control on your radio until the radio is constantly making static noise. This is called 'opening the squelch'. When this is done, weak signals can be detected that would normally not be heard. These signals will be of very marginal quality, however.

- **Use longer antennas.** Radios with removable antennas offer additional possibilities. Replacing the normal flexible antennas (sometimes called 'rubber ducks') with extendable antennas will increase the radio's efficiency. Be sure to use an antenna designed for the frequency you are operating on.

  Flexible rubber duck antennas are rather inefficient. They are used to keep the antenna at a length that is not annoying to the user. Extendable antennas normally extend to ¼ the wavelength of the radio signal. This is much more efficient. When operating in remote areas, extend such an antenna to full length.

- **Keep radios vertical.** Radio signals are polarized. Tilting the radio changes the angle of the polarity. If the transmitting antenna is at a different angle than the receiving antenna, some of the signal is lost. The closer the angle difference between antennas comes to 90 degrees, the more signal is lost, until only a very small percentage of the signal makes it to the receiver. To avoid this problem, everyone should hold their radios so that the antennas are vertical. Many SAR people working in the field use radios mounted in chest packs. Often these radios are mounted at approximately a 45 degree angle. If two people with chest pack mounted radios are trying to communicate with each other, the antennas can very easily be almost 90 degrees out of alignment with each other and the signals will be very weak. If you are trying to communicate out of a fringe area or with someone in a fringe area, take your radio out of the chest pack, hold it above your head, and hold it vertically.
- **Try everything.** When all else fails, try transmitting in the blind; that is, transmit and just hope that someone can hear you and will be able to act as a relay, if necessary. It is possible you can be heard – even if you can't receive.

4. SPECIAL SITUATIONS

Long Range Communications

Sometimes VHF or UHF radios just do not have enough range. Therefore, radio amateurs may use high frequency (called HF or short wave) radios to talk long distances. By choosing the correct frequency and the correct time of day, they can communicate over distances ranging from a few hundred miles to around the world. If you have a need for especially long range communications, check with a Ham about the feasibility for your situation.

Caves

Traditional radios will not transmit through rock. However, specialized cave radios are available within the state that will perform this function. These radios are not as convenient as handhelds, but they can provide the necessary communications.

Military field telephones are a more readily available method for cave communication. While cumbersome, they are the most reliable form of underground communication.

Until one of the above communications systems arrives, don't rule out the low-tech option of leaving notes and sending runners.

5. SUMMARY

Get familiar with your own radio equipment and know how to operate it quickly and in the dark. Ensure you know the different types of radios, frequencies, and other types of communications that are being used on the SAR mission. Know radio etiquette. If at all possible, get your Ham license; it's an easy process.

There are times when none of the above communication techniques will work. When this occurs, communicate the way it was done before radios and cell phones:

Shine a light and make a loud noise.

Chapter 3: Safety in Search and Rescue

This Chapter covers the following topics:

1. General Safety
2. Health Concerns
3. Natural and Man-Made Hazards
4. Weather Hazards
5. Helicopter Safety
6. The Team's Responsibility and Right of Refusal

1. GENERAL SAFETY

As a search and rescue volunteer, safety should be your first priority. The safety of you, your team members, and the public should be considered throughout a search and rescue operation.

Search and Rescue incidents are naturally stressful and at times have the potential to activate your sympathetic nervous system causing a hormonal release of epinephrine. This release can cause many changes in your body including an increase in heart rate and breathing. An important principal of stress management and scene safety is the concept of situational awareness. Situational awareness is your ability to perceive and identify elements of information that are critical to the success of the team and the overall mission. More specifically, situational awareness involves constantly identifying what has happened around you, what is currently happening, and the forethought of what could potentially happen. By increasing your situational awareness during search and rescue operations you will become more adept at assessing and managing risk. Risk can be defined as the probability of an adverse event occurring multiplied by the consequence. Risk = Probability x Consequence

When preparing to enter the field during a SAR operation ensure that you have the proper equipment and are appropriately dressed for the environment. Take into consideration the climate, weather report, and elevation of the area you will be operating in and be prepared for any change in the weather (see *Chapter 1: Gear and Clothing*).

Knowing your own mental and physical limitations, as well as the abilities and weaknesses of your team members is of vital importance. Poor physical fitness can have negative effects on the team and ultimate mission success. Get fit and stay fit.

Statistically, your greatest risk during a search & rescue mission is during the drive to and from incident base. Tragic accidents and near misses have been attributed to exhaustion and sleep deprivation post mission. Ensure that you have had adequate rest and when in doubt, pull over and sleep. Do not allow the excitement of a developing SAR mission to cloud your adherence to traffic laws. Please drive safe.

2. HEALTH CONCERNS

One of the most important safety considerations in SAR work is the recognition of medical emergencies in others and cognizance of your own wellbeing. A SAR member is only as effective as his or her training and knowledge. This guide is meant to provide a brief overview of common medical problems and emergencies encountered during SAR missions. This guide is NOT indented to be a protocol or dictate how you should provide appropriate emergency care. As a member of a SAR team it is important to recognize that formal education and training in emergency and wilderness medicine is indispensable and could save the life of you, your teammates, or the patient. Proper education can be obtained from various training institutions throughout New Mexico and the nation. At minimum, Wilderness First Aid and CPR is recommended. Perhaps the most beneficial entry level medical education for a SAR provider is a Wilderness First Responder course. Realize that by participating in SAR missions you will routinely be hours away from definitive medical care. More so, you could be hours away with a critically injured patient. Knowledge saves lives.

Through proper education and training you should know when a situation is a medical emergency and be prepared to request additional medical resources. Notify Incident Base of any medical emergency as soon as possible.

It is important to notify the ICS Staff of any existing health conditions you might have including any recent illnesses. Be respectful if the ICS Staff does not assign you a mission field task, as the last thing a team needs is for one of their members to become ill or injured.

Be aware of any allergies you have and let someone know what to do if you could have a life-threatening allergic reaction. Know where the closest medical treatment can be obtained. If you take medication, ensure you have the medication with you. Also beware of bites and stings from insects, spiders, and snakes, as well as injuries from cactus and allergic rashes from various plants. Always look before you put your hands and feet into a brushy area, crevices, and rock piles. Cold and heat related issues will be discussed later in the Weather Hazard section in this Chapter.

High-Altitude Illness

High-altitude illness takes place when the body is unable to effectively compensate for hypobaric hypoxia (low oxygen resulting from low atmospheric pressure). The severity of illness experienced is dependent on many factors, including baseline or home elevation, rate of ascent, length of exposure at high altitude, overall health of the individual, and genetic predisposition. New Mexico offers many areas of high altitude (defined as 5,000 to 11,500 feet) and some areas of very high altitude (defined as 11,500 to 18,000 feet), with the highest elevation being Wheeler Peak (13,159 feet). Many popular areas of recreation in the State take place at high or very high altitude (Sandia Peak, Santa Fe Ski Area, Taos Ski Valley, etc.); thus, lost or injured subjects and rescuers alike are at risk of high-altitude illnesses during SAR operations in such areas. It is important to recognize that the progression from mild to severe altitude illness takes place over a spectrum, oftentimes making it difficult to determine the severity of the illness present. Evacuation to a lower altitude is always warranted when high-altitude illness is suspected, especially in its severe forms.

Acute Mountain Sickness (AMS)

While considered to be a mild, non-fatal form of high-altitude illness, AMS can be debilitating to those experiencing it and can eventually progress to more severe forms. AMS commonly occurs to individuals that ascend to 8,000 ft or higher from below 3,500 ft. Individuals that have spent time adjusting to high altitude can generally tolerate ascending to higher elevations with fewer complications. Onset of symptoms associated with AMS can occur within a few hours of arrival at altitude. Symptoms that occur

after spending 36 hours or more at the same altitude are not likely the result of AMS and should be considered to be of a different origin. AMS will commonly resolve within 1 to 2 days at high-altitude as the body acclimatizes.

Acute mountain sickness should be considered in anyone at high-altitude experiencing a headache AND one or more of the following symptoms:

- Difficulty sleeping
- Loss of appetite
- Nausea and vomiting
- Fatigue
- Dizziness or light-headedness

NOTE: Symptoms associated with AMS are non-specific and could be the result of other more life-threatening illnesses. AMS should only be considered as the source of symptoms after a thorough evaluation has been performed by a skilled medical provider.

High-Altitude Pulmonary Edema (HAPE)

High-altitude pulmonary edema is a life-threatening condition that occurs in the lungs. In response to the low pressure of oxygen at high altitude, the blood vessels in the heart vasoconstrict (narrow). This causes the blood pressure within the lungs to increase. As this occurs, fluid leaks out of the blood vessels and into the lungs, further inhibiting the oxygenation of vital organs such as the heart and brain. While HAPE has been reported at as low as 5,000 ft in patients that are high risk, it is unlikely to occur at elevations less than 11,000 ft. Individuals that ascend in elevation rapidly and are physically exerting themselves are more likely to develop HAPE. The signs and symptoms associated with HAPE are:

- Difficulty breathing, particularly while at rest
- Cough (May produce frothy and/or bloody sputum)
- Rapid respirations
- Rapid heart rate
- Chest pain
- Wet lung sounds
- Weakness
- Cyanosis (blue skin color)

While supplemental oxygen may help a patient that is experiencing HAPE, rapid descent to a lower elevation is the most effective treatment. Recognize that other life-threatening illnesses may be present; advanced life support resources should always be requested for anyone experiencing the above symptoms.

High-Altitude Cerebral Edema (HACE)

HACE is an uncommon but life-threatening condition. Hypoxic conditions at altitude can cause the brain to swell with fluid. This puts an increased pressure on the brain and nerves within the rigid confines of the skull and results in neurological dysfunction. It typically will occur in those that initially experienced AMS or HAPE and either remained at high altitude or continued to higher elevation. HACE has rarely been reported below 10,000 ft and usually occurs only at much higher elevations.

Signs and symptoms associated with HACE are as follows:

- Ataxic gait (lack of coordination when walking)
- Fatigue
- Altered mentation (from confusion to coma)
- Irritability
- Headache
- Nausea and vomiting
- Vagueness and confusion.

As with all other forms of high-altitude illness, prompt evacuation to a lower elevation in the setting of HACE is the first priority. Even the most severe cases of HACE can be fully reversed with descent. Supplemental oxygen can always be beneficial, if available. If a patient is suspected to have HACE, advanced life support resources should be requested immediately.

3. NATURAL AND MAN-MADE HAZARDS

Most types of terrain occur in New Mexico. These include desert, high and rugged mountains, wilderness areas, high plains and mesa tops, and rivers and lakes. Each type of terrain has its own specific hazards. The lists of hazards in this section are not all inclusive. The following will provide you with an overview of terrain and hazards that could be encountered throughout New Mexico.

Natural Hazards

Some of the natural hazards in New Mexico include:

- Cactus and other spiny plants, dead snags, thick growths of trees and brush;
- Loose rocks and rock slides, steep drop-offs, sink holes, high altitude, avalanches, caves;
- Bears, mountain lions, bobcats, wolves, livestock, snakes, insects, spiders;
- Streams, rivers, lakes, flash floods;
- Cold and heat, wind, rain, hail, snow, lightning, bright sun.

Man-Made Hazards

Some of the man-made hazards encountered in New Mexico include:

- Marijuana fields that may or may not be guarded or rigged with dangerous traps
- Methamphetamine labs which have the potential to be explosive, toxic, and potentially deadly
- Mines, Indian ruins, old cabins and other buildings;
- Barbed wire (which is a tripping hazard and may be strung across arroyos);
- Militia groups and other individuals who will take action if trespassed upon;
- Hunters;
- Wildland fires.

Protection

Be aware of your surroundings and the hazards around you by maintaining a high level of situational awareness. During your briefing with the incident command staff, ask questions and talk about the hazards you might encounter on your assignment. If you are familiar with the area offer your assistance

to the command staff and inform other team members of your knowledge. Take necessary precautions to protect yourself and your teammates and use personal protective equipment if necessary.

Loose and falling rock is the number one killer in alpine terrain and on any SAR operation poses a danger to those traveling on or below steep and rocky terrain. A litter shield can be used to protect the subject's head and facial area from falling items (rain, snow, leaves, twigs, rocks, etc.) and a helmet should also be placed on the patient. A helmet should be worn by litter carriers on a steep slope, on a technical rescue, and while working in caves.

Wear gloves to protect your hands when working with ropes or litters. Gloves may also be useful when traveling through heavy brush. Carry some type of medical exam glove and avoid latex as many people have allergies. Nitrile, vinyl, or even a heavy dishwasher glove is recommended, as it will degrade less over time in your pack. Take adequate personal precautions before touching a bleeding subject or teammate.

4. WEATHER HAZARDS

Lightning

Lightning has been the 7th leading cause of environmental death in North America over the last decade, and New Mexico has led the nation in per capita lightning strike fatalities in the past. While on a SAR mission, it is first important to be aware of local weather patterns and check a detailed weather forecasts. 92% of lightning strikes occur between May and September, and 72% occur in the afternoon/early evening. While in the field, observe for signs of a building thunderstorm and listen for thunder. Modern lightning education provided by NOAA (National Oceanic and Atmospheric Administration) focuses on the 30-30 rule. This rule advises individuals to seek shelter if less than 30 seconds between lightning and thunder is observed, and also that an area is not safe until 30 minutes after a storm has passed. When adhering to the 30-30 rule, shelter should be sought inside an enclosed vehicle or modern-built building.

Rescuers should ultimately realize that there is not a safe place outside during a lightning storm and all efforts should be aimed at moving oneself and team to a safe location. If this is not possible, teams should move to the lowest risk place available, and practice smart group management. In a backcountry environment, this means avoiding areas that are exposed and higher than adjacent areas, ridgelines, large bodies of water, or the largest tree in a stand of trees. Shallow caves and cliff faces offer no protection, and water even deep inside of a cave can be a potential conductor. Rescuers should spread out 20 feet minimum while still maintaining visual contact and focus on getting to generally lower, rolling terrain. Once there, lightning strikes are essentially random, so finding a dry ravine will probably be the lowest risk area if you choose to stop moving. The "lightning position" is often suggested to be beneficial when waiting out a lightning storm, and consists of the following; 1) insulating yourself from the ground with a pad or pack, 2) crouching in a position low to the ground and 3) limiting surface area contact. Although this technique is commonly described as beneficial, no substantiated data exists to support this notion. Prevention is really the key to avoiding lightning strikes, and both rescue teams and individuals should consistently weigh the risks and benefits of fielding teams during lightning season in high-risk areas.

The Lightning Strike Victim

Roughly 10% of lightning strikes are fatal. Initial treatment of lightning victims should focus on scene safety of the rescuers, and triage if multiple victims are involved. Lightning strike incidents differ from many other multi-casualty incidents in that "reverse triage" should be utilized. This means that resources should be directed towards victims that do not have pulses, and/or who are not breathing spontaneously. This is because victims that *are* breathing spontaneously and *do* have a pulse also have a *very high*

likelihood of survival, and intervention is not the priority in this group. When addressing the pulseless patient who is not breathing, treatment should follow standard CPR protocols. Often times these victims require longer than normal periods of assisted rescue breathing.

Victims who are breathing spontaneously and have a pulse may suffer various traumatic injuries, cardiac abnormalities, and altered sensory perceptions. Many victims will also have hearing deficits from ruptured eardrums. It should also be noted that many lightning strike victims will experience long-term, neurological and/or psychological changes. All victims should be initially evaluated by medical personnel and transported to a medical facility with physician level care.

Flash Floods

Many deaths occur in New Mexico each year from flash flooding. For those living in a desert unaccustomed to fast moving water, it can be easy to underestimate the power of water. Six inches of fast moving water can knock you off your feet. Flash floods can roll boulders, tear out trees, destroy buildings and bridges, and scour out new stream or river channels. Rapidly rising water can reach heights of 30 feet or more.

Occasionally, floating debris or ice can accumulate at a natural or man-made obstruction and restrict the flow of water. Water that is held back by an ice jam or debris causes flooding upstream. Subsequent flash flooding can occur if the obstruction should suddenly release.

Flash floods are caused by heavy rain associated with a severe thunderstorm. Fast or slow moving thunderstorms, thunderstorms that move repeatedly over the same area, or heavy rains from tropical storms and hurricanes can all produce flash flooding. Topography, soil conditions, and ground cover also play an important role.

At times there will be little warning that a flood is coming. Listen for thunder from a faraway thunderstorm that could be headed your way and watch for rapidly rising water. Get to higher ground immediately (be aware of lightning hazards). Do not attempt to cross any fast moving water. Notify Incident Base of any potential hazard you encounter and advise them if your team will need assistance.

Cold Injuries

Cold illness and injuries are common during any season in New Mexico. A summer storm at altitude can easily drop temperatures capable of inducing hypothermia. Proper preparation and planning is essential to preventing a cold injury. Carrying adequate clothing, staying dry, proper layering techniques, adequate caloric intake, hydration, and a good weather report are all ways of mitigating the risk of hypothermia. (See more on clothing in *Chapter 1: Gear and Clothing*.)

Hypothermia

Hypothermia is defined as a body core temperature below 95°F. A progression of symptoms can be seen from mild, moderate, to severe hypothermia. Hypothermia occurs most often in cold climates when your internal body temperature drops approximately three degrees below normal. In a cold environment your body must be able to retain heat, generate heat, and also discharge heat. While it is important to layer clothing in cold climates, it is also important to realize that your body can overheat in the same cold climate. Preventing perspiration and wet clothing can be essential to maintaining a normal body temperature in a cold environment.

When traveling in cold conditions and also when treating a person with hypothermia it is important to know the ways that the body can loose heat. Heat loss can occur by the following four mechanisms and treatment should be first aimed at preventing further heat loss by combating the following:

- Conduction – Loss of heat due to contact with another object
- Convection – Loss of heat due to the movement of air (wind) across the body
- Radiation – Loss of heat given to the surrounding atmosphere with no physical contact involved
- Evaporation – Loss of heat due to evaporation of liquid i.e. sweat and wet clothing

Mild hypothermia

A wide spectrum of symptoms can be seen with mild hypothermia. Shivering is the main sign that will be seen. Additionally, a person may feel cold, have a fast heart rate, fast respiratory rate, and have contraction of blood vessels seen in the arms and legs. These are all responses the body has to preserve heat. Increased urine production (cold diuresis) may also be seen.

Treatment for mild hypothermia includes adding more clothing layers and removing any wet clothing. An increase in physical activity can be helpful, but be careful not to deplete too much energy or create excess perspiration. Get indoors from the cold or make some kind of shelter to prevent the four mechanisms of heat loss. Drink warm liquids and eat high caloric foods. Avoid alcohol, caffeine, and nicotine. If needed, start a fire.

Moderate hypothermia

The progression from mild to moderate hypothermia is hallmarked by the cessation of shivering. As a person's body continues to loose heat the body will be unable to continue generating heat through shivering thermogenesis. Heat production decreases 2 to 4 fold when shivering stops. This occurs at a core temperature of 88°F. At this stage an increase in physical activity can be detrimental as this can displace cold blood from the extremities back to the core. Some common signs and symptoms of moderate hypothermia are un-coordinated movements including stumbling, sluggish movements, and being withdrawn.

Without the intervention to stop further heat loss the moderate hypothermia patient will continue to decline in core temperature. A person can become disoriented, confused, and even combative. Paradoxical undressing can be seen at this stage.

The treatment for moderate hypothermia is essentially the same as for mild hypothermia, only more aggressive in nature. The goal should be to first prevent further heat loss, then add heat to the patient by various mechanisms (warm water bottles in the axilla/groin, campfires, ready heat blanket if available (http://www.chinookmed.com/cgi-bin/item/03683/s-hypothermia/-Ready-Heat-Disposable-Heated-Blanket-34%22x60%22), and warm liquids if the patient can maintain his or her own airway. Get the patient to medical personnel as soon as possible.

Severe hypothermia

Severe hypothermia is a medical emergency and can lead to death. An altered level of consciousness and the loss of reflexes and voluntary motion hallmarks the progression from moderate to severe hypothermia. Many severely hypothermic patients will be unconscious. It is important to rule out other causes of unconsciousness (hypoglycemia, drug overdose, trauma, etc.) before assigning an unconscious patient the diagnoses of severe hypothermia. Severely hypothermic patients commonly present with a lowered heart rate and respirations. It may be difficult to detect a heart rate on a severely hypothermic patient. Take adequate time and care when assessing for a heart rate. Do not begin CPR

unless you are certain there is not any cardiac activity. Care should be taken when moving a severely hypothermic patient as rough handling can potentially precipitate ventricular fibrillation. However, the ultimate goal should be to move the patient towards a hospital capable of re-warming a severely hypothermic patient. It is somewhat impossible to rewarm a severely hypothermic patient in a backcountry setting. Most unconscious hypothermic patients will require a helicopter evacuation and treatment should be aimed at preventing further heat loss. This can be accomplished by removing any wet clothing, packaging in a hypothermia wrap (tarp, ground pad, sleeping bags). Heat can be added to the hypothermia wrap by adding hot water bottles or commercial heat blankets (ready heat blanket mentioned above).

NOTE: A helicopter, if available, should be called for a severely hypothermic patient in cardiac arrest. The saying of "No one is dead, until they are warm and dead" holds true for severely hypothermic patients. Numerous case reports exist of severely hypothermic patients in cardiac arrest for prolonged periods surviving with proper treatment and rapid evacuation to a medical center capable of endovascular rewarming or ECMO. Medical helicopters will be hesitant to transport a patient in cardiac arrest. In such a case, recommend that the Incident Commander contact the University of New Mexico, EMS Consortium Physician on call through the UNM Reach & Treat Team for guidance.

Frostbite

Frostbite occurs when localized tissue is frozen. Frostbite most often occurs in body parts furthest away from the heat, i.e. fingers, toes, ears, noses, and cheeks. Frostnip, the initial stage of frostbite, is caused by the cooling of tissues without destruction of the cells within the tissues. Frostbite involves direct tissue and cell destruction. Improper, tight fitting garments and footwear can promote frostbite. Extremely low temperatures and wind chill can lead to exposed body tissues freezing in minutes.

In cold temperatures cold vasodilation occurs and blood is shunted away from the extremities. In general, it is difficult to foretell the extent of frostbit damage. The medical community has divided frostbite into degrees of injury from first degree to fourth. The degree of injury is based on clinical presentation after freezing and rewarming has occurred. In a backcountry SAR situation you may only witness the presentation of the freezing phase. Once rewarming has occurred the clinical presentation will change. Realize that rewarming frostbitten tissue in the backcountry can be extremely difficult. Additionally, worse outcomes will happen if frostbitten tissue is rewarmed and then allowed to refreeze. Treatment in the backcountry should be aimed at preventing further heat loss of the tissue affected and evacuation to a medical facility.

Signs and symptoms of initial frostbite include loss of sensation, numbness, and a pale waxy appearance. In later stages edema is common, clear and dark blisters can form, and the patient can loose the ability to move the affected area. When frostbitten tissue is thawing it can be extremely painful.

Prevention methods for frostbite include:

- Wearing appropriate clothing for cold weather.
- Dressing in layers including a windproof, water resistant layer.
- Covering any exposed flesh.
- Changing out of wet clothing.
- Avoiding prolonged exposure to the cold.
- If possible, taking breaks in a warmer area.
- Avoiding alcohol, caffeine, and nicotine.
- Check yourself and your teammates

Intervention for potential frostbite:

- Recognition
- Seek shelter, move out of wind if possible
- Remove clothing on affected area and replace with dry clothing
- Place involved extremity in companions axilla for 10 minutes
- If sensation returns, proceed with caution
- If sensation does not return after 10 minutes of warming seek shelter, radio and return to base camp
- Seek medical attention

NOTE: Frostbite and hypothermia commonly occur together. Do not forget to treat hypothermia.

Avalanches

Avalanches can and do occur in the high mountains of New Mexico. SAR members need to be aware of the possibility of avalanches as hazards to themselves and SAR subjects. Do not proceed into avalanche terrain while on a SAR mission without the proper snow safety equipment, training and knowledge of the snowpack and weather conditions. If a rescuer lacks the proper knowledge of avalanche terrain assessment and/or companion rescue, their travel in the winter backcountry should be limited to slopes less than 20 degrees with no overhead hazard. Avalanche safety is too complex a subject to cover in this *Study Guide*. SAR members should consider enrolling in an avalanche education course if they intend on responding to winter SAR events in the mountains. The American Institute for Avalanche Research and Education[4] and American Avalanche Institute[5] offers such courses. Always ask about avalanche dangers during your team briefing, and ensure that individuals with extensive avalanche training are involved in the decision-making process regarding navigation of avalanche terrain.

Avalanche Victims

The most important consideration for SAR personnel when responding to an avalanche victim is to ensure the safety of the responders involved. Approximately 23% of avalanche accidents result in fatality. Avalanche fatalities result from 3 primary causes; Asphyxia (74%), Trauma (25%) and Hypothermia (1%). The time of burial and extent of burial (partial vs. full burial) are the two factors that will greatly impact survivability. Initial treatment should be directed towards stabilizing Circulation (active hemorrhage), management of the Airway (opening and clearing the airway of snow), and providing rescue breathing. Standard CPR protocols should be initiated in the pulseless victim who is not breathing. Victims who have a pulse and are breathing should be assessed and treated for trauma while hypothermia treatment is initiated. Current literature exists to guide the trained professional in response to avalanche victims, and can be found via the ICAR (International Commission for Alpine Rescue) website[6].

Hot Climate

Illnesses associated with physical exertion and overheating are common in the hot environment. As rescue operations are oftentimes very strenuous for prolonged periods of time, rescuers need to be attuned to their body and watch for signs of overexertion. Similarly, rescuers should keep a watchful eye on their team members to ensure that everyone is maintaining a safe level of exertion and exposure. SAR members should prepare for working long hours in hot environments by conditioning their bodies well in advance of participating in such operations. By exercising in a hot environment, many beneficial changes will occur that will both increase physical performance and decrease the susceptibility for injury

[4] Avalanche Research and Education: http://avtraining.org
[5] American Avalanche Institute: www.americanavalancheinstitute.com
[6] http://www.alpine-rescue.org/ikar-cisa/documents/2013/ikar20131013001087.pdf

or illness. Individuals undergoing such a regimen should do so cautiously and may want to consult their physician beforehand.

While mild forms of heat illness oftentimes resolve with resting in a cooler environment, severe forms can lead to morbidity and mortality. The various forms of heat illnesses are discussed below, but it is sometimes difficult to determine the severity or cause of illness present. When in doubt, rescuers should always have a low threshold for evacuation to a cooler environment and should always consider requesting advanced life support for further assistance.

Heat Cramps

Exercising in a hot environment can oftentimes result in muscle cramping or spasms. While heat cramps are generally considered to be a mild form of heat illness and not a medical emergency, they can be quite painful and may interfere with the rescuers ability to operate on a mission. The exact cause of heat cramps is still unknown, but they generally resolve with rest, hydration, and replenishment of electrolytes. Electrolytes are best restored through salty snacks or sports beverages; salt tablets have been shown to be ineffective and should be avoided.

Heat Syncope

Occasionally, individuals will experience a syncopal episode while exercising in a hot environment. A syncopal episode is defined as a brief loss in consciousness with rapid return to normal mental status. Minor muscle spasms may occur and should not be confused with seizures. While heat syncope itself is not an emergency, it should be recognized that other more severe medical illnesses (i.e. heart attacks) could also result in syncopal episodes. Rescuers should consider other causes of syncope before suspecting heat to be the cause.

Heat Exhaustion

Heat exhaustion is a mild to moderate form of heat illness. Individuals with heat exhaustion may experience fatigue, nausea, vomiting, dizziness, or a headache. They will oftentimes be sweating with flush, red skin. Heat exhaustion should be managed by removing the individual from the hot environment, resting, and eating/ drinking as needed. The symptoms of heat exhaustion can take a while to resolve; patience while resting is important to managing this illness. After resting, an individual will usually be able to self-evacuate as long as a slow pace is used and breaks for rest are frequent. While heat exhaustion itself is not considered to be a life threat, it may progress to heat stroke is physical activity or exposure to heat continue.

Heat Stroke

Heat stroke is a true medical emergency that warrants immediate recognition and management. The mortality rate of heat stroke is approximately 10%; if the patient develops hypotension (low blood pressure), mortality rate increases to 30%. Heat stroke is characterized by decreased neurological function, evident by altered mentation, confusion, agitation, seizures, or coma. Contrary to previous understanding, an individual that is experiencing heat stroke can still be sweating. While advanced life support should be requested to manage anyone suspected of heat stroke, the first priority should be to immediately cool the person down as fast as possible. This can be done by moving the individual to the shade, pouring cool water over their body, fanning them, or even placing them into a cold body of water **as long as their head is protected from submersion.** Tight fitting clothing may inhibit heat loss and should be removed. Immediate evacuation to an emergency department for further evaluation is necessary, even if the individual's condition improves with cooling techniques.

Dehydration

Dehydration occurs when the loss of fluid surpasses the amount of fluid that an individual is ingesting. While sweating can be significant and may contribute to dehydration, oftentimes dehydration is a result of not drinking enough fluid. Proper hydration techniques are necessary both for preventing and treating dehydration. Water should be ingested with additional electrolytes (sodium, potassium) either in the form of salty snacks or a sports beverage. Previous dogma taught that if you were thirsty than you were already dehydrated. Such statements had no supportive evidence, and adopting this hydration strategy can result in hyponatremia, a serious condition that results in swelling of the brain as a result of over hydration. While the exact amount that someone should drink varies from one person to another, drinking to thirst is considered a safe hydration practice.

Dehydration can be a serious illness that may result in renal (kidney) failure, heat exhaustion/stroke, and shock. An individual that is thought to be dehydrated and is exhibiting altered mental status, a rapid/weak heart rate, or other severe symptoms may require aggressive medical management. Consider requesting advanced life support resources as necessary.

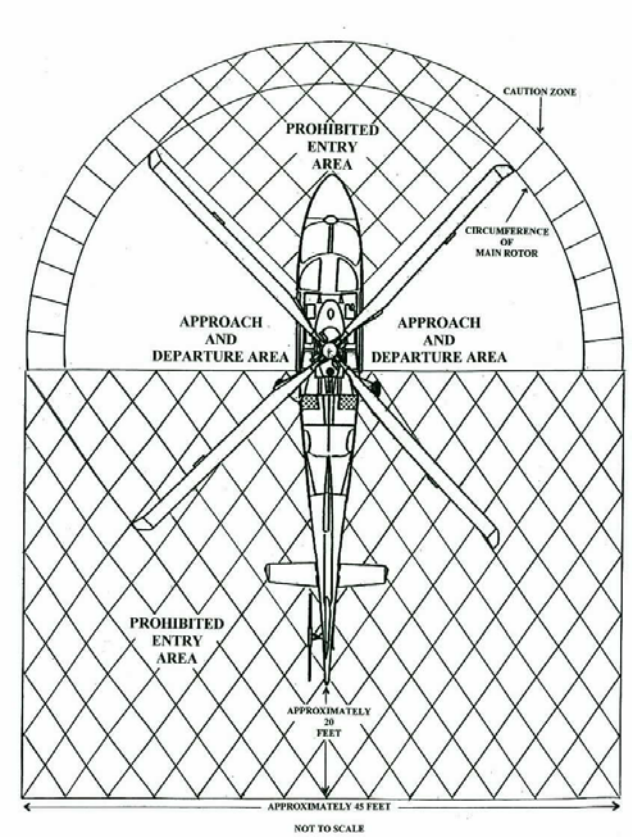
5. HELICOPTER SAFETY

Helicopters can be a blessing on a SAR mission, but they are inherently very dangerous. The following lists examine the hazards to be aware of and important points to be considered when working near helicopters.

Outside the Aircraft

The main rotor

The overhead main rotor moves at a very high rate and may flex as much as 2.5 to 3 feet. The current New Mexico State Police (SP) helicopter has a very pronounced forward tilt to the main rotor. On level ground, standing in front of the SP helicopter, a person 5'9" or taller can reach up and touch the tip of the main rotor blade (while the main rotor is not turning). Therefore, do not approach this helicopter from the front. As with any helicopter, <u>do not approach the helicopter until cleared by either the pilot or the crew chief</u>. For prohibited zones on the current SP helicopter, see the diagram on the next page.



(Footprint of the current New Mexico State Police Helicopter)

The tail rotor

Tail rotors also rotate at a high rate and can be very difficult to see, especially in low light or dark conditions. Stay away from the tail boom of any helicopter.

Loading the aircraft

Do not carry anything over your shoulder or higher than eye level when approaching or departing the aircraft. If you have a large or bulky pack, carry it in front of you, no higher than eye level. Do not ever try to put on or take off a jacket, shirt, vest, etc., while standing or walking under a turning rotor system (e.g., you insert one arm into a sleeve, then raise that arm above your head to ease your other arm into the opposing sleeve). If you and your team are being transported to your assignment, <u>always</u> keep your gear with you at all times. Do not allow your gear to be transported on a separate trip.

Opening and closing aircraft doors

Remember that not all helicopter doors operate the same or have the same type of doors, even on the same models. Here are some basic guidelines:

- If you have not been briefed on how to operate the doors, leave them alone.
- Do not force a door open and do not attempt to force a door to close.
- Do not slam the door when you close it.
- Do not mistake a door ‘jettison’ handle for a door ‘operating’ handle.

Noise level

The turbine engines used to power many helicopters produce a very loud, high-frequency whine. Exposure to this noise level, even for a short time, will cause pronounced hearing loss. Personnel working in and around the helicopter must use appropriate hearing protection.

Blowing debris

The air downwash from the rotating main rotor can propel small debris such as wood chips, dirt, small rocks, and other objects as fast as 40 to 50 mph. Because of this, eye protection is mandatory. Suitable eye protection provides an occlusive seal around the eyes; sunglasses and partial face shields will not provide adequate protection.

Inside the Aircraft

Improper cargo loading/distribution

Ensure you give the pilot an accurate account of the total weight (people and gear) that needs to be transported. The pilot can then more accurately plan flight time, fuel load, and number of refueling stops and transport trips required to complete the mission. When you load your equipment into the helicopter, make sure that all items are adequately secured with tie-downs or seatbelts and that no object will fly out of the cabin when the doors are opened.

Passenger interference with flying/engine controls

In most helicopters, the pilot sits in the right seat. This may change depending upon the make of the helicopter or if modifications have been made. If seated in the co-pilot's seat, be aware of the controls all around. Keep your hands away from the instrument panel, overhead console, and center console. Also keep your hands and feet away from aircraft controls.

Use of intercom and radio

Most aircraft are equipped with a voice activated intercom system. You should receive a briefing on how to operate the system, proper positioning of the microphone and volume controls, and push-to-talk switches. Make sure you are briefed on its correct operation. Do not withhold information regarding the safety of the flight or personnel because you might think you are interfering with radio traffic. Take the initiative and alert the pilot.

Seatbelts/shoulder harnesses

It is very important that you correctly use the aircraft's lap belt and shoulder harness. There are different types of restraint systems and it is imperative that you receive an adequate briefing on the proper operation of that system.

Helicopter Landing Zone (LZ)

Wires

Possibly the most deadly adversary of a helicopter pilot is a wire stretched across a flight path. Every year, crewmembers and passengers are killed and helicopters destroyed because of encounters with wires. There should be no wires across or within the LZ. Ideally, there should be no wires within ¼ to ½ mile of the LZ. However, sometimes a helicopter must operate in the vicinity of wires. Every effort must

be taken to locate every wire within ½ mile of the LZ and pass that information on to the pilot before an approach has begun. During operations in low light or darkness, wires within ¼ mile of the LZ should be marked and illuminated. Spotlight the wire directly or illuminate the pole from which the wire is hung.

Poles and stumps

The pilot must be made aware of every pole, fence post, pole remnant, tree stump, and similar objects within the LZ. Poles over 5 feet in height are a hazard to the main rotor and tail rotor, while poles and stumps over 18 inches in height are a hazard to the tail rotor. Remnants of cut-off poles and stumps may be difficult to see, but can create a rollover hazard.

Vehicles, personnel and animals

Do not allow vehicles or unauthorized personnel within 150 to 200 yards of the LZ. Flying debris created by the main rotor downwash may cause damage or injury. Maintain LZ security at all times. Most animals, especially horses, do not react well when helicopters are in the vicinity. Therefore, livestock should be secured, if possible. If this is not possible, another LZ must be found.

Loose items

Objects such as tarps, tents, trash bags, clothing, head gear, trash barrels, etc., must not be in the LZ during flight operations. Secure portable radios when approaching an operating helicopter. They can be pulled out of your hand or a pack in a split second.

Other aircraft

If there is another helicopter involved in the SAR mission, safety becomes even more important. The more helicopters in the LZ, the greater the risk of injury and accidents. The ICS Staff (in particular, the Air Operations Branch Director, or AOBD) must keep all pilots (helicopters and fixed-wing) informed of other aircraft in the area.

Other Helicopter Considerations

- If helicopter assistance is requested, a pilot may want to know: whether or not a hoist pickup is needed, the approximate wind speed and direction at the LZ or rescue site; visibility and obstacles in the area; and type of terrain and the slope of the ground.During cold weather, be aware that the main rotor downwash can cause an immediate drop in temperature, increasing the danger of hypothermia or frostbite. All personnel in the area should be dressed properly.
- Never try to judge weather conditions for a pilot. Describe the situation and let the pilot make the final decision on whether or not to make a landing.
- Do not set off smoke bombs during fire season. A handful of dust thrown into the air or a cloth streamer held above your head can help the pilot determine wind direction.
- No smoking within 100 feet of the helicopter or 500 feet of a fuel truck.
- At the first sign of trouble, *hit the ground*. A helicopter that is coming apart throws metal every direction.
- If the helicopter has landed on a slope, never approach it from the uphill side.
- Finally, the pilot always has the final say in any situation involving the safety of the crew, passengers, aircraft, or any other aspect involving helicopter operations.

6. THE TEAM'S RESPONSIBILITY AND THE RIGHT OF REFUSAL

The team, as a whole, has a responsibility not only to its members but to the subject as well. A good Team Leader should make sure that his or her team:

- Is properly outfitted,
- Has knowledge of basic search techniques and navigation,
- Has good communication,
- Has first aid training,
- Is aware of the hazards in the search assignment, and
- Has the appropriate training and skills for the assignment.

Before leaving Incident Base, you and the ICS Staff will discuss your team assignment. It is important that you explain to the ICS Staff if a particular route or segment might be inappropriate for the team's skills, training, equipment, and experience.

In the field, you are the eyes and ears for Incident Management staff. Some hazards may not be known to the ICS Staff. If you find a previously unknown hazard while on your assignment (e.g., a stream that is now high and fast moving), you need to do a risk assessment, balancing the needs of the mission with the danger posed to your team. Remember, risk = probability x consequence. Do not automatically continue. You should stop, make observations, assess the risk, and contact Incident Base. If necessary, your assignment may be adjusted.

You, as an individual volunteer, always have the right to refuse an assignment. If you feel there are hazards in your assignment that are beyond your ability to mitigate, discuss the situation with your Team Leader and the ICS Staff. Also, be aware that it is your responsibility to report any accident, injury, and/or illness to your Team Leader and the Incident Commander.

Chapter 4: The Search

This Chapter covers the following topics:

1. Fundamentals of Search Planning
2. Sign-in and Team Briefing
3. Search Considerations
4. Search Techniques
5. Finding and Handling Clues
6. Death Scene
7. Team Debriefing and Sign-out
8. Summary

1. FUNDAMENTALS OF SEARCH PLANNING

The search area is the geographic location presumed to contain the missing subject and in which search operations are located. During the planning for a search, the area is divided into segments based on information gathered from the initial and subsequent investigations and search team results.

Search Probabilities:

Each segment is assigned a Probability of Area (POA) – the estimated probability, expressed as a percentage, that the segment contains the subject. Each segment is sized suitably for a specific search resource, such as a hiking or snowmobile team.

When a team searches a segment, there is an estimated probability it would have found the subject if the segment actually contained the subject. This is known as the Probability of Detection (POD). The POD can depend on the:

- Type of search resource used (foot teams, vehicle teams, helicopters, canine team, mounted team, etc.)
- Environment (day vs. night, overcast vs. bright sunlight, rain vs. clear, heavy forest vs. high desert, weather, etc.)
- Effort expended in the area (time spent searching and the search technique used)
- The object the searchers are looking for

Depending on your team's kind, the Incident Management Team (IMT) may ask your team to estimate your POD based on how you carried out your search during the team's debriefing. By practicing your search techniques in controlled exercises you can learn to estimate your POD. Studies have shown that most searchers, including experienced searchers under estimate the POD. POD may also be

determined mathematically based on the searchers' search width and time spent searching. POD is affected by the type of search conducted, the kind of search team, the environment and how long search teams are actively searching. If you have any interest in learning more about search theory, there are many on-line sources and written documents that cover the subject.

As searchers complete their respective assignments, the search managers need to consider the Probability of Success (POS). The POS is the probability that the subject will be located. By associating the POD with the POA in the equation POA X POD = POS, the search managers can determine the POS of the search segment.

As assignments are completed, the POA is adjusted by the derived POS for each searched area. The new POA will be used to plan future team assignments in that segment. This information could lead to areas being searched multiple times until the adjusted probability has been sufficiently reduced. Therefore, you might be asked to search a segment that has already been searched.

You may be asking; "Why do I need to know this stuff? I just want to go search." The answer is simple. As a searcher, you won't be doing any of the calculations to determine the POA or the POS of a search segment. But, as a searcher, you do need to be aware of the importance of your POD from each of your search assignments. The POD is instrumental in assisting the search managers to allocate resources to accomplish the incident objectives.

2. SIGN-IN AND TEAM BRIEFING

When you arrive at Incident Base, sign-in on ICS Form 211 and include applicable information. This critical action is for your personal safety and allows the Incident Management Team (IMT) to manage the human resources on an incident.

Prior to your team starting its assignment, you will be briefed on the following:

- Specific information about the subject
- Assigned search area, the tactics and techniques to be used, and associated maps
- The communications plan
- The "death code" (a phrase used to communicate to Incident Base that the search team has located a deceased subject – discussed in more detail in *Chapter 2: Communications*)
- Safety and hazard information and the rescue plan
- Location of the media and/or family
- Any other information the ICS Staff feels you will need to do your job

If your team is equipped with one or more Global Positioning System units, you may be asked to track your route during your search.

This is the time to ask any questions you may have.

3. SEARCH CONSIDERATIONS

Identification of the search area

In the briefing for an area search, you will be given the boundaries of the segment you are to search. Search segments are chosen for specific reasons by the ICS Staff. They allocate search resources by estimating the probability that each segment contains the subject and the odds that a particular search technique will locate the subject if he or she is actually there. It is essential to the planning and execution

of the mission that you carry out your assignment in the correct area and according to the briefing; do not deviate from the assignment without permission.

One of your team's priorities is to identify your assigned segment and then make sure the segment is covered in the assigned manner and time allocated. This could mean marking the region with trail tape, Global Positioning System (GPS) waypoints, or even just marks on a paper map. Your team leader should determine the best spacing between searchers for route or grid searches that will effectively cover the assigned area within the time allocated. At the conclusion of the assignment, you must verify that you covered the assigned area and report any gaps in your coverage.

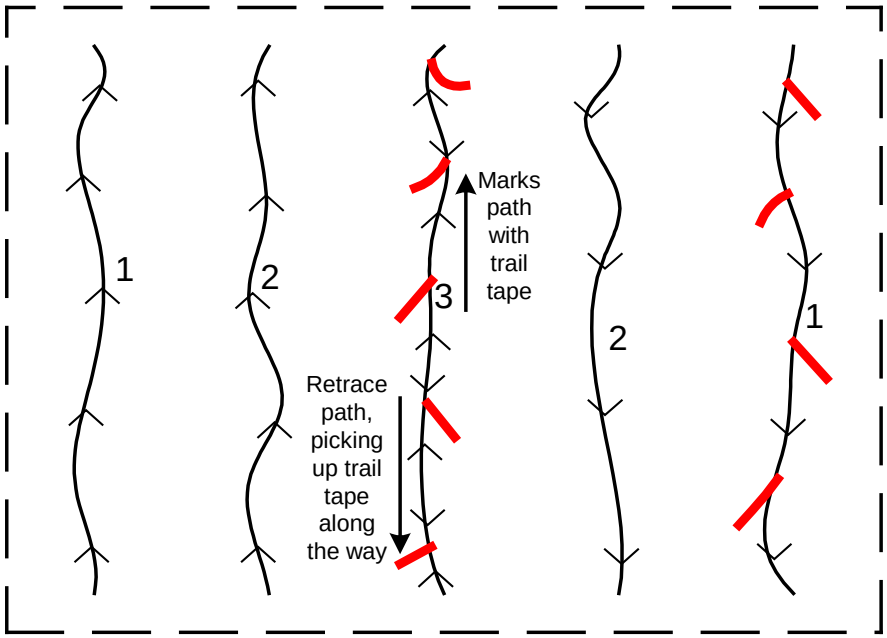
Marking the search area

In general, personnel move through the search segment in an organized line, marking the search site as they travel through it. For example, in the illustration below, there are three searchers moving through an area. Searcher 1 will walk a path parallel to some search area boundary, such as a trail, fence, drainage or simply a compass heading. Searchers 2 and 3 then place themselves within the assigned area some distance to the right of searcher 1. While moving from the bottom left of the search area, searcher 3 (the guide person) marks the path taken with streamers of trail tape. This searcher will also walk a straight bearing to keep the search within the desired bounds.

When the top boundary of the search segment is reached, the line reorganizes to the right, and begins to search from the top right down to the bottom right. Searcher 3 retraces the path taken on the first pass, retrieving the trail tape laid out before, while searcher 1 marks the path taken on the right. This process continues until the final pass, after which there should be no trail tape left in the area and the entire area has been searched. In larger teams the roles of guide person and marker might fall to other searchers.

By marking the area searched in this manner, your team can maintain a consistent direction through the search area and avoid large gaps in coverage.

It may be necessary to mark the top, bottom, and sides of the search area for future teams if the segment is not bounded by obvious physical boundaries like trails or fence lines. The markers can be either removed by later teams or biodegradable flagging tape can be used.



Efficiency vs. thoroughness

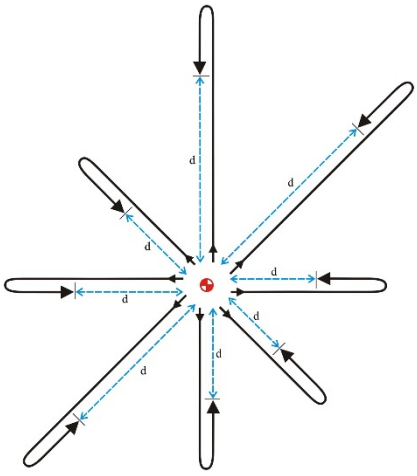
One choice to be made in selecting an area search technique is how thoroughly the area needs to be searched or covered. It is a mistake to cover an area thoroughly when you are asked to cover it quickly (or vice versa). If a subject is in a segment, you could have a high probability of a find if you searched the area in tight formation, shoulder-to-shoulder – but it is seldom wise to do so.

Search planners decide the thoroughness needed in a given segment. We should not assume that maximum thoroughness is either necessary or even desirable. Sometimes we need to sweep quickly through a low-probability region. It all comes back to the goal of the IMT needing to increase the overall probability of finding the subject quickly.

Average maximum detection range (AMDR)

An easily measured quantity often used in a grid search, the AMDR (also known as a Detection Range Experiment) is an estimate of the average distance beyond which searchers can no longer detect the object they're looking for.

The measurement process is easy. An object the size, shape, and color of a possible clue is placed in terrain similar to that of the search area. Searchers first walk away from the object until it is no longer visible (this distance is known as the extinction distance). Searchers then walk towards the object until it can be seen again (the detection distance). The distance is measured by pacing. The searchers then move clockwise around the object and repeat the measurement every 45 degrees. The figure on the right shows how the experiment should be conducted. The average of the eight measured detection distances is the AMDR. It is a very rough measure of the detectability of the object in the search environment.



Effective Sweep Width

The Effective Sweep Width (ESW), also known as the Sweep Width (W) is a mathematically derived value that can assist search managers in determining the POD of a search team. The value is basically the distance to the left and right of a search team member, that a search team member may detect a specific object. The ESW is affected by many factors to include the terrain, environmental conditions, the search object, searcher speed and even the type of search sensor (K-9, naked eye, night vision goggles, etc). The ESW is normally based on extensive studies of searchers (sensors) moving through a specific area (terrain), at a consent speed, looking for specific type of object. Only after numerous studies are conducted and analyses of the data are completed, can the ESW can be determined for a particular search area.

Without the extensive studies, the ESW can be estimated by taking the AMDR and multiplying it by a factor of 1.1 for low visibility objects to 1.8 for high visibility objects. The visibility of the search object may be determined through the Incident Management Teams investigations. A subject wearing all hunter orange may be considered high visibility while a hunter in all green or black may be considered low visibility.

Search managers than can take the estimated ESW, apply it and other factors to a search team and determine what POD could be reached and, more importantly to the search team, obtain specific data from a search team's debriefing and compute what POD was obtained by the team.

4. SEARCH TECHNIQUES

A progression of techniques is usually applied to a search. The two principal approaches of search strategies are **passive** (indirect) and **active** (direct).

Passive Search Approach

Passive Approach includes those tactics, strategies and considerations that gather information about the subject, confine the subject to a search area, determine if the subject has left the search area, causes the subject to move to a specific location or reveal the subjects location to searchers. They typically do not involve physically entering a search area to look for the subject or clues. Typical tactics of the passive approach are fact-finding/investigation, attraction, and containment/confinement.

Fact-finding/Investigation

Early in a SAR mission, the New Mexico State Police Mission Initiator (MI) and the Incident Commander (IC) are the primary users of these techniques. The investigator gathers information about the subject and reporting party, as well as information necessary to determine:

- The urgency of the situation
- The objectives and strategies for conducting a search
- Whether a search should be initiated at all

Continued investigation is critical throughout the mission to refine search plans or to possibly locate the subject outside of the search area (commonly called the "rest of the world" or ROW). For example, the subject may actually have made his way to an area hospital, home, or other location.

While investigation is a critical component of search operations, it is not a responsibility of field teams. As a field responder you should not conduct investigations unless you have been asked to do so,

especially if the investigation involves speaking to the reporting party or to a member of the subject's family.

During the course of a search you might, however, encounter hikers and other parties who might have helpful information. It is entirely appropriate for you to speak to these people and report any data back to Incident Base.

Attraction

These techniques attempt to catch the attention of the missing subject. Two common methods are sound and light attraction.

Using whistles, horns, loudspeakers, or even just your voice, you can periodically make noise and then pause to listen for any response. It is critical to observe a period of complete silence after the first noise is made. Talking, crunching of leaves or snow under foot, rustling of clothing, or the blaring of team radios can completely obscure any response from the subject. After the period of silence, the process is repeated once more. The second attempt allows for the possibility that the first noise alerted the subject to "something" and that the second noise will be properly recognized for what it is.

Remember, it could be very difficult for the subject to hear even your loudest noises over chattering teeth and/or when the hood of the subject's jacket is pulled over his head!

Staff at Incident Base and those on containment/confinement assignments may also use light attraction. For example, they may shine bright lights in all directions in hope the subject may see them and walk toward them. A Law Enforcement Officer may also use flashing lights for attraction, as well as using the siren for sound attraction. There is also the technique of placing a battery-operated strobe light and a note at a trail intersection to attract the missing subject.

Positioning searchers in lookout towers, look-overs, scenic views, bridges and other high areas is another passive tactic that can assist searches in locating the subject. Personnel located at high points in or around the search area can continuously scan the search area with binoculars, night vision goggles, thermal imagers or by the naked eye to locate the lost subject. The high point itself can act as an attractant and attract the lost subject to its location.

Containment/Confinement

These techniques are designed to prevent the subject from leaving the search area undetected. Containment allows the search to be confined to a small area and improves the probability of locating the subject with limited resources and time.

Containment/confinement assignments include:

- blocks on roads or trails
- blocks or camps at choke-points along travel routes
- patrols along search region boundaries (perimeter search) looking for the subject
- lookouts on high points as mentioned earlier
- establishing "track traps" on areas of possible travel. These traps will need to be checked regularly to determine if they have been disturbed.

Containment/confinement assignments are crucial in the earlier stages of a search and should be maintained throughout the search mission. You might see these assignments as particularly

unglamorous or mundane, but they are critically important. If we can be sure the subject has not left the search area, the opportunity for a find in the primary search area increases.

Active Search Approach:

Active tactics involve deploying search teams to conduct proactive searches in a region thought to contain the subject; the two key tactics are hasty and area searches.

Hasty Search

This refers to the ***rapid deployment*** of searchers to locations, or along routes, that are likely to contain the subject or clues of the subject's passage. This technique is commonly used in the initial phase of a SAR mission.

The hasty search is not limited to the simple "clearing" of a trail by walking along it looking for the subject although this is certainly a common hasty search assignment. Typical assignments include:

- Checking the immediate area, trails, road, buildings, campsites, and other high probability areas.
- Checking the Last Known Point (LKP) where the subject was last known to be.
- Checking the Point Last Seen (PLS) for clues to the subject's direction of travel, tracks, and other data that could be helpful.
- Hiking along and beside trails the subject might have taken and looking for clues including determining possible decisions points where the subject could have gotten off trail.
- Checking attraction features such as buildings, trails, roads, water sources or drainages that might have attracted the subject or that might yield clues to the subject. This is also known as Points of Interest or Spot searches

Segment Search

After the initial deployment of hasty search personnel, it is often necessary to search larger areas as well as other routes and attractive features.

Segment searches are often referred to as grid or line searches, but does refer also to route searches and sound sweeps. A team of searchers is generally organized along a line. The team moves deliberately through their assigned segment looking for clues. In some cases a team may be asked to repeat a search in the same area, but at right angles to the original line.

A segment search is much more resource-intensive than a hasty search and is by necessity more destructive of clues.

Segment Search Tactics: Segment searches can be classified as route search, grid search (loose, tight or evidence), sound sweep and expanding circle – these each have different methods of deployment of searchers. Searchers need to attempt to keep their spacing uniform throughout the assignment during segment searches to insure a thorough coverage. Leaders should select search area boundaries, whether the boundary is natural, man-made, or set up, that are easily identifiable by the search team. During route search, searchers may be spaced apart to achieve an Effective Sweep Width, a value normally determined by the search managers from AMDR experiments. The number of searchers, speed of searchers, size of search area and terrain are just some of the variables used in the equations to determine the Effective Sweep Width that could produce a desired POD for the search segment.

Route Search: The most common segment search tactic used is where searchers follow a track parallel to a side boundary and maintain a predetermined separation. The search area may be covered in multiple passes and purposeful wandering (explained below) may be employed.

Grid Search: The grid search tactic is to be utilized when the POD needs to be raised and when looking for unresponsive subjects, to include evidence. Grid searchers are normally conducted with a line of searchers moving through an area with the searchers tightly spaced and following a compass bearing, attempting to travel as straight as possible to insure thorough coverage. Grid searches can be further described as loose, tight and evidence, depending on the searcher separation as determined by the AMDR or the effective search width to obtain a needed POD.

Loose grid search: Loose grid searches require less effort to cover large areas but have a lower probability of locating the subject or any clues. The size of loose grid teams is generally three to five searchers who are separated by more than twice the AMDR. They are spaced closely enough to see one another, but there may be areas between them that are not being searched effectively.

Loose grid techniques are typically used early in a search, especially when:

- The search area is very large.
- There is insufficient information to suppose that one area is more likely to contain the subject than another.
- Insufficient resources are available to concentrate large amounts of effort in one segment.

Tight grid search: A tight grid search focuses on thoroughness to achieve a high POD. Searchers move through the assigned area in parallel tracks of spacing less than 1 ½ times the AMDR. Tight grid search teams are usually larger than a loose grid team to keep the search time within reasonable limits.

By being closely spaced, searchers scan overlapping areas. Thus an object between them is less likely to be missed and the POD rises. Conversely, the area they cover in a single sweep is reduced, and the effort and time required to search the segment is increased.

A tight grid search is not always appropriate and is a ”last resort” technique because:

- The gain in POD from the increased effort is not linear. Often the extra effort is better spent searching additional areas.
- A large search team moving through an area is more likely to destroy clues.
- Coordinating a large team in a highly-organized tight-grid search is time consuming.
- Searchers spend a lot of time on the organizational tasks instead of searching.

That said, when a high-POD search is an operational necessity, a tight grid search is the tool of choice.

Evidence search: An evidence search is an especially thorough tight grid search designed to find everything that can be found. As such, this technique is usually used at a crime scene or suspected crime scene where finding every single clue is more important than the time taken to find them. It is often used when the subject is known to be deceased and where time is no longer a factor.

Expanding Circle: This tactic is only effective for a small area and is primarily used around the Initial Planning Point (IPP). It is conducted by starting the search at the IPP or where a clue has been located and searching in a “spiraling out” pattern. It is best to use an experienced tracking/sign cutting team to avoid destroying clues such as tracks. This tactic can also be deployed to follow the contour of a hilltop working down, referred as a “contour search”

Sound Sweep: This tactic is typically used in conjunction with other tactics like area and route searches. A sound sweep may be conducted by an individual team without coordination. However, if multiple teams are in the field, synchronized sound sweeps will be coordinated by Incident Base by radio.

Purposeful Wandering: Grid searches are normally conducted by a line of searchers working parallel to each other in an attempt to search as much of the ground as possible. One approach to increase the POD for these techniques is to use "purposeful wandering" in which the searchers zigzag or weave through an area rather than move in parallel lines. By doing so, they increase their coverage by expanding the length of the travel path, and consequently, the time it takes to complete their assignment. It should also be noted that if searcher separation is more than 2X the AMDR, the opportunity for areas not to be covered does increase. The search should still be conducted by having one searcher form a guide line of trail tape and walk a straight bearing.

Emergency Locator Transmitter (ELT) Searches

Though not a search tactic per se, searchers should be aware of what is called an ELT search. In the case of aircraft accidents, a very rough landing or related incidents, the aircraft's ELT transmits radio signals. On newer ELT models, a UHF signal is transmitted to a satellite which can then provide coordinates for the ELT signal. This can significantly reduce the search area and make a find much quicker. On older ELT models, a VHF signal is transmitted with no corresponding satellite detection and location. In this situation, the search area can be very large.

The Incident Commander, notified of an ELT signal in his/her district, may contact the Area Commander to obtain air resources such as the Civil Air Patrol, State Police and/or Guard helicopters to narrow the search location. The Incident Commander may also call out specially trained ground teams using equipment that can receive the ELT signal and triangulate to determine the location of the aircraft.

5. FINDING AND HANDLING CLUES

The "Searcher Cube": While moving through the search area you must search the entire searcher cube around you. That is, you must look all around you; left, right, up, down, and behind. An important clue, or even the missing subject, might be obscured from view when it is right next to you, but clearly visible after you've passed it. If you don't turn around, you will miss it!

Practice searching with your team by laying out clues through an area and taking turns walking through the area looking for them. Experience shows searchers spend a disproportionate amount of time looking forward and to the right. They miss clues as a result.

Clue Awareness and Basic Tracking: You must be alert to clues subjects leave behind as they move through the search area. There may be only one subject, but there may be many clues. Concentrating solely on finding the subject may lead you to neglect important signs, such as:

- indicators left deliberately by the subject
- bits of gear dropped accidentally or shed in an attempt to lighten a load
- trash dropped
- subtle indicators left by moving through the area, e.g., broken branches

Footprints are by far the most common clue left by a subject. It is not always obvious that footprints found in the field belong to the subject. With some up-front homework, it is often possible to determine the type of footwear (size, sole pattern, etc.) worn by the subject and thus better qualify the clues.

Here are two helpful tricks for locating footprints:

Use a raking light: Hold a flashlight or your headlamp as close to the ground as possible with the beam pointing out in front, allowing the beam to illuminate the ground at a shallow angle. Doing so causes the edges of the footprint to cast longer shadows, thereby placing it in sharp relief and making it more visible.

Look for track traps: Track traps are areas where the ground conditions are particularly conducive to creating and holding footprints. Good traps are soils of uniform, fine texture and without a lot of other clutter such as rocks and branches. Examples include soft, moist soil; sand; and anthills.

The search techniques of tracking and sign-cutting require a very high level of clue awareness. While attaining these skills takes a great deal of training and practice, they have tremendous value.

Tracking refers to following marks made by the subject as he moves over the ground. In addition to footprints, marks might include tall grass bent over in the direction of travel or a path of disturbed dew or frost on the ground.

Sign-cutting refers to traveling around an area where the subject is trying to be contained, looking for evidence that the subject has crossed this boundary.

These techniques may be used as part of a containment/confinement strategy, as well as in area and hasty searches. If tracks can be found at a containment point and attributed to the missing subject, his direction of travel can be established. Resources can then be shifted to areas adjacent to the original containment area.

Handling Clues: If you find a relevant clue:

First, determine whether the object you find is something relevant. For example, finding a cigarette butt on a search for a missing young child is not generally a cause for excitement, nor would be finding a beer can during a search for someone known to have been hiking with only a water bottle.

Second, don't disturb the clue. Report the clue to Incident Base; they may ask you to provide a GPS fix of the item's location and/or mark the clue for other resources to investigate. (See *Chapter 5: Map and Compass* for a discussion of GPS receivers and how to use them.)

Mark around the object, without disturbing it, using brightly colored trail tape. In addition, hang a long piece of trail tape from a nearby tree or other feature so that it can be seen easily by approaching personnel. Write the date, time, mission number, and your team call sign on the streamer. Marked in this way, it should be easy for other teams to find the item. It will also prevent the same clue from being reported to Incident Base by other teams.

In some cases you may be asked to bring the clue to Incident Base. If so, you should certainly record the position where it was found, e.g., using a GPS receiver, and mark its location as discussed above. If the clue is to be used as a scent article for tracking dogs, special precautions must be taken to avoid contaminating the item. In that case Incident Base will instruct you how to proceed.

You may also be asked to photograph the clue. If so, include in the photograph an object that will show size and scale. It can be extremely difficult from photographs to determine the size and how an object is oriented unless there is some reference point in the photograph. A simple plastic ruler or other known size object can help investigators during the course of the incident. Another good item is a small plastic arrow to indicate north in the photograph. You should also record the date and time the photograph was taken.

6. DEATH SCENE

Unfortunately, you may come upon the search subject after he or she has died. If this happens to you, preserve the location as if it were a crime scene and immediately notify Incident Base.

When calling Incident Base, you should use the death code given to you at your briefing. (See *Chapter 2: Communications* for further discussion about the death and other codes.) The code conceals this sensitive information from anyone who might be listening on radios or scanners, i.e., the media and the family. This prevents news of the subject's death from being disclosed inappropriately. The first word that a family member has died should not come from the television news or from a reporter asking the family for comment.

If your team comes upon a subject believed to be dead, only one team member should approach the body. It is best if the person doing so has medical qualifications and/or is the team leader. The remainder of the team should stay well away from the scene and not trample any clues that might remain. Once the investigating searcher has confirmed that the subject shows no signs of life, that person should withdraw from the body using the same path used for approach, rejoin the rest of the team, and tape off the approach to, and if possible completely around, the scene. The death scene area must be protected.

It is a good idea to have a small disposable camera in your pack in case you are requested to take photographs of the death scene. This photographic information will be important to the field investigator from the New Mexico Office of the Medical Investigator (OMI) if he or she cannot go directly to the scene.

No one should move the body or clues until the OMI field investigator has approved the removal of the body, either directly or through the State Police. Also, a State Police officer may need to actually see the body and scene before the body is moved.

Upon return to Incident Base, keep in mind that family members may be present so comments or discussion regarding the death scene should be handled only in the presence of Incident Base staff and with extreme discretion.

7. DEBRIEFING AND SIGN-OUT

At the conclusion of you team's assignment, you will be debriefed by a member of the Incident Management Team (IMT). It is at this point that you will be asked if your assignment was completed as prescribed, suggestions for future searches, hazards in the area, etc. After debriefing, you may be given another assignment or released. When released, be certain to sign-out on NMSAR Form 211. The IMT will remain at IB until all personnel have been accounted for.

8. SUMMARY

Effective searching requires far more training and practice than most of us commonly assume. The dedicated SAR professional, paid or unpaid, should make every effort to study these skills and practice them regularly. Set up mock SAR missions with other area teams to increase your skill level. Contact specialty SAR teams to come and teach their specialty, e.g., high angle technical rescue, or tracking.

The art and science of searching has been changing over the years, so the continuous review of new material is highly recommended.

Chapter 5: Map and Compass

This Chapter covers the following topics:

1. Maps
2. Map Coordinate Systems
3. Using a Compass
4. Using GPS Receivers in SAR
5. Practice Exercises

1. MAPS

A good knowledge of maps is required of everyone in SAR regardless of their specialty. You may need a road map to find your way to base camp, a street map to locate a meeting location, or a topographic map to find and record your search area. This section will discuss the features of maps that you will most often encounter during searches.

A map is a way to depict certain features on the surface of the round earth as a projection on flat paper. Maps have been made for nearly every conceivable purpose. They may show land use, highways, waterways, school districts, etc.

The maps used most frequently in SAR are called topographic maps; they tell us about the elevation and land contours/features in an area as well as some man-made features.

Scale

The most important feature about a map is its scale. This relates the ratio of a distance on a map to what it is on the ground. The most common map scale used in SAR is 1:24,000 (found on the 7.5 minute quadrangle or 'quad' map), in which one inch on the map equals 24,000 inches on the ground. This is also equal to 2000 feet or the distance that you can walk in about 6 minutes at 4 miles per hour. These maps are published by the United States Geological Survey (USGS).

Other map scales sometimes used are 1:100,000 (Bureau of Land Management metric scale maps), 1:126,720 (US Forest Service maps), and 1:500,000 (aeronautical sector maps). In general, these are not detailed enough for use in ground search, but they may be useful in missing aircraft searches where large areas need to be covered.

In map terminology, 'large scale' means large detail, 'small scale' is small detail. A map with a scale of 1:100,000 (considered small scale) will show less detail than one with a scale of 1:24,000 (large scale).

Map Features

The general shape of land is shown by contour lines. These lines indicate positions of equal elevation. Contour lines never cross although they may often appear very close together. The altitude between adjacent contour lines is known as the contour interval, which is not always the same on all maps. It is not unusual for adjacent maps to have different contour intervals. The value of the contour interval is shown on the map legend. Elevation values are printed in several places along the major (index) contour lines.

Steep terrain is indicated by closely-spaced contour lines. If the contours are widely-spaced you can expect more gentle slopes. The general shape of contour lines gives you an idea of the type of terrain you can expect.

For example, mesas are usually quite distinctive. They appear as widely-spaced contour lines surrounded by contour lines close together; the latter represent the walls of the mesa. Figure 1 shows an example of a mesa.

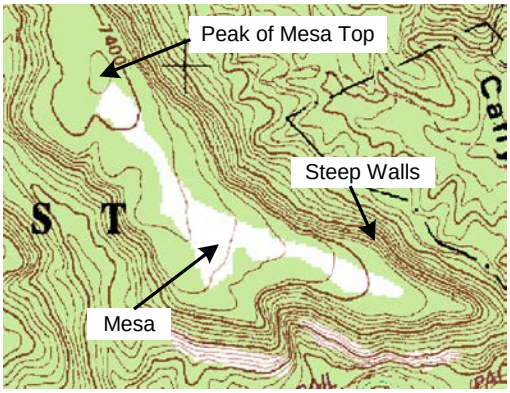


Figure 1: Mesa

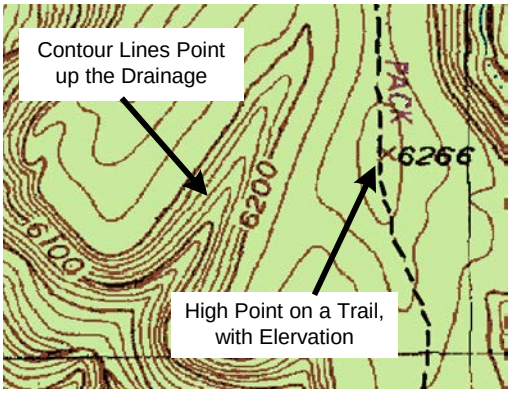


Figure 2: Drainage

Drainages are distinguished by contour lines that 'point' uphill. The direction of elevation change can be determined by examining the altitude associated with the contour lines. In the example of a drainage in Figure 2 you can see the direction is uphill since the elevation goes from 6100 feet to 6200 feet. Streams are often found in drainages. A solid blue line indicates continually-flowing steams. Intermittent streams are shown as a blue broken line:

Canyons may have very steep sides, shown by closely-spaced contour lines, or they may have more gentle slopes.

Figure 3 shows an example of a narrow canyon with steep sides and Figure 4 shows an example of a broader canyon with gentler sloping sides.

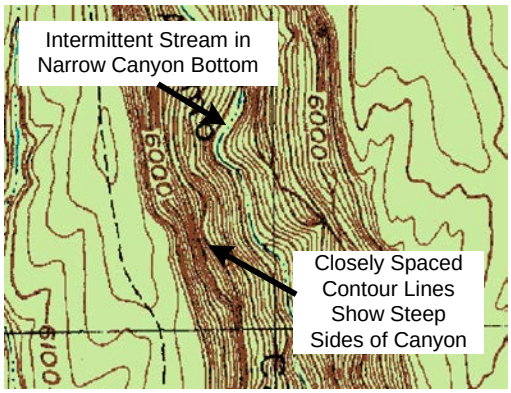


Figure 3: Steep Canyon

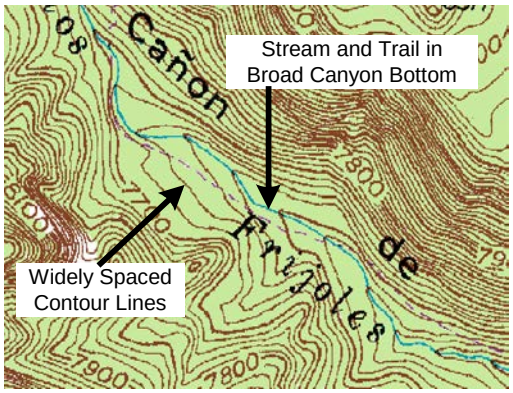


Figure 4: Broad Canyon

Ridgelines may be difficult to identify, as the surrounding terrain may be fairly gentle. They can be identified as places where contour lines 'point' downhill – rather than uphill as with drainages. Ridgelines often intersect. You should understand how to identify ridgelines as they are often used as boundaries for search areas. Figure 5 shows some examples of ridgelines.

A 'saddle' is a low point on a ridgeline. The contour lines resemble a horse saddle. Examining the altitude of contour lines can help identify it. Figure 6 shows an example of a saddle.

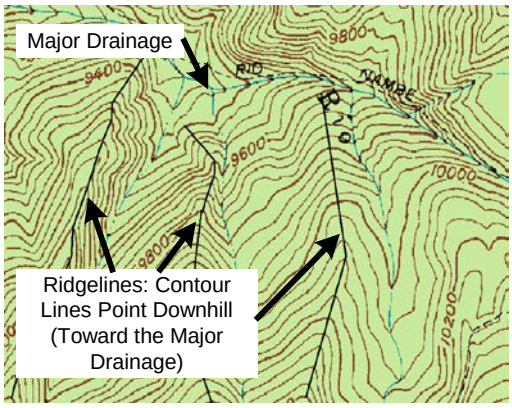


Figure 5: Ridgelines

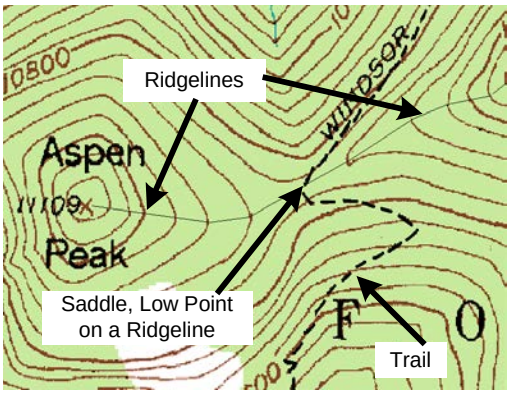


Figure 6: Saddle

Topographic Map Symbols

Many symbols are used to designate natural and man-made features on a map. The colors of the symbols indicate similar classes of information. Water (streams, lakes, ditches) is shown in blue. Contour lines are brown. Major roads are red, minor roads and trails are black. (Copied maps, of course, show all symbols in black or gray, so you will need to learn to interpret them from their shape.) Many other features are shown on the topographical maps, including: power lines, ranch water tanks and ponds, ranch airstrips, railroad tracks, mines and cave entrances, buildings, land cover, springs, dry lake beds and swampland.

A complete list of topographic symbols is available from the US Geological Survey's website (see *References*). From their home page, search for "topographical map symbols."

Map Datums

Another important feature of maps is their datum. A datum is essentially a starting point from where land was surveyed and maps were constructed. It also includes numbers that describe the shape of the earth. The difference in location *will be significant* among maps made with different datums. Therefore, be sure that you know what datum is used on your map and set your GPS receiver with the correct setting!

Most of our 1:24,000 topographical maps were made using the North American Datum of 1927 that is accurate only in the continental U.S. It is abbreviated as NAD27 (CONUS) in GPS receivers. Some newer maps are made with a different datum called WGS83, which is nearly identical to WGS84. At this time, about twenty New Mexico 1:24,000 maps are made with the WGS83/84 datum.

The following table may be used to make corrections from one datum to another. The values are accurate to within about 10 meters (about 33 feet) in New Mexico.

	NAD27 to WGS83	WGS83 to NAD27
East Coordinate:	Subtract 50 meters	Add 50 meters
North Coordinate:	Add 200 meters	Subtract 200 meters

2. MAP COORDINATE SYSTEMS

On nearly every search you will need to find your location on a map, either to locate yourself or to report it to Incident Base. In familiar territory you could describe your position as "*At the intersection of the East Fork with the Gila River*" or "*On the Winsor Trail at the Nambe Lake drainage*."

Many times, though, you will not have such convenient landmarks and will need to locate your position with reference to a grid of numbered lines on the map. There are two grids that can be used: latitude-longitude and Universal Transverse Mercator.

Latitude-Longitude

This grid system overlies the earth using two sets of lines. One set of lines converges at the north and south poles, while the other lines are parallel with the equator.

Latitude is a number that tells us how far we are north or south from the equator. This distance is divided into 90 parts called degrees. A degree of latitude equals 69 miles. The zero point for measuring latitude is the equator. In the northern hemisphere, latitudes increase in value going north away from the equator. Thus the country of Costa Rica is at 10 degrees latitude, while New Mexico is further north at latitude 37 degrees. In the southern hemisphere, though, latitude values increase going toward the south.

Longitude is a measure of distance in the east-west direction. The total distance around the earth is divided into 360 parts, again called degrees. At the equator a degree of longitude is 69 miles. But as you move away from the equator a degree of longitude represents fewer and fewer miles. (In fact, right at the poles a degree of longitude represents zero distance.) Unfortunately longitude numbers give us a

varying, not constant, measurement of distance. Because of this, our topographic maps are not square – they are always taller than they are wide. Nevertheless, pilots and others use this system because it covers the whole earth in a uniform manner.

The zero point for longitude is through a point in Greenwich, England called the prime meridian. Longitude values extend both west and east from this line. In the eastern hemisphere, longitude values increase as you go east. Where we live in the western hemisphere, values increase going toward the west, or right to left on our maps. (This is often confusing as we are used to numbers getting bigger going from left to right – as the way highway mile markers increase from zero at a state's western boundary to a higher value to the east.)

Both latitude and longitude distances must be subdivided into smaller units for practical use. This can be done in two ways or by using a combination of them.

- One way is to divide the units using the decimal system. A position might be described as 35.243 degrees north by 105.820 degrees west.
- A second way subdivides degrees in 60 parts, called minutes. Minutes can then be subdivided in 60 parts called seconds. Using this system a location would be reported as having latitude of 35 degrees, 14 minutes, 34 seconds and a longitude of 105 degrees, 49 minutes, 11 seconds.

It is not unusual for both systems to be combined and a location reported as 35 degrees, 14.567 minutes and 105 degrees, 49.183 minutes. There seems to be no standard way of reporting latitude-longitude. Therefore, you must say clearly what you mean by emphasizing the words 'degrees', 'minutes', 'seconds', and 'point' (or 'decimal'). For example you might say "*Thirty five degrees, fourteen point five six seven minutes*."

It is very difficult to determine the latitude and longitude of a point on the 1:24,000 scale maps we normally use in search and rescue work. The maps show few latitude and longitude lines, they are oddly spaced apart, and units of distance vary.

Latitude and longitude position reporting is used more commonly during a search for an aircraft emergency locator transmitter (ELT) or personal locator beacon (PLB), and by pilots assisting with a ground search. (See *Chapter 4: Search Techniques* for a brief description of ELT searches.)

Universal Transverse Mercator (UTM)

Because of the difficulties in using latitude-longitude, the UTM system of coordinates is more commonly used during a SAR mission for locating and reporting positions. It is consistent over the entire earth and is a decimal based metric grid system where UTM numbers represent equal distance values in both west-east and south-north directions.

In the UTM system, the earth is divided into zones, each of which is six degrees of longitude wide. There are 60 zones in the world. They are numbered, west-to-east, beginning at 180 degrees longitude. A metric grid and numbering system is placed on each zone. These grids and numbers are identical for each zone. The numbers we see in our zone will look just like those in another zone; only the zone number will be different. Most of New Mexico falls in zone 13. The western part of the state is in zone 12. Figure 7 shows how the zones overlay New Mexico.

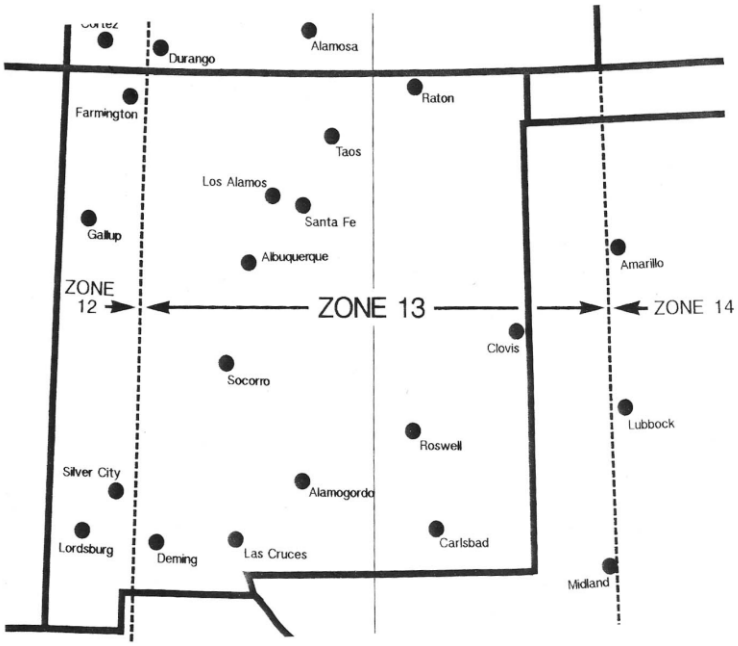


Figure 7: New Mexico Zones

Each zone has a square grid superimposed on it. The grid is oriented so that its vertical lines (south-north) are parallel to the center of the zone and the horizontal lines (west-east) are parallel to the equator.

The vertical grid lines represent the distance in kilometers in an easterly direction. The numbers in the west-east direction (sometimes called 'easting') are arranged so there will never be negative numbers. Making the UTM coordinate at the center of the zone equal to 500 kilometers does this.

The horizontal grid lines represent the distance in kilometers from the equator. In the northern hemisphere the zero point is at the equator and numbers increase to 10,000 kilometers at the North Pole. These numbers are sometimes referred to as 'northing'. (Incidentally, in the southern hemisphere, numbers begin as zero at the South Pole and increase to a value of 10,000 kilometers at the equator.)

UTM coordinates are typically stated with the east value first, then the north value is given. For New Mexico, a complete UTM position report consists of two values (at a minimum): an east value (number of kilometers eastward into either zone 12 or zone 13) and a north value (number of kilometers north of the equator). If the search area is near the border of zones 12 and 13, the zone number must be reported also. A zone with its coordinates is shown in Figure 8.

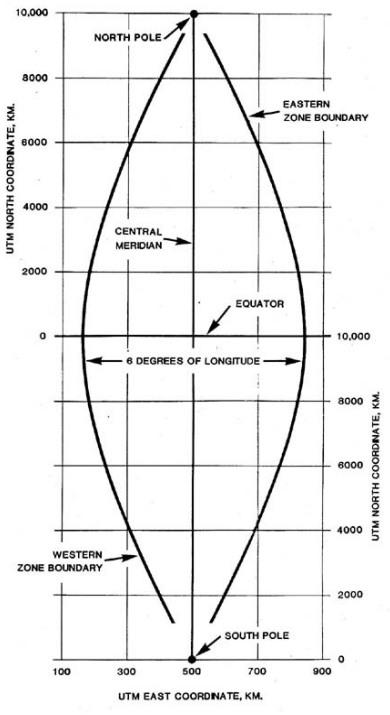


Figure 8: Zone with Coordinates

Notice that there is no real zero point for the east coordinate. The east coordinates range from 166 to 834 kilometers (at the equator.) The east coordinate (in kilometers) will always have 3 digits. North coordinates (in kilometers) in New Mexico will always have 4 digits. Therefore, you can always tell east from north coordinates by the number of digits they have. Notice, too, that the zone boundaries do not extend all the way to the poles. The UTM system is only used between 80 degrees south and 84 degrees north latitude. A different grid system is used in polar areas.

Remember that UTM east coordinates change abruptly when you move from one zone to another. If, for example, you are on a search in western New Mexico, one team may be reporting east coordinates in the 700s while another team may have coordinates in the 200s – even though they are less than a mile apart. This is because one team is in zone 12, the other in zone 13.

When using a 1:24,000 scale map, you must determine your UTM coordinates from grid lines that are printed on the map. Not all USGS maps have printed grid lines, but the positions of the lines are always shown on the margin or boundaries of the map with blue tic marks. The value of the coordinate is printed nearby. It may be necessary to draw the grid lines on maps if they are not there.

Let's say that you want to determine the UTM coordinates of your position, shown at point X on the map section in Figure 9. Your east coordinate will be somewhere between 459 km and 460 km. You will need to report its value to the nearest tenth of a kilometer. This requires that you estimate how far the point is to the right of the 459 km line. You can do this visually by first imagining a vertical line that is drawn half way between 459 km and 460 km. That will be 459.5 km. Half way between that line and the 459 km line would be 459.25 km. Point X would be a little to the left of that imaginary line or at 459.2 km. Similarly, in the north direction, point X would be on the 3976.5 imaginary line, and its coordinate would then be 3976.5 km.

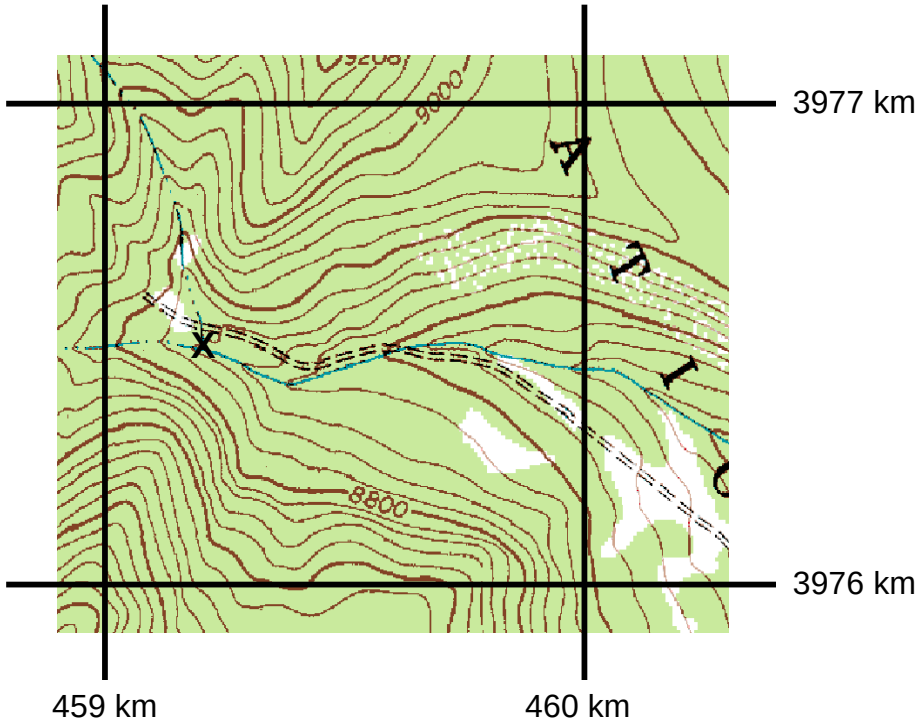
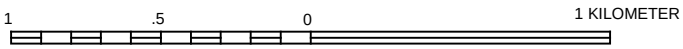


Figure 9: UTM Coordinates

If you were asked to report this location, you might say: "*I am located at the following coordinates: 459 point 2, E and 3976 point 5, N."*

In most cases this is adequate accuracy. You will have described your position to the nearest 0.1km, 100 meters, or about 110 yards (the length of a football field). That's close enough for most SAR purposes. If you found a clue at that location, you will need to mark it with trail tape so that others can find it.

You can use the kilometer scale printed on the bottom of the map to subdivide the grid. It looks like this:



The subdivisions on this scale can be transferred to a piece of paper or cardboard and then used to subdivide the UTM grid square. There are also grid readers and UTM interpolators available for this purpose.

Converting Between Coordinate Systems

UTM coordinates can be converted to latitude-longitude and vice versa. Solving these equations requires using a computer. Numerous programs are available. One can be found at the Mountain Canine Corps website. Others can be found with web searches. In the field, you can use your GPS receiver to make this conversion. For more information on using your GPS receiver, see section 4 of this Chapter.

3. USING A COMPASS

All SAR personnel are required to carry a compass. Correctly demonstrating its use is a requirement during the Field Certification examination. Several types of compasses are suitable. The orienteering compass provides the most value for SAR and is relatively inexpensive. Sighting compasses are excellent alternatives. They are a bit more expensive but are capable of taking bearings to the nearest ½ degree.

Parts of a Compass

A compass has three basic parts: a base plate, a magnetized needle, and a rotatable scale (see Figure 10). Despite being so simple, the compass allows us to do three critical tasks: take a bearing, follow a bearing, and use the compass as a protractor to determine directions.

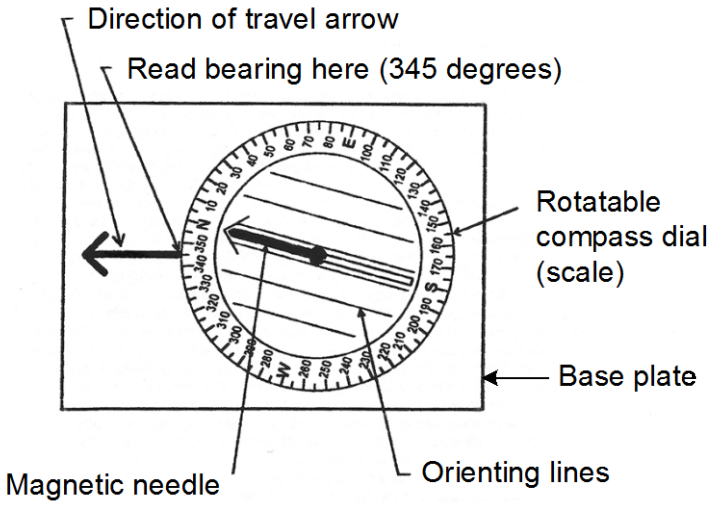


Figure 10: Compass

The compass needle aligns itself with the earth's magnetic field. This field is not very strong and can be easily overwhelmed by nearby magnetic objects. Anything made from iron is liable to cause an error. The speaker in radios contains a magnet and can cause errors, as can belt buckles. Working with your map and compass on the metal hood of your vehicle is not a good idea. Also, you may encounter magnetic materials in the field; iron ore is an example. Be suspicious of compass readings when you are searching in areas where mining has taken place. Experiment with your compass to learn what objects you might be carrying will deflect the compass needle.

The rotatable compass scale is calibrated into 360 parts, called degrees. The center of this scale has an arrow inscribed on it. Normally, this arrow points permanently to zero degrees (true north). Some compasses, however, allow you to adjust the position of this arrow to compensate for magnetic declination. (Declination will be discussed later in this Chapter.) To use this feature, rotate the arrow so that it points to the local declination rather than to true north. Don't forget to state whether the bearing is true (includes the declination) or magnetic when you report your location to Incident Base.

The compass base plate will usually have an arrow printed on it. This is called the 'direction of travel' arrow. It should always point away from you when you are taking or following a bearing. Compasses

without the arrow have a line inscribed under the scale. This is the part of the compass that will face away from you. Orienting lines on the base are useful in aligning the compass on a map to true north.

Taking and Following Bearings

To take a bearing (i.e., to determine the compass direction from you to a distant object) hold the compass in a comfortable position in front of you and rotate yourself and compass to face that object. Then allow the compass needle stop moving. Rotate the compass scale so that the arrow in the scale lies directly under the north-pointing end of the needle. (The end of the arrow may be colored red or have some other distinctive marking.) Read the value of the magnetic bearing at the direction of travel arrow or at the line inscribed under the scale.

Following a bearing (also known as a heading) uses the same steps but in a different order. First, rotate the scale until the direction you want to go is opposite the direction of travel arrow. Then hold the compass in front of you and rotate your body until the north end of the magnetic needle is directly over the arrow inside the scale. Walk in that direction keeping the needle over the arrow.

Both of these procedures will require some practice, possibly during team training sessions. Also, orienteering has become a popular activity. Going to an orienteering meet can provide you with excellent practice and instruction. More information can be found at the New Mexico Orienteers and other orienteering websites.

Measuring and Plotting Bearings

A compass can also be used as a protractor to plot and measure bearings. You will not use the magnetic needle during this procedure, so you can ignore nearby magnetic or metal items. Only the rotatable compass scale and an edge of the base plate are used.

To measure a bearing (or angle) between two points, first draw a line on a map that connects them. Then place the edge of the compass base plate along this line. Rotate the compass scale until north on the scale (zero degrees) points to north on the map. Read the bearing at the direction of travel arrow or at the north mark under the scale. This will give you the true (not magnetic) bearing between the points.

Plotting a direction of travel is done by first setting that value opposite the direction of travel arrow. Put the edge of the compass base plate on the location of your starting point. Keep it there while you rotate the whole compass until north on the scale points to true north on the map. Draw a line along the edge of the compass through the starting point. This will be the desired direction of travel.

Using Triangulation

Triangulation is a way to locate your position on a map by taking compass bearings on two or more distant points and plotting them on a map. The point where the plotted lines intersect will be your location.

Here's an example: Let's say you are somewhere in the area shown on the map in Figure 11. You look around and decide that you can visually identify both Kennedy Point and the peak of the hill marked with the elevation of 10,420 feet. You use the procedure outlined earlier to take bearings from each of these two landmarks. Taking magnetic compass bearings you get the following:

Magnetic bearing to Kennedy Point = 231 degrees.

Magnetic bearing to peak 10,420 = 157 degrees.

Our map reference is <u>true</u> north but we have taken magnetic bearings. Therefore, we must convert from magnetic to true. The magnetic declination in this area is 10 degrees (see the next section for more information on this conversion process), so we make the following correction arrive at true bearings:

True bearing to Kennedy Point = 231 + 10 = 241 degrees.

True bearing to peak 10,420 = 157 + 10 = 167 degrees.

Now, we need to plot lines from those points to find our location. From our bearings, we know the directions *from us to the landmarks*. But, to find our location, we must work in reverse to find the directions *from them to us;* that is, 180 degrees (or half a circle) away from our bearings. This is called the 'back bearing'. We get this by adding or subtracting 180 from our true bearings. We either add or subtract 180 so that the result *is less than* 360 degrees. Here's the math:

Back bearing from Kennedy Point = 241 – 180 = 61 degrees.

Back bearing from peak 10,420 = 167 + 180 = 347 degrees.

Now we can use our compass or other protractor to plot lines from the two points. We are at the intersection of the two lines. This is shown in Figure 11, below.

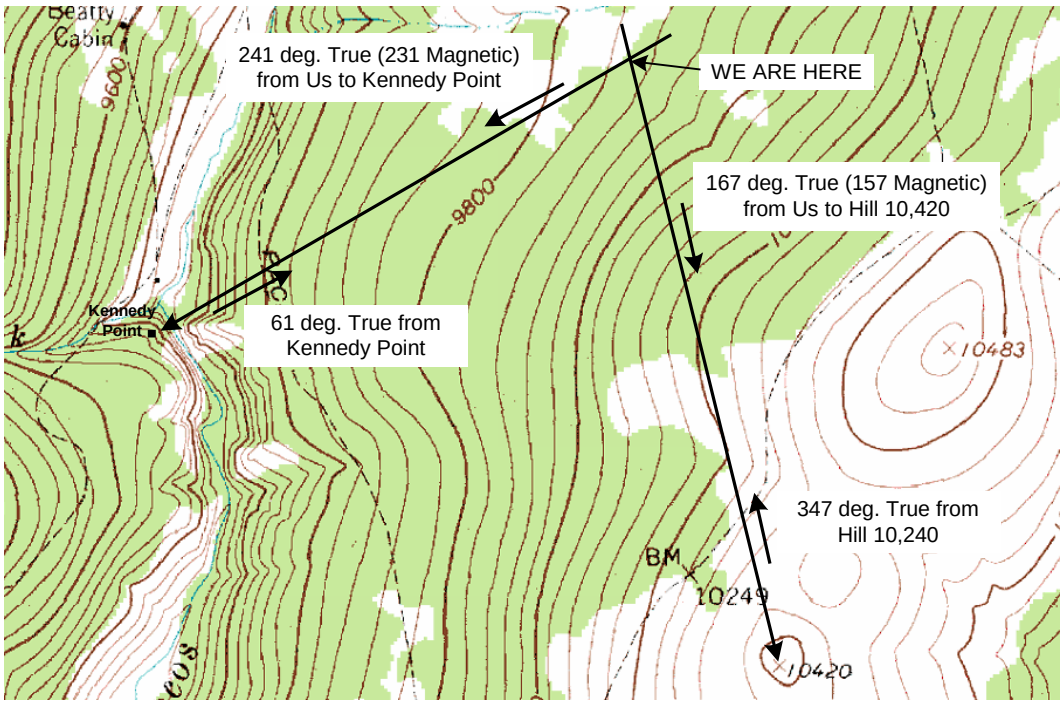


Figure 11: Bearings and Triangulation

Magnetic Declination

A compass needle does not point to true north. Instead, it aligns itself with the earth's magnetic field. The difference between true north and magnetic north is called magnetic declination. Magnetic declination is not a constant value – it changes with location and with time.

In New Mexico in 2006 the declination varies across the state from a value of 8.5 degrees at the southeast corner of the state to 10.5 degrees at the northwest corner. The rate of change is about one degree every 15 years.

Declination can be found on USGS maps on a diagram below the mapped area. It shows three arrows. One points straight up towards a 'star' that represents the North Star or true north. Another arrow points off to the right (in New Mexico) and has the letters "MN" at its end, which stands for magnetic north. The difference between true and magnetic north is shown on the diagram. The units of measure are degrees. A date is associated with the declination value. Be sure to make note of this date if you are using a very old map as the declination may have changed since the map's printing.

Correcting for magnetic declination is easy but may not be immediately intuitive. The rules for New Mexico (where magnetic declination is east) are: add declination to magnetic to get true or subtract declination from true to get magnetic ("ADD TO MAG" or "SUB FROM TRUE"). Putting a sticker on your compass with these hints will help you get it right when you are tired and sleepy.

A good reference for magnetic declination is at the National Geophysical Data Center section of the National Oceanic and Atmospheric Administration's website. Graphs of declination can be found there. You can also enter locations and dates for which exact declinations will be calculated.

4. USING GPS RECEIVERS IN SAR

GPS receivers have become an important item in our bag of tricks. It has made life much easier for everyone since we can immediately know your team's location and plot it on a map at Incident Base. GPS receivers can also be set to record your track while on an assignment. These data can be downloaded and printed on a map. This is particularly valuable if a search lasts more than one day and the new staff needs to know exactly what areas had been covered previously.

How They Work

GPS receivers work by receiving radio signals from orbiting satellites. The transmitted data contain very precise timing signals and the location of the satellite. Many satellites may be 'visible' to the receiver at a given time, and it will use them to provide the best geometry for an accurate position.

If you are in a location that shields part of the sky from certain satellites, the position accuracy may be less than desirable. There is little that we can do about this, however. Another factor that affects location accuracy is the quality of the timing signals that are received. If they are delayed the accuracy will be reduced. Anything that slows the signal as it comes to your receiver will contribute to position errors. Being in a heavily forested area will slow the signals. Also, signals may be reflected from a canyon wall, be delayed, and cause errors. If at all possible, try to find a place that has a clear view of the sky when taking a GPS reading. If you can't do that, an error of several hundred feet in your reported position may result. Having additional information – such as being on a certain trail – might help to make a better estimate of your position. Let Incident Base know if you suspect your location is not accurate when reporting in.

Datum

Be sure you set up your GPS receiver to correspond to the datum of the map you are using. This will be either NAD27 (CONUS) or WGS83. (There are many choices on your receiver, so scroll through them all to find the right one.) The coordinate style should be set to UTM (or UTM/UPS on some receivers). Ensure you and Incident Base are using the same datum.

Position Display

The position display on GPS receivers may contain more information than is needed. You need not report everything on the display. For example, the screen may show:

13	**S**	**0384521**
UTM		**4014683**

The number 13 is the zone number. It will rarely change during a search so there is no need to report it unless you are near the border between zones on the west side of the State. The letter "S" does not need to be reported, but be aware that it is not always an "S". And yes, we know that these are UTM coordinates; don't report those letters either. We are left with two numbers: the UTM coordinates that give our position. The leading zero in the first number has no meaning and can be ignored. The remainder of that number has 6 digits. This identifies it as the east coordinate in meters. The other number has 7 digits indicating the north coordinate in meters. However, most people report them as displayed, giving 7 digits for each coordinate.

Someone will need to convert these units to kilometers for map plotting. That is done simply by moving the decimal point 3 places to the left and rounding the number to the nearest tenth of a kilometer. The above coordinates, in kilometers, would be:

384.5 (E)

4014.7 (N)

You can make these changes when reporting coordinates if you feel comfortable doing so. If not, just report the two numbers as you see them on the screen.

Tracking Your Progress

There are special settings on your receiver to record your track. You may have a choice of recording track points after specified time or distance intervals. Another choice is to record your position after you change direction of travel; this setting works well and records adequate information without running out of memory. Start the tracking feature soon after leaving base. Be sure to turn it off when you return so that extraneous information is not recorded.

Waypoints

Waypoints are positions you record (i.e., 'mark a waypoint') on your GPS receiver. These positions can be used to plot a path from Incident Base to a particular point in the field. For example, you see there is a mesa between you and your destination. Using a map, you can pick several points around the mesa that will provide a smoother path to reach your destination. Record these waypoints into your GPS receiver. You then use your GPS to travel from one point to the next, eventually arriving at your destination.

Of course, using your GPS receiver to record several waypoints on your path while on a search assignment (e.g., at points where you leave an established trail) is also handy. You can then use these waypoints to follow your path back to Incident Base, if necessary.

GPS – in Summary

The discussion in this section was very general because there are many models of GPS receivers in use today. Get familiar with your own model of GPS receiver and be sure you can:

- Change your GPS datum,
- Change between UTM and latitude-longitude coordinates,
- Reset and initiate track logs,
- Enter and recall waypoints, and
- Use your GPS to set up routes to a waypoint.

Using your GPS receiver will require some practice since it can do many things. Don't wait until you are on a mission to learn how to use it.

5. PRACTICE EXERCISES

1. On the map in Figure 12, identify the following features:

A. Mesa _____
B. Steep cliffs _____
C. Intermittent stream _____
D. Drainage going uphill to the northwest _____
E. Ridgeline _____

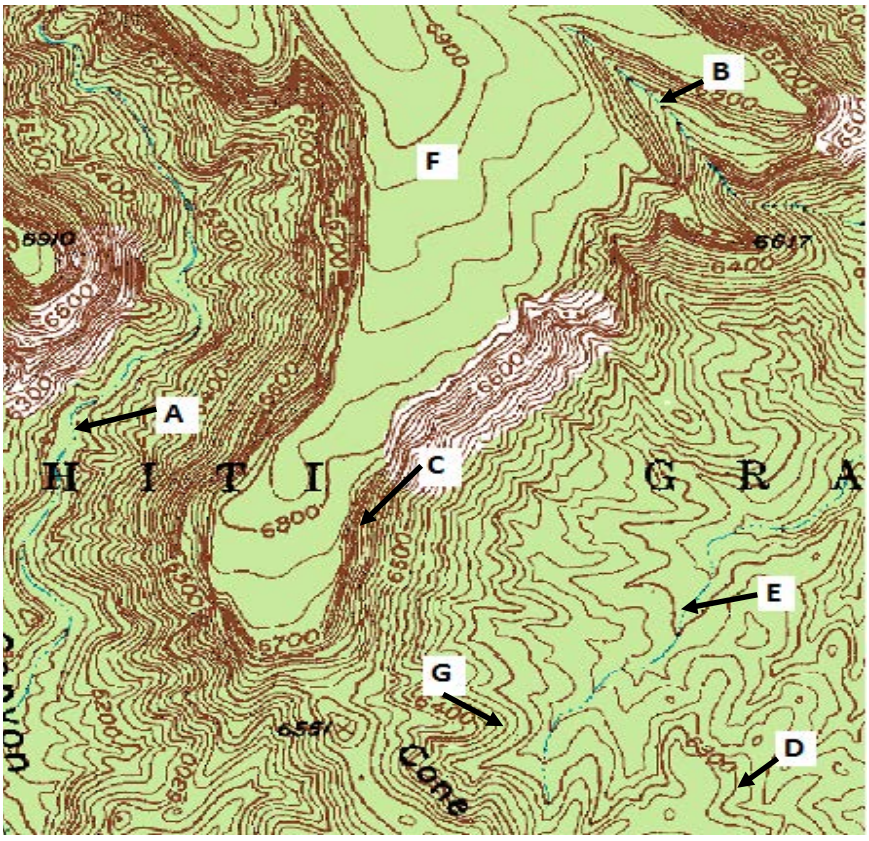


Figure 12: Exercise 1

2. On the map in Figure 13, what are the UTM coordinates at the cross in kilometers of:

A.		E		N	E.		E		N
B.		E		N	F.		E		N
C.		E		N	G.		E		N
D.		E		N	H.		E		N

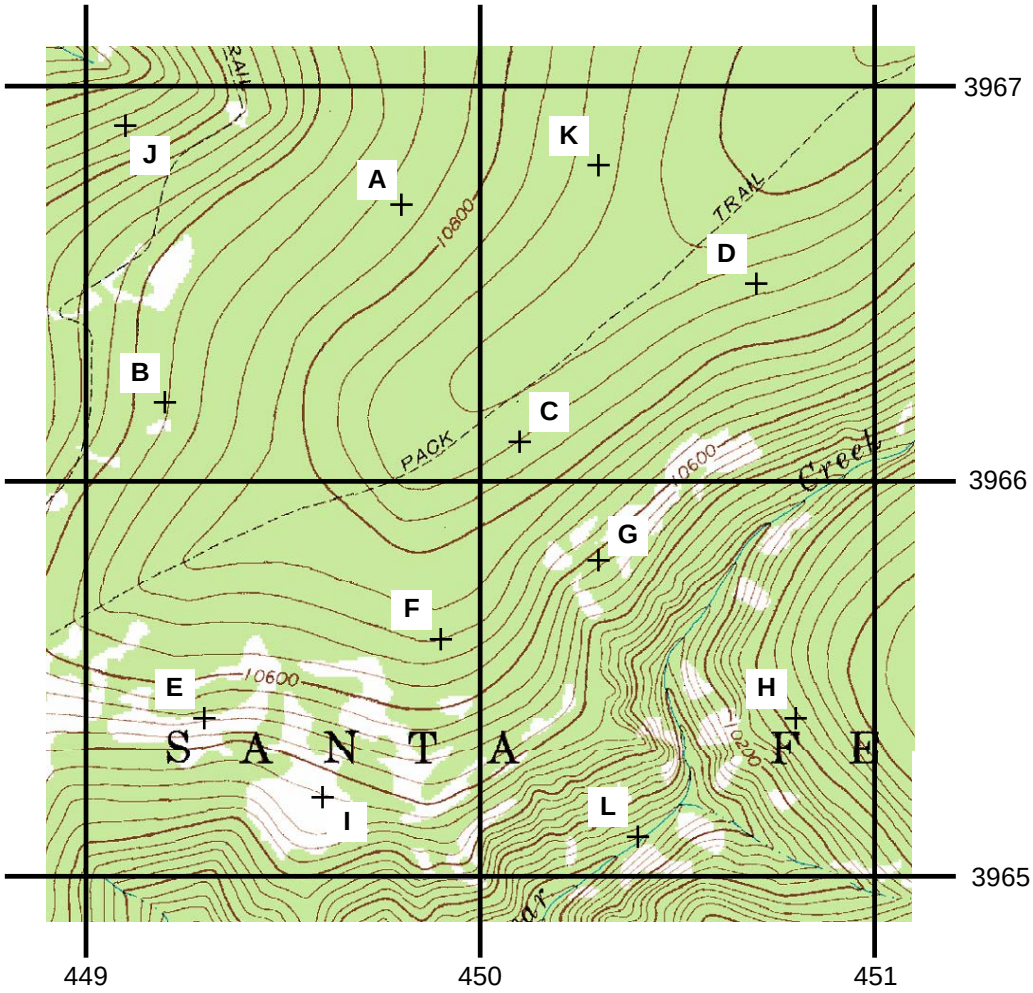


Figure 13: Exercises 2 and 3

3. In Figure 13, what points on the map correspond to the following coordinates as displayed on a GPS receiver?

A. 0450312E 3966797N…… _____
B. 0449598E 3965210N…… _____
C. 0450396E 3965112N…… _____
D. 0449097E 3966911N…… _____

4. Your GPS receiver consistently shows coordinates that are different from other receivers and are not consistent with map locations. Which one of the following is most likely to be the cause of this problem? _____

A. Low battery
B. Incorrect datum setting
C. Poor GPS coverage

5. What geographic feature is shown in the center of the map in Figure 14 at the point where the trails intersect? _____

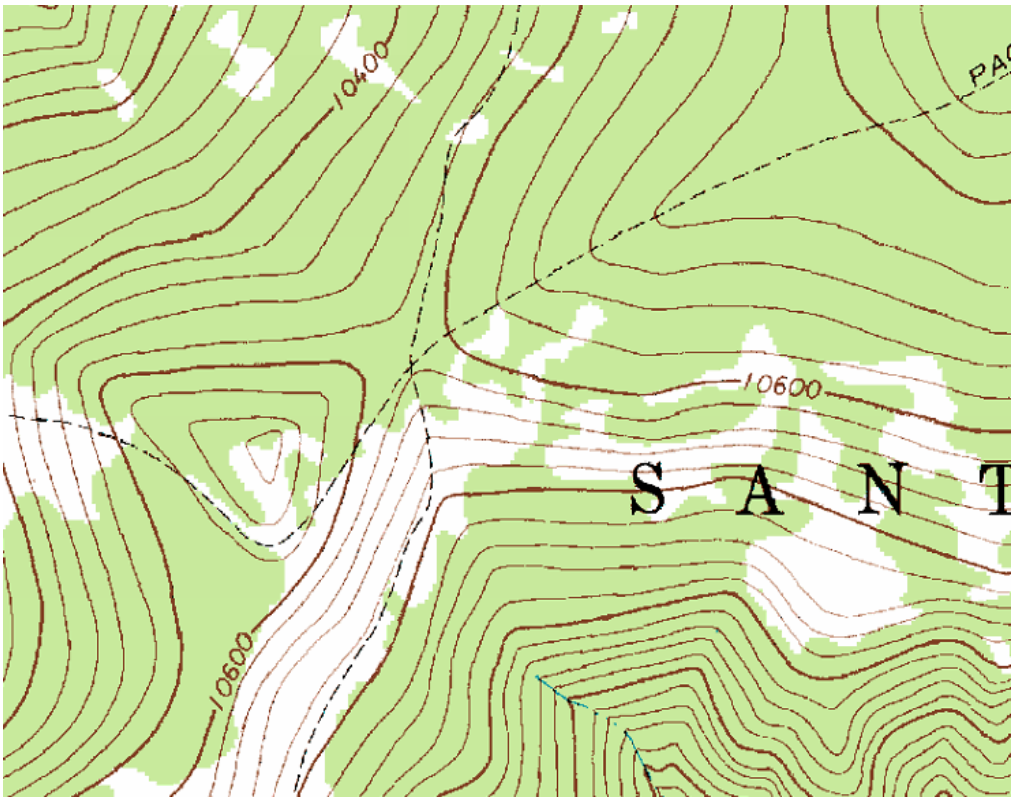


Figure 14: Exercise 5

6. Your team has been assigned to do a line search along the ridgeline shown by the wider dashed line on the map in Figure 15, below.

A. What magnetic compass bearing would you follow on this route? The magnetic declination is ten degrees. _____

B. Would you be traveling uphill or downhill? _____

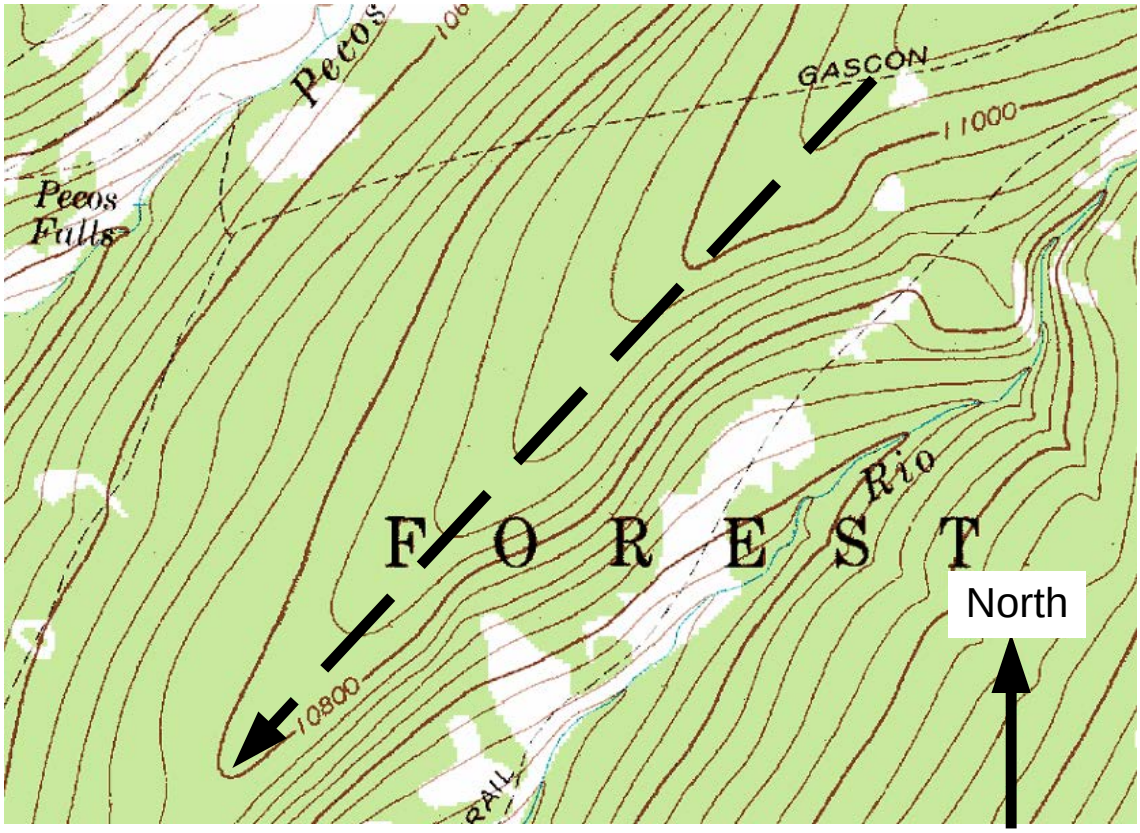


Figure 15: Exercise 6

Exercise Answers

Exercise 1:

A. **F**
B. **C**
C. **A and E**
D. **B**
E. **G**

Exercise 2:

A. **449.8** E, **3966.7** N
B. **449.2** E, **3966.2** N
C. **450.1** E, **3966.1** N
D. **450.7** E, **3966.5** N
E. **449.3** E, **3965.4** N
F. **449.9** E, **3965.6** N
G. **450.3** E, **3965.8** N
H. **450.8** E, **3965.4** N

Exercise 3:

A. **K**
B. **I**
C. **L**
D. **J**

Exercise 4:

B (Incorrect Datum setting)

Exercise 5:

Saddle

Exercise 6:

A. **213 degrees magnetic**
B. **Downhill**

References

Chapter 1: Gear and Clothing

Some of the information in the Gear and Clothing Chapter was gathered from various websites, including the National Association for Search and Rescue (NASAR) website (currently at http://www.nasar.org/nasar/) and various SAR team websites. The 1997 version of the *Study Guide for Search and Rescue Field Certification* was also used.

Chapter 2: Communications

Some of the information in the Communications Chapter was gathered from various websites, including the National Interagency Fire Center website (currently at http://www.nifc.gov/).

A good source for communications in caves is *On Call*, edited by John C. Hempel and Annette Fregeau-Conover, and is available from the National Speleological Society website (currently at http://www.caves.org/).

Chapter 3: Safety in Search and Rescue

Some of the information in the Safety in Search and Rescue Chapter was gathered from various websites, including the National Weather Service website (currently at http://www.nws.noaa.gov/) and websites like MedicineNet, Outdoor Action, and the British Columbia SAR website.

The Helicopter safety information came from Kim Wallis, former NMSP Helicopter pilot. Much of this information can be obtained at Helicopter Safety training sessions held in New Mexico at least once a year.

Chapter 4: Search Techniques

The material in this chapter is available in more detail in chapter 14 (Search Operations) of *Fundamentals of Search and Rescue*, published in 2005 by NASAR and available through their website.

Details of the aspects of search theory are explained in *Principles of Search Theory* by Jack R. Frost, available from the NASAR book store.

An explanation of the measurement of sweep widths for land SAR is available in a report by R. Quincy Robe and Jack R. Frost entitled *A Method for Determining Effective Sweep Widths for Land Searches*, available at the National Search and Rescue Committee (NSARC), US Coast Guard Operations Group website (currently at http://www.uscg.mil/hq/cg5/cg534/default.asp . See also the report *Sweep Width Estimation for Ground Search and Rescue* by R. Koester, D.C. Cooper, J.R. Frost and R.Q. Robe, also available at the NSARC website.

Chapter 5: Map and Compass

For more detailed information on the UTM system, see *The UTM Map Coordinate System*, by Robert Cowan, fall 1990 issue of *Response* magazine.

A complete list of topographical map symbols can be found on the United States Geological Survey's website, searching the website for "topographical map symbols" (currently at http://erg.usgs.gov/isb/pubs/booklets/symbols/topomapsymbols.pdf).

For more information on Orienteering, try the New Mexico Orienteers website (currently at http://www.nm-orienteers.org/) or do a web search.

To download a copy of coordinate system conversion programs, go to the Mountain Canine Corp's website (currently at http://www.mc2sar.org/) or do a web search.

For a good reference on magnetic declination, go to the National Geophysical Data Center's website (currently at http://www.ngdc.noaa.gov/geomag/declination.shtml).