# Communications and Accountability



Unit 23: Communications and Accountability
Date Last Updated: February 19, 2020





## Communications

- Radio – limited resource, shared locally and globally
- International convention on shared use of radio spectrum
- National laws implementing the international agreements
  - US: FCC – Federal Communications Commission
    - Specific rules for specific Radio Services

For communications in SAR we tend to rely heavily on portable radios.

Seems simple, push the button and start talking...

Lots more than that involved in communicating effectively and professionally.

Radio frequencies are a limited resource, some sorts of radio signals readily travel around the world, so there is an international convention on how to share that limited resource, and national implementations.

In the US, the Federal Communications Commission produces specific rules for different radio services – public safety is one radio service, amateur radio another, broadcast television another, etc.



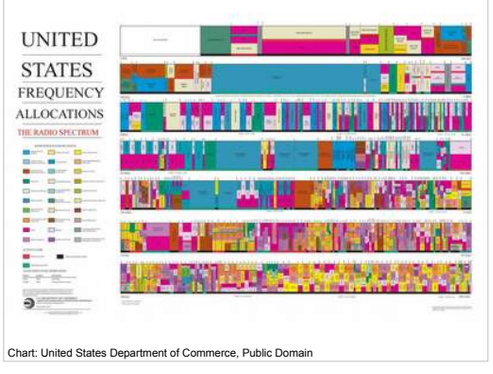


Chart: United States Department of Commerce, Public Domain

Here is a visualization of radio frequencies are allocated in the US by the FCC.

Very detailed: Lots of complexity.



## Radio Services

- No License required
  - FRS
  - MURS
  - CB
- License required
  - Amateur Radio Service (individuals)
  - Public Safety (public safety agencies)
  - Land Mobile (commercial)
  - GMRS (families)
- [Marine]

Some radio services require a license, some do not. Capabilities of services vary considerably.

Marine radio service is limited to marine use only, land to land communication not permitted (no shore to shore communication).

Licensed operation under the Amateur, Public Safety, and Land Mobile all have more capabilities, including distances covered, that the FRS, MURS, and CB radio services.

- FRS, No License, Small set of shared frequencies, 0.5 watt, FM, UHF.
- GMRS, License per family, Small set of shared frequencies, 7 shared with FRS, 8 repeater pairs, Typically 1-5 watt, up to 50 watt, FM, VHF.
- Citizens Band. No License. Small set of shared frequencies, AM, HF.
- MURS, No License, Small set of shared frequencies, 2 watt, FM, UHF
- Public Safety. License per agency, frequency coordination through coordination body (APCO), one or a few frequencies. May be encrypted, VHF or UHF, 11KHz FM, can be Trunked digital, often repeater pairs.
- Amateur Radio. Individual license, written tests. Multiple bands, many frequencies, repeaters, digital networks, location beacons, video, many different capabilities.

Here's some of the capabilities of some of the radio services potentially usable by SAR resources.



## Parts of a Radio

- Antenna
- PTT button
- Battery
- Volume control
- Squelch control
- Speaker
- Microphone

FRS Radio: Open Clip Art

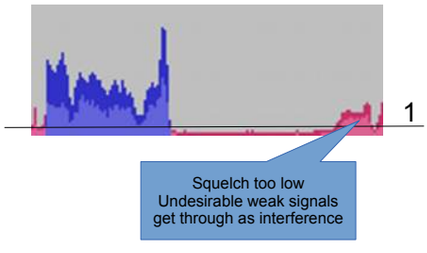
Get to know your radios.

PTT button, location of the microphone, battery level, volume, squelch.

Squelch may be hidden behind a menu rather than a physical dial.



## Squelch



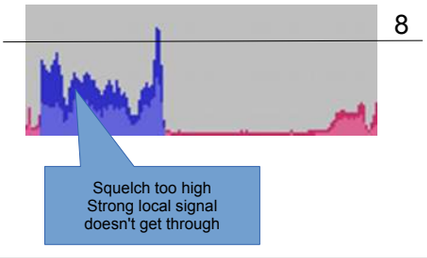

Squelch control lets you decide how strong a radio signal needs to before the radio will turn it into sound and play it over the speaker.

Turn squelch down to zero and you will hear the background noise of the universe – static, until a signal comes through.

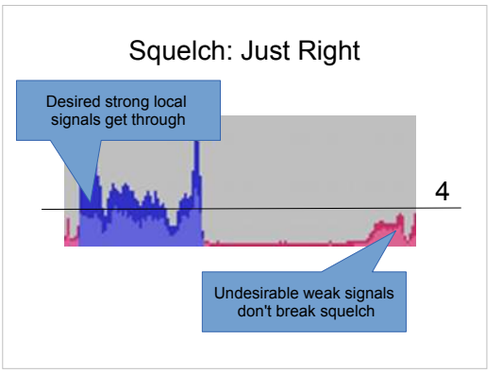
Set a low squelch level, and you will hear weak signals, this may be undesirable, they may be other people at a distance using the same frequency for something else. Or, it may be desirable, you may need to turn down the squelch to hear a transmission at distance in terrain.



## Squelch



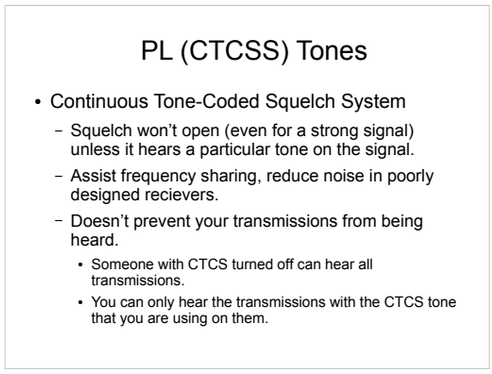

Turn the squelch up too high, and you won't be able to hear most of the strong local signals you are interested in.




You've got the squelch set right when you can hear the signals you want to hear, but not other weak signals.

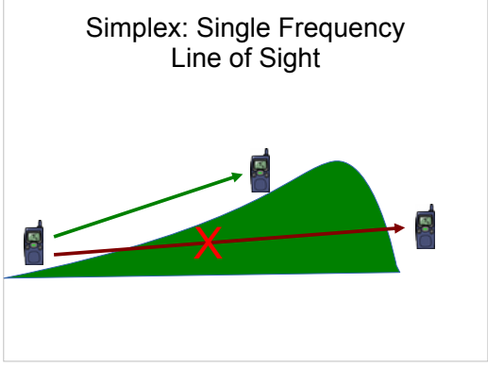
In general, you want the squelch set just above the noise background – turn the squelch down until you hear static, then turn it up slightly so that the radio goes quiet.






PL Tones (nothing to do with privacy): A tool that can help you to reduce the amount of unwanted noise you have to hear.





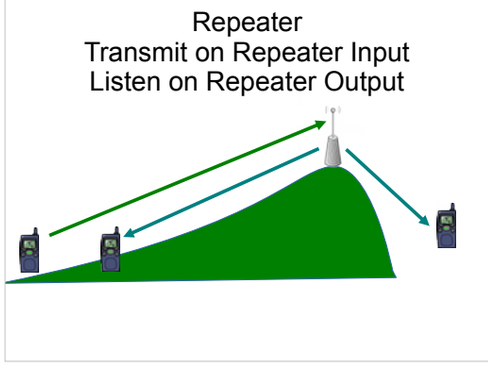

You will often be operating radios on a single frequency (simplex), line of sight.

Terrain gets in the way (hills, gullies, etc.).

Buildings get in the way.

You probably won't be able to talk to another station on the other side of a hill.






In some services, repeaters can be used, an radios are programmed to use two frequencies at once.

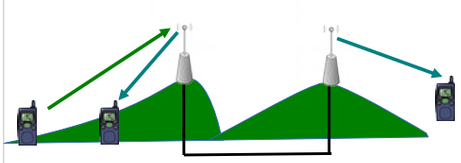
A repeater is placed on a high point (or a tower on a high point).

Radios transmit on one frequency. The repeater listens on this frequency. The repeater re-transmits the signals it receives on a second frequency. All the other radios are listening to this repeater output frequency.

Everyone who the repeater can hear can talk with anyone else who can hear the repeater.

Radio systems can also use multiple linked repeaters.

## Linked Repeaters
## Transmit on Repeater Input
## Listen on Repeater Output



Public safety systems often use linked repeaters – any repeater can pick up a transmission, and all of the linked repeaters will retransmit it.

These systems may also be trunked – and may support complex frequency sharing.



## Troubleshooting Radio Communications

- Some common sorts of issues
  - Low Battery: Radio transmits briefly then drops out. Radio can hear transmissions but won't transmit.
  - Loose speaker/microphone connector: Radio appears to be on but isn't transmitting and/or you can't hear anything.
  - Weak, broken signals: Hold the radio up in the air, antenna vertical. Turn down the squelch. Hold the radio vertical over the top of a car. Move to higher ground

Train as you search.

Use your radios regularly in training.

Under stress, you tend to revert to training.

Understand their capabilities.

Give problems an opportunity to arise, then work them through.

First word or so lost in a transmission?

Probably Operator error, not pausing before talking.

So:



## Using a Radio

- **Plan** what you are going to say.
- Listen to make sure channel is clear.
- Press PPT button.
- Pause.
- State your message.
- Release the PPT button.
- Establish contact then transmit message.
- Use plain English, no codes.

Think out your (brief) message.

Listen (don't step on someone else who is transmitting).

Press Push To Talk (PTT).

Pause. Then start talking.

First call up the station that you are trying to reach, then when you've established contact, transmit your message.

Plan out what you are going to say to help keep the transmissions short (someone else might have something more important to say than you).



## Establishing Contact

- One Convention:
- Your call **to** the station you are calling:
  - Ground Team 3 **to** Operations
- Another Convention:
- The station you are calling **from** your call:
  - Operations **from** Ground Team 3

Two methods for establishing contact (for initiating communications).

You TO the station you are calling.
**Or**
The station you are calling FROM you.

Within an agency, often one convention adopted and the pro-word left out. "Ladder 2, Control". Common among people who are talking to each other all the time, know each other's voices, etc.

For multi-agency response, use a pro-word (and settle on the convention that emerges in the incident).

Doesn't particularly matter which convention.

## Failure Modes: If you start talking before transmitting

- Your call **to** the station you are calling:
  - m 3 **to** Operations
  - This is Operations, station calling, go ahead.
- The station you are calling **from** your call:
  - **from** Ground Team 3
  - ????

With one difference between the two conventions:

It is not unusual for the beginning of a transmission to be lost (someone starts talking before pressing down the PTT key, someone keys up a repeater and starts talking before it picks up the signal and starts repeating it).

The typical failure case of the beginning of a transmission being lost is more easily recovered in the me TO you order than in the you FROM me order.

Better: **Avoid the Problem:** Remember to start transmitting, pause, and only then start speaking.



## Call Signs: Who are you calling

- ICS Positions
  - Command: The incident commander
  - Operations: The operations section chief
- ICS Locations
  - Base: A logistic support base
  - Staging: A staging area
- Functional call signs
  - Ground Task Force 5:
  - Ground Strike Team 3:
  - Team Pippa (Single Resource)
  - Control (or Fire Control, or Dispatch: a PSAP center)

In general, don't call people by name over the radio, call their call sign – usually a handle for their functional role in the incident.



## Acknowledge **and** Echo Back

- *task:* Task 4 to Operations
- *ops:* Go ahead Task 4
- *task:* Completed assignment, returning to pickup point.
- *ops:* **Acknowledged, task 4 completed assignment, returning to pickup.**

When someone communicates some message to you do two things:

(1) Acknowledge their message.

(2) Repeat it back to them.

Why?



Take out your notebook and a pen
Turn around
Prepare to copy a location

19T 0297385 4710843

Have most of the class turn around and prepare to copy the coordinate.

Have one member of the class read out the coordinate.

Then (click to display the text),

How well did everyone copy the coordinate?

Take out your notebook and a pen.
Turn around.
Prepare to copy a location.

19T BH 87446 09591

Repeat with this location, except have one member of the class read out the coordinate while **writing** it down (forcing them to read more slowly).

Discuss.

Was this easier to receive? Why?



## What To Say

- Radio check when departing staging.
- Call in when starting assignment.
- Welfare check, often every 30 minutes.
- Call in upon completion of assignment.
- Clues, with location (unless directed to call in by cell phone).
- USNG Coordinates in **full**, unless some other practice has been established in the search (e.g. first 4 digits each of easting and northing).

Always call for a radio check before departing staging – make sure that your communications work before you begin an assignment.

Call in when you start on an assignment.

There should be a radio check of all deployed resources in a search, typically every 30 minutes.

Call in when you complete your assignment.

Call in clues, unless you've been directed otherwise.



## Choose Words For Clarity

- Affirmative instead of (Yes, OK, 10-4)
- Negative instead of No
- Obtain instead of Get
- Standby instead of Wait
- Received, Acknowledged instead of (OK, 10-4)
- Niner for 9
- Numbers individually: 12 as "one two" not twelve.

Get into the habit of using words that can be clearly understood over the air.

Avoid the use of codes (that's also an ICS expectation, use plain language for communication).



## How To Say It: Be Professional

- To the point, brief, transmissions
- Speak in a clear normal voice
- Control your emotions
- Remain impersonal: no irritation, sarcasm, disgust, laughter.
- Be courteous (but not "Please", "Thank you")
- No Humor on the Air

People are listening.

They will misinterpret what you say.

Be professional.

## What Not To Say

- Assume all communications are being monitored (by the general public and the news media)
- Use other communication channels (cell phone) to report a find of a deceased person
- No codes, unless you have been briefed on a code to use to communicate sensitive information (such as a find of a deceased subject when cell coverage aren't available).
- You do not want someone to overhear something they shouldn't (the perpetrator may be monitoring search communications).
- Absolutely no swearing the radio

The press is listening.

Friends and family may be listening.

The perpetrator may be listening.

Be professional.



## It Is Unlawful To

- Transmit false distress signals
  - For transmissions in training that could be mistaken for reports of distress, regularly state “This is a Drill”
- Transmit obscene, indecent, or profane language.
- Cause malicious interference.

Certain transmissions are illegal.

These include:

Transmitting False distress signals. Make sure you always include the phrase “This is a Drill” when making transmissions during training that could be mistaken for a real emergency.

Transmitting Obscene language.

Malicious interference with other radio users.



## Not responsible for communications on your assignment? **Turn your radio off.**

- Unnecessary noise.
- You are wasting your battery. 12 hours from now it may be needed!
- Rumor Control: Someone in hearing distance may hear something they shouldn't (e.g. a friend or family member).

On an assignment, give the communication role to one person. Other people on the assignment don’t need their radios on.



## Radio Nets

- Formal Nets Have:
  - A Net Control Station
  - Check In procedure
- Some Types of Net
  - Status (PAR) check
    - Net control calls each station on a list
    - Each station replies briefly with their status.
- Traffic net on more than one frequency
  - Check in and net management on one frequency.
  - Passing of long messages from one station to another is moved to another frequency.

Usual use of tactical frequencies – arbitrary station to station communication.

What happens when things get complex?
Lots of people need to communicate?

Controlled Net – All calls directed to a Net Control station, net control directs stations how and when to pass messages to each other.

On Controlled Nets, net control can direct stations with messages (traffic) for each other to pass that traffic on another frequency, then return to the net.

Common controlled net in SAR: Status/PAR check.

## Personnel Accountability Report (PAR) [Status Check]

- Roll Call
- Is everyone in an incident physically accounted for?
- Initiated by Command (or a net control station) at regular intervals (20 or 30 minutes).

Status check (PAR (Personnel Accountability Report) in the fire service) – roll call of resources – checking that all personnel are accounted for.



- Fire Service: Call sign, PAR, personnel count, location
  - IC: *Command to all stations stand by for a PAR.*
  - IC: *Ground Task 1, PAR*
  - Ground Task 1: *Ground Task 1, PAR 8, segment 3.*
  - IC: *Ground Task 2, PAR*
  - Ground Task 2: *Ground Task 2, PAR 6, segment 5*
- More usual in SAR: call sign, status
  - IC: *Command to all stations stand by for status check.*
  - IC: *Ground Task 1, status check*
  - Ground Task 1: *Ground Task 1, on task*
  - IC: *Ground Task 2, status check*
  - Ground Task 2: *Ground Task 2, on task*

Fire service typically has a stylized form – when called on by net control (or command) each resource replies with its call sign, PAR, number of personnel accounted for, and location.

SAR, typically more relaxed, reply with call sign and brief status “on task”.



## Accountability Systems

- Location of all personnel at all times.
- Identity and location of all responders to the incident.
- Use at every incident (including every training).
- Location and assignment (or other status) of all responders at all times.

Communications are partly about command and control, but also heavily about accountability: Knowing where everyone is in a search all the time.

Searches tend to send people off on assignments in a flurry of activity. It is very easy to loose track of who is where.

Always take the time to carefully track who is where doing what.

Make it a habit in training – sign ins, signouts, task assignment forms, status checks.

Train as you search. Make accountability a habit in training so it will be habitual under the pressures of a search.



T-Cards

As we’ve seen before, t-cards, one form for keeping track of who is where.

What are others?

How do we manage accountability in a SAR incident?

How do we track who is at the incident?

How do we track if everyone has gone home safe?

Discuss.

## Managing Accountability

- Who has been mobilized for the incident. (sign in)
- Who is out on which task. (SAR task assignment form)
- What is the status of each resource. (T cards)
- Communications to support accountability: (test, on task, regular check-ins, off task).
- Regular status checks – may include location.
- Demobilization: Did everyone get home safe. (demoblization plan and implementation)

In SAR we try to maintain accountability of:

Who has been mobilized to an incident.

Who is where and what they are doing during and incident.

Regularly checking on the status of all resources deployed in the field.

Demobilization and has everyone gone home safe.





# Mechanized Platforms


Unit 24: Overview of ATVs, Mountain Bikes, Snowmobiles/Snowmachines, and Helicopters in SAR.
Date Last Updated: February 19, 2020





## Not Traveling on Foot

- Helicopters
  - Helicopter Operations
  - Helicopter safety, PPE
  - Landing zone
  - Flight safety
  - Air observer
- Mountain Bikes
- ATVs
- Snowmobiles

A variety of mechanized platforms can be used in inland SAR. We'll give an overview here.



## Helicopter Operations

Locate, Access, Stabilize, Transport

- Search
- Rescuer Transport
- Medivac
- Helicopter Rescue
  - Hoist Rescue
  - Short haul

RICSAR K9 Jep, UH-60 Black Hawk Familiarization
RI National Guard, public domain image by Staff Sgt. Peter Ramaglia

Helicopters can be used at any phase in LAST.

They can be used to transport searchers or rescuers.

The can be used as search platforms (most common use in search in MA – MSP air wing providing aerial platform for FLIR).

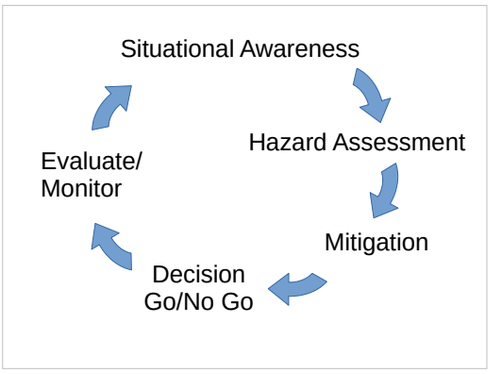
They can be used for medical evacuation.

They can be used (if properly equipt and certified) to perform some types of rescue operations.



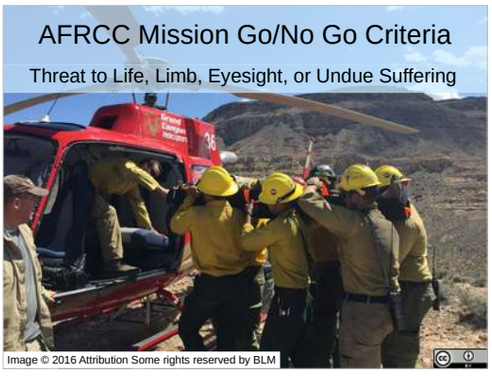
## Helicopter rescue involves unique hazards, which can be fatal


Helicopters come with substantial risks




And with hazards needs to come a systematic approach to assess those hazards, the ability to mitigate them, and a weighing of risk and benefit in a go/no-go decision: e.g. following the Cyclical Risk Management Process.



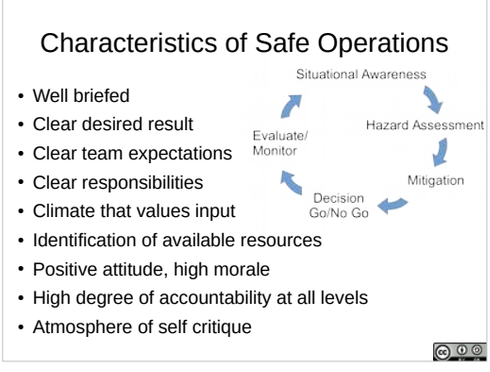



Helicopters aren't used lightly.

Helicopters can be used for lots of things, that doesn't mean they should be.

Recognizing the risks inherent in Helicopter operations, the AFRCC includes an assessment of the benefit in the go/no-go criteria for helicopter use. Benefit must be that using the helicopter can reduce a threat to life, limb, eyesight or undue suffering.






Let's think for a bit about what makes for safe operations. [Discussion].

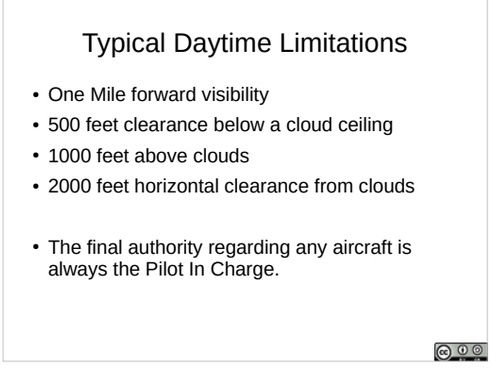
What happens when an operation is not well briefed?
When clear objectives aren't expressed?
When there aren't clear expectations on each team?
When there aren't clear responsibilities?
When there isn't awareness of available resources?

What happens when the climate doesn't value input?
When people have a negative attitude or low morale?
When there is no accountability?

What happens when we aren't willing to critique ourselves?

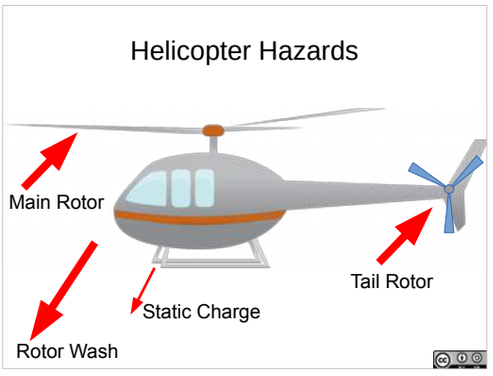
How do these characteristics of safe operations relate to the cyclical risk management process?






Back to helicopters.

Helicopters are limited by the weather. If the weather isn't good, don't be surprised if they won't fly a mission.




Working around helicopters is hazardous.

Four of the hazards posed by helicopters are:

The rotor wash (blow stuff into your eyes)

The main rotor and tail rotor.

Helicopters develop a static charge. Forming a circuit between the helicopter and the ground can deliver a very large shock.









Landing zones are dangerous

Helicopters stay up by forcing air down with their rotors.

Lots of air.

## Landing Zone Safety

- Secure loose clothing and equipment.
- Keep landing areas clear of loose debris.
- Provide visual wind indicators for landing and takeoff.
- Wear eye and hearing protection. Wear a helmet secured by a chin strap.

The rotor wash will blow things around on landing and take off – moving lots of air.

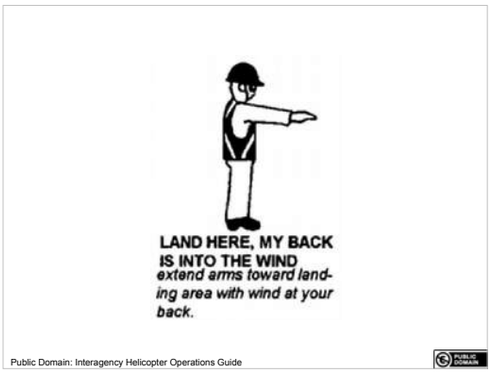
Keep the landing area clear of debris.

Keep your own clothing and equipment secured.

Wear hearing and eye protection and a helmet.

The pilot needs to know what the wind is doing: Provide an indicator of the wind (large flagging tape streamers...)






Here's a signal that can be used to indicate the wind direction.

Stand upwind of the landing zone. Face the landing zone, extend your arms to point with the wind into the landing zone.

At night, shine headlights onto the landing zone.



## Landing zone/Helispot

- Preferably: pre-planned landing zone, with ground support from local fire department.
- Check and clear the area of FOD – Foreign Object Debris.
- At night, illuminate helispot with lights shining onto the ground (not strobes).
- No Flares, No Smoking, No ignition sources.
- Site clear of overhead wires, towers, obstructions. Site clear of all obstacles taller than 12 inches. Site with less than 7 degree grade.

Landing zones are usually pre-planned and known to the local fire department and or PSAP (dispatch center).



## Landing Zone Safety - Approach

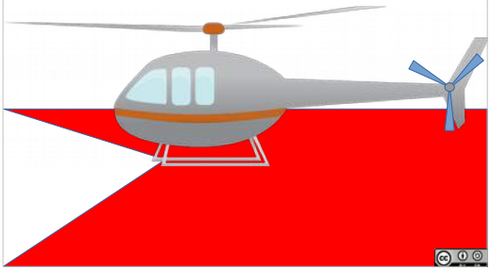
- Never approach the helicopter until the pilot or crew directs you to do so.
- Approach and depart from front or with 45° of the front of the helicopter, unless directed otherwise.
- Approach crouching, in full view of the pilot.
- Do not walk toward the tail rotor.
- Approach from downhill side, depart downhill.
- Carry nothing above shoulder level.

Only approach a helicopter under the direction of the crew.

Carry nothing above the shoulder level.



## Only Approach on the Crew's Signal Usually from the front



Remain at least 150 feet away from the Helicopter.

Only approach under the crew's direction.

Medical helicopters may load from the rear. Only approach with an escort by a crew member. Why? You don't want body parts chopped off by the tail rotor....



## Only Approach on the Crew's Signal



## NE Regional Medical Helicopters (e.g. Boston MedFlight)


Remain at least 150 feet away from the Helicopter.

Only approach under the crew's direction.

Medical helicopters may load from the rear. Only approach with an escort by a crew member. Why? You don't want body parts chopped off by the tail rotor....

## Landing

- Preferred: Full touchdown, flat landing zone clear of obstructions
- Slope landing: Up to 5 degree slope. Risk of striking tail on slope. Risk of dynamic rollover.
- Power on landing: Both skids on ground, running full power. Snow landings, landings next to drop off.
- One Skid landing, Toe-in landing.
- Hover Landing: Skids don't touch the ground, aircraft can move.

Preferred landing is on a flat landing zone clear of obstructions.

Landing in other conditions may be possible, but comes with increased hazards.



## Slopes

- Approach and depart from front or with 45° of the front of the helicopter.
- Approach from the down slope side of the helicopter.
- Depart the helicopter going down hill.

Approaching or leaving a helicopter on sloping ground – do so on the downhill side.

Only approach or depart from within 45 degrees of the front.



## Flight safety

- Seatbelts fastened at all times.
- Secure all loads (packs, ropes, loose equipment) under the direction of the crew.
- Secure canines under the direction of the crew (rappelling harness, muzzle).

In flight, follow the directions of the crew.

Keep seatbelts fastened at all times.

Secure all loads (including canines) under the direction of the crew.



## Required Pre-Flight Helicopter Safety Briefing

- Personal protective equipment (e.g. gloves, flight helmet, clothing)
- Approach and departure around aircraft
- Location of the first aid kit and any survival equipment
- Location and operation of the fire extinguisher, first aid kit and emergency location transmitter (ELT)
- Emergency electrical and fuel shutoff controls
- Operation of doors and seat belts
- Emergency procedures and exits

A crew member is required to give a safety briefing covering these points to all helicopter passengers.

ICS Helicopter Related Locations

Helibase:

Helispot:

There are two Helicopter related location under ICS:

Helibase – a place where helicopters can land, be fueled and maintained.

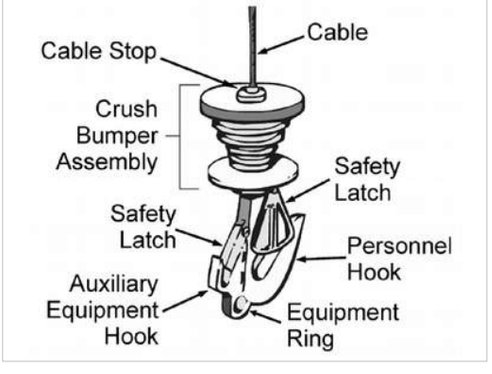
Helispot – a place where helicopters can land.

Most municipalities in MA will have pre-planned Helispots for medical helicopters known to the local fire department and to dispatchers.



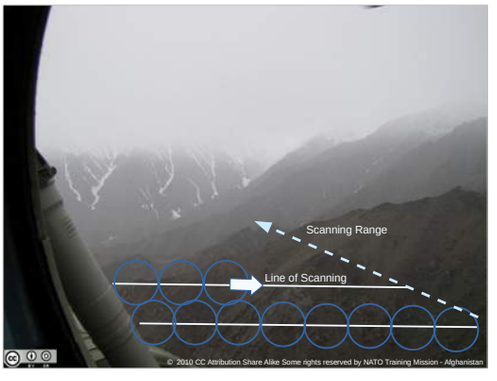

Helicopters with appropriate equipment, certifications and trained crew can perform some rescue operations (vertical hoist between the ground and the helicopter; rarely short haul or long haul).






This is a typical helicopter rescue hook. Humans get hooked into the large hook (not the smaller auxiliary equipment hook or the equipment ring).

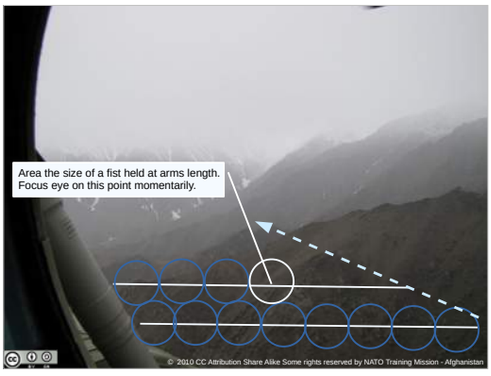





Helicopters can be used as aerial search platforms, as can other aircraft.

Air observers are trained to scan the ground in a systematic way.

Unlikely to be used as an air observer, but the technique is valuable for observing in search in general.




Hold a fist at arms length.

This is the size of the area you look at – focus the eye and your attention on this area momentarily

Don't scan your eyes across the landscape, look at one area, then move to the next, look there momentarily, then move to the next.

Looking on one side, work from the direction of travel backwards in a line, then move to the next line forward.

Time to complete one diagonal line is time it takes aircraft to advance one fist width.



## Air Observing

- Highly Fatiguing – limit to 2-3 hour sessions.
- On spotting something, point at it.
  - Note the position of the sighting with respect to landmarks.
  - Notify pilot.
  - Use clock positions to describe location of sighting.

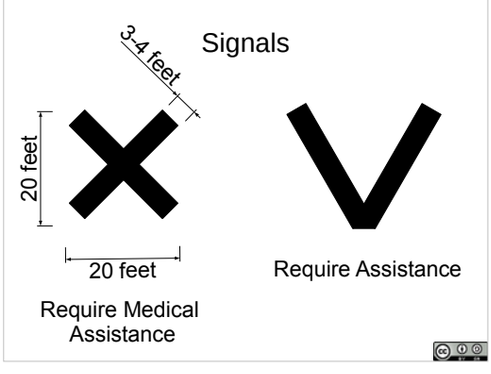
Air observing is highly fatiguing – limit to 2 to 3 hours.

On spotting something, point at it (also standard practice for a person in distress in the water).

Tell the pilot (use clock positions, 12 o'clock straight ahead of aircraft, 3 o'clock straight off right side, 6 o'clock directly behind.

Note landmarks around the location.





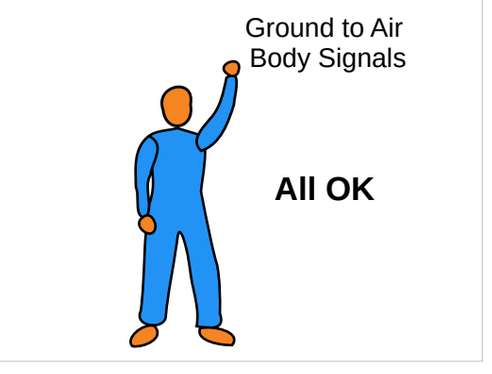

Back to survival: STOP: Plan: first aid, Shelter, Fire, Signals

Two signals for ground to air signaling by persons in distress from Annex 12 to the Convention on International Civil Aviation.

Make as large as possible, preferred minimum size is 20' by 20' with width 1/5 to 1/6 of length.
Make as strongly contrasting with the background. Make deep/tall to cast shadows if possible.
Place in the open, visible from the air, away from shadows.
Destroy after signal has served its purpose.

Audience: Aircraft.





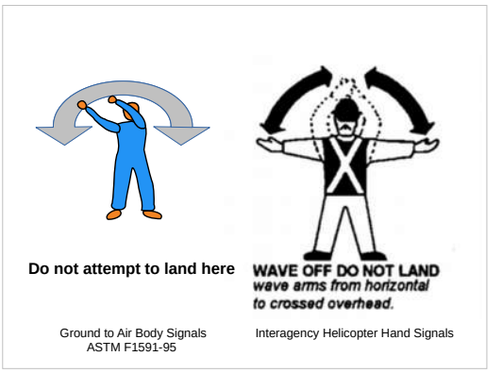

Those are signals that you make in the ground in case an aircraft flies over – that is, prepared messages.

There are other body signals you can give to communicate in real time with an aircraft overhead in the absence of radio communications.

Here's one.

Stand still with one arm straight up in the air – signal that all is OK.

These signals, unlike the ground marking messages are recognized in the US, but are not international and are not specified in the Convention on International Civil Aviation.




Here's another.

Two forms of a signal to not land – waving both arms back and forth.

Waving both arms together from side to side is from a standard set of ground to air body signals.

Bringing the hands together overhead from the horizontal and back is from the set of Interagency Helicopter Hand Signals.




How can bicycles be used in SAR?



## Safety

- Trail riding isn't like riding on the street.
- Be Fit, Hydrate.
- Ride within your skill level. Stay in control of your bike.
- Wear PPE
- Yield to horses: Dismount, wait for them to pass Talk with the riders, they may have seen the subject.
- Yield to other trail users (talk with them).

Despite the picture on the previous slide, mountain biking isn't like riding on pavement.

Terrain is irregular, there are hills, rocks, trees.

You need to be fit. You need to be competent on a mountain bike on trails.

You need PPE.



## PPE

- Helmet
- Gloves
- Eye protection
- Appropriate footwear: without laces or keep laces tucked in.
- Layered clothing when cold.
- Suitable clothing for the conditions.
  - Consider protective clothing – padding for hips, elbows, shoulders.
  - Keep pants legs tucked in.

Key piece of PPE is the helmet:

But also, gloves, eye protection, clothing suitable for the weather (hot/cold/wet/dry) while doing episodic strenuous exercise.

Make sure that boot laces and pants can't get entangled in the chain.

Trail conditions may merit padding and protective clothing. Weather likewise.

## Use in Search

- Rapid coverage of trails.
- Less clue destruction (physical and audible) than ATVs.
  - Stop and check for sign, particularly check track traps.
- Requires PPE
- Unlike horse, rider has to drive.

Mountain bikes are valuable tools for search.

Mountain bike teams can rapidly cover trail systems.

They are quieter and less destructive than ATVs.

Rider still has to operate the bike: Stop and check for sign, in particular check track traps.




ATVs can be used in SAR.



## ATV

- Engine driven, primarily intended for off road travel.
- Definition and regulation varies by state, generally handlebars and a seat straddled by the rider.
- Independent suspension
- Rider Active – operation affected by position of the rider.
- Most are single rider only
  - If designed to carry passengers, requires: extra seat with back, extra footrests, bars for passenger to hold.

Definition of an ATV varies from state to state, engine driven, designed for off road use, usually have handlebars and a seat straddled by the rider, usually only one rider.

Unlike a car, they are Rider Active – handling and operation is affected by the position of the rider.



## Safety

- Obtain specific training (**this isn't it**) before operating an ATV. It is a powerful, dangerous vehicle.
- PPE
- Inspection checklist before use (per owners manual).
- Know your limitations and stay within them.

Behave in their own sort of ways, thus require specific training (this isn’t it) to operate.

## PPE

- Helmet (meeting state requirements) with face shield or Helmet with shatter resistant goggles.
- Gloves – thick, padded knuckles
- Boots – above ankle, keep clothing tucked in, raised heels, rubber soles.
- Protective clothing – with kneepads, chest protector, padding for hips, elbows, shoulders. Legs: over the calf cut and abrasion resistant protection.
- Layered clothing when cold

ATVs require PPE.



## ATV: Use In SAR

- Fast, can haul loads.
  - Logistic support for rescue operations
- Loud, destructive.
  - Stop to listen.
  - Stop to check for sign – particular attention to track traps
- Focus on Safety
- Interacting with mounted SAR:
  - Pull over, stop, turn off engine, remove helmet.

ATVs can be used in SAR operations.

Primary role: Logistic support.

They are loud and destructive.

When using in the Locate phase of a search and rescue operation:

Stop. Listen. Look.

Pay particular attention to tracktraps and check for sign.

If interacting with horses, pull over, stop, turn off engine, remove your helmet (so you look human to the horse).




Snowmobiles can also be used in SAR.




Like ATVs, Snowmobiles require specific training (and this isn't it).

Like ATVs, Snowmobiles require PPE.

Some specific hazards include: cold injuries, wetlands, streams (e.g. breaking through ice and falling into water), fence lines (e.g. decapitation), and vegetation (e.g. running into trees or tree limbs).

## Snowmobile: Use in SAR

- Fast, effective cross country transport on snow.
- Loud
  - If in Locate phase, consider stopping regularly and moving away from the machine for sound sweeps.
- Destructive
  - Watch for Clues
  - Check choke points on travel routes carefully for sign.

Similar to ATVs, Snowmobiles can support SAR operations.

Good for logistic support and for travel over snow.

Like ATVs, loud and destructive.

When in the locate phase of a SAR operation:

Stop, Look, Listen.

Check for sign.

Particularly stop and check choke points on travel routes for sign.



## Advantages/Disadvantages?

- Equine
- Mountain Bike
- ATV
- Snowmobile
- Foot

What are the advantages and disadvantages of these SAR platforms?

Discuss. Some examples:

Horses: Sensor itself. High vantage point. Rapid travel. High maintenance/training/care/feeding needs.

Mountain Bikes: Rapid travel, quiet, needs maintenance.

ATV/Snowmobile: Rapid, loud, destructive of sign, need maintinance, specialized training.

# Land Navigation VII
# Communicating Location


Unit 25: Land Navigation VII: Communicating Location (Grids and GNSS)
Date Last Updated: February 19, 2020





## Describing location on a map

- PLSS = Township, Section, Range
- Latitude and Longitude (Geographic coordinate system)
- UTM: Universal Transverse Mercator
- MGRS: Military Grid Reference System
- USNG: US National Grid
- UPS: Universal Polar Stereographic
- Ordinance Survey (GB) Grid
- State Plane Feet
- etc....

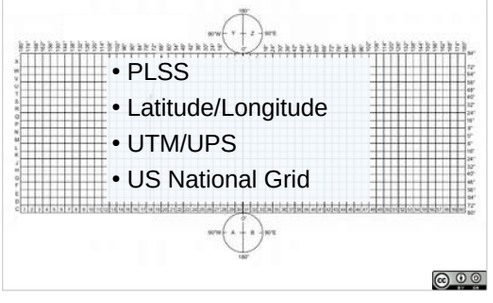
There are many ways to describe a location on the surface of the Earth.

Most place some sort of a grid on the map.

Some are only used in some parts of the world, some can be used anywhere.



## Map Grids




We will look at a few of them.

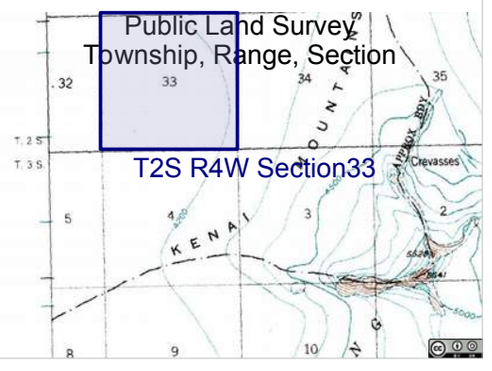
Public Land Survey System (Township/Section/Range) widely used in the central US and Canada. A regional grid.

Latitude and Longitude. One grid for the entire world.

UTM: Universal Transverse Mercator. The whole world in 62 grid zones *(60 zones, plus 1 UPS zone at each pole)*.

and a variant of UTM: US National Grid. Defines ways to simplify UTM coordinates.



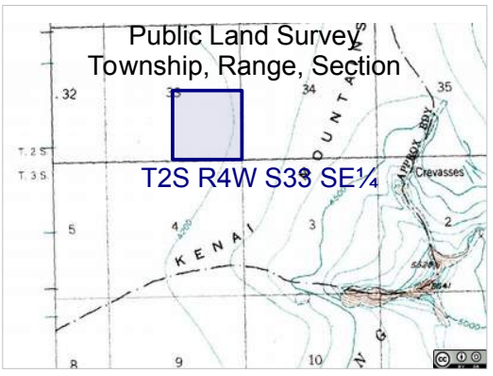



The Public Land Survey System divides portions of North America into a grid of east-west Township lines and north-south Range lines. Township and Range lines are each 6 miles apart from each other and form a grid of 36 square mile squares (these run off of baselines, thus Township 2 South is the second township south of some baseline).

Each Township/Range is divided up into 36 one mile squares called sections. The sections are numbered (with one pattern in the US and a different one in Canada).

A single one mile square can thus be referenced by township, range, and section: Township 2 South, Range 4 West, Section 33.

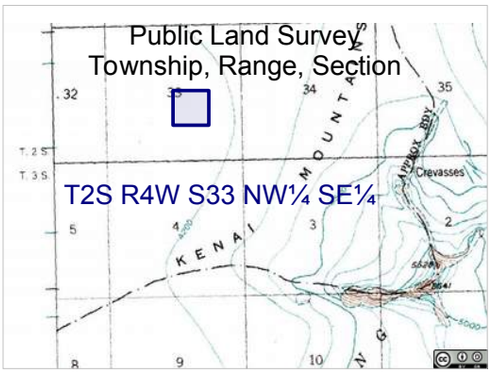
(Locations aren't unique, there are multiple baselines).




To describe a position more precisely than a one mile square, sections can be divided into quarters.

Here is the South East quarter of Township 2 South Range 4 West Section 33.



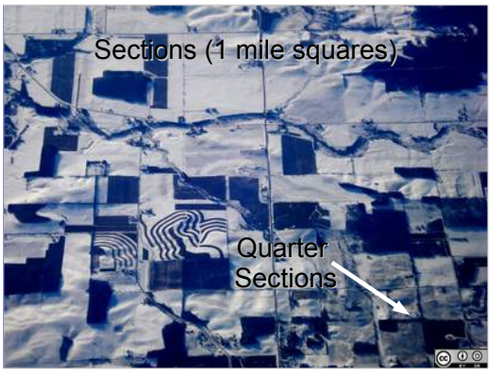



Quarter sections can be further divided into quarters.

North West quarter of the South East quarter of Township 2 South Range 4 West Section 33.

And so on.






You fly over the middle of the country and you see the PLSS grid laid out on the ground in roads and fields.

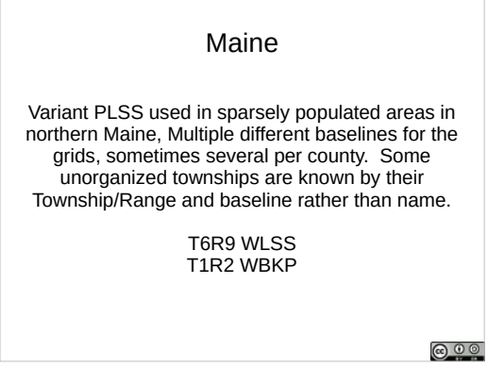
The PLSS dates from the time of settlers moving west.

In the central US and Canada, the grid has the advantage of being laid out physically on the ground with roads, fences, and fields.

There are multiple other regional grid systems in use in the world, PLSS is unusual in that humans made roads along the grid lines – there is a physical grid on the ground.

What use in New England?

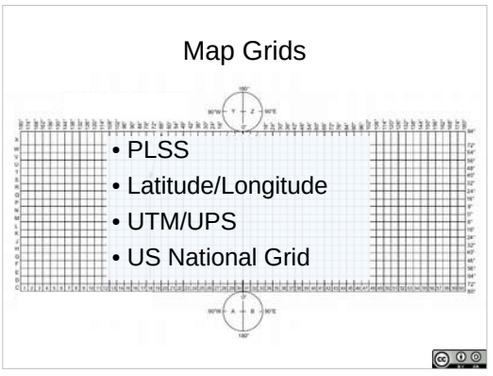





None, except in some parts of rural Maine.

There are unorganized townships in Maine known by their Township and Range, not by name.

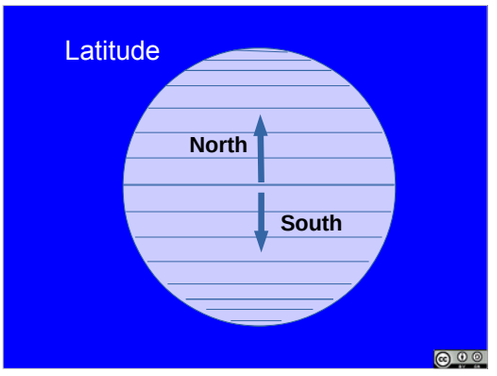
T6R9 WLSS refers to a 36 square mile area, Township 6 Range 9 off of the WLSS baseline.




Next: Latitude and Longitude.

Latitude and Longitude allow you to describe your position anywhere on the surface of the Earth with a pair of numbers.



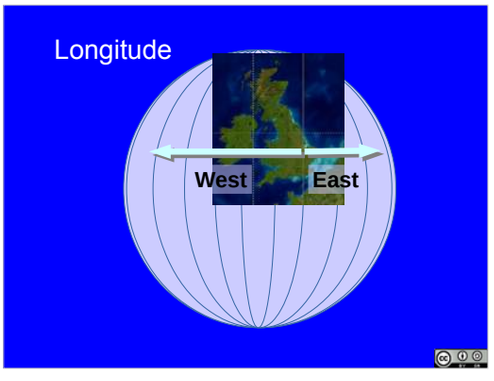



Latitude is position north or south of the Equator.

Equator is 0 degrees. North pole is +90 degrees. South pole is -90 degrees.

Lines of Latitude are evenly spaced on the surface of the Earth. One degree of latitude is 60 nautical miles (or 69 miles or 111,194 meters). (one minute of latitude is one nautical mile thus 1.85 km, one second of latitude is 1/60th of a nautical mile thus 30.8 meters).





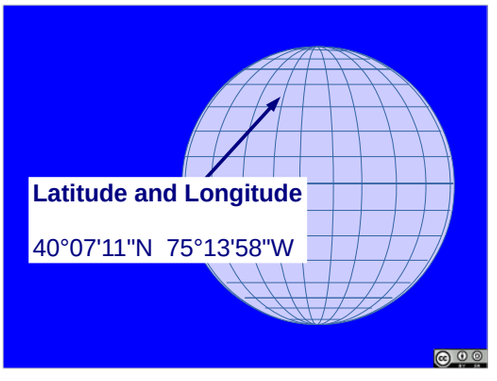

Longitude is position East or West of an arbitrary line (which runs through Grenwich, England). Lines of longitude are called meridians.

Longitude is conventionally a number in the range 0 to 180 degrees West or 0 to 180 degrees East.

Meridans converge towards the poles, so the distance represented by one degree of longitude varies depending on how far the position is from the Equator. At the Equator, one degree of longitude is 111,194 meters (or 60 nautical miles). Move north or south and this gets smaller (just for longitude).

Degrees of longitude do not translate easily to distances (in miles or meters). This is a disadvantage of Latitude/Longitude.

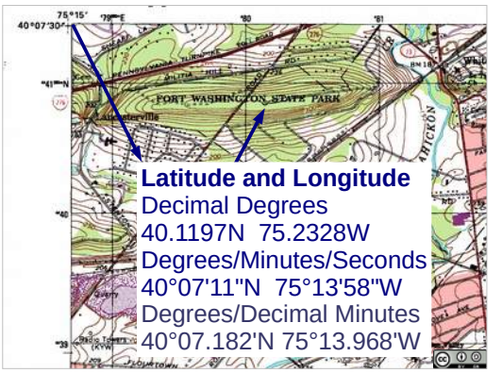





A particular point on the surface of the Earth is described with a Latitude and a Longitude.

Latitude and Longitude can be expressed in Degrees, Minutes, and Seconds (with 60 Minutes to a Degree, and 60 Seconds to a Minute.

Here we have a position of 40 degrees 7 minutes 11 seconds North, 75 degrees 13 minutes 58 seconds West.



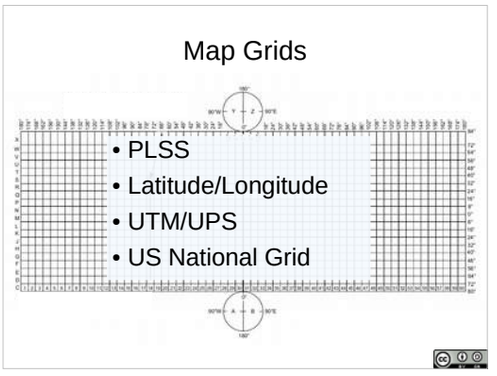

Latitude and Longitude can be expressed in three different ways:

Most common: Decimal Degrees (widely used by Geographic Information Systems (GIS), and by Google Earth and Google Maps).
Decimal degrees are often represented with North and East positive, and South and West negative (you can type "40.1197, -75.2328" into Google maps (**4 decimal places is about 11 m precision in latitude**)).

Also used (and printed on USGS topographic maps) are: Degrees, Minutes, and Seconds (**one second of latitude is about 30 meters**, Lat/Long tics on the edge of the maps are typically 2'30" (or 4.6 km apart)).

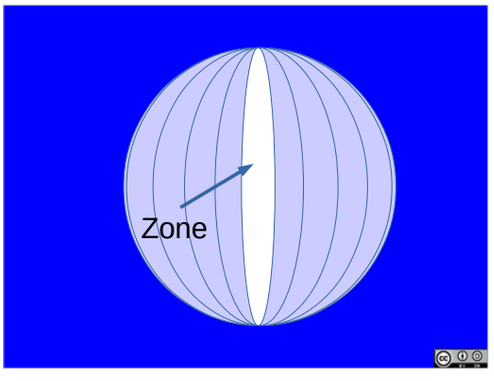
Sometimes used: Degrees and decimal minutes.






Next: UTM: Universal Transverse Mercator.

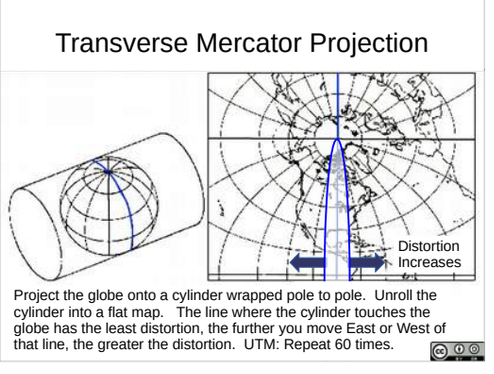





UTM starts by dividing the world up into 60 6 degree wide zones (60*6=360).

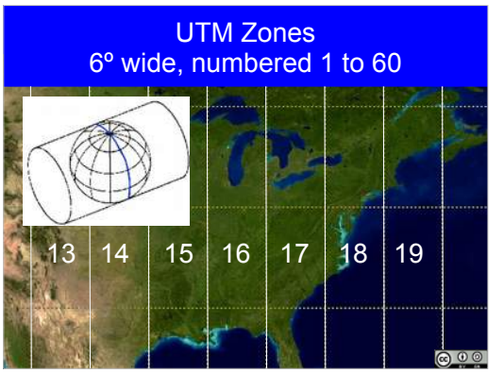
This doesn't make a lot of sense until you look at how UTM uses this to minimize distortion when turning the spherical globe into a flat map.






UTM is Universal Transverse Mercator. In UTM, each of the 60 6 degree wide zones is projected separately onto a cylinder touching the surface of the earth in the center of the zone (the cylinder is then unrolled into a flat map (and the 60 zones can be spliced together to make a map of the world)).

In the Mercator projection, the cylinder touches the Earth at the equator, and distortion increases towards the poles (Greenland looks much larger than it really is) It the transverse mercator projection, distortion increases away from the center of each zone. Since the zones are only 6 degrees wide, distortion on maps of small areas is minimized.



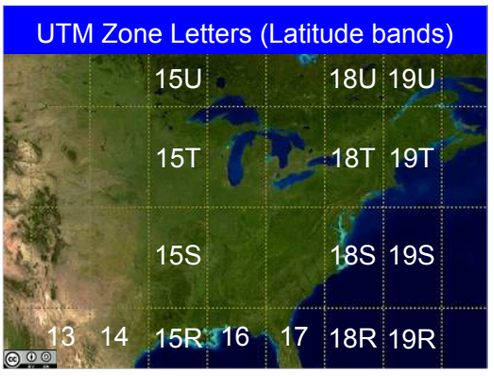

The Universal in UTM comes from repeating this transverse projection of a narrow slice of the globe onto a cylinder 60 times - onto 60 cylinders, one centered on each zone. When these 60 zones are stitched together, they give a flat map of the world.

Each zone is 6 degrees wide.

The 60 zones are numbered 1 though 60 (starting at 180 degrees West (the zone 30/31 boundary runs through the Greenwich meridian)).

New England falls into zones 18 and 19.






Zones are divided into 8 degree tall bands, each band is given a letter.

New England falls into the T band, thus into 18T and 19T.



## Latitude Band Letters

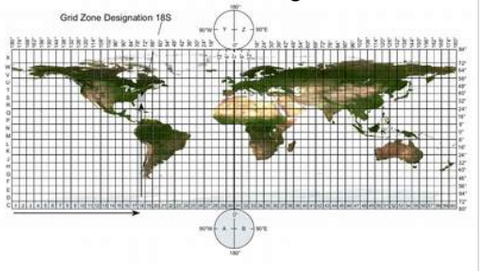
- 8 degree tall bands (except for X)
- Starts with C at 80 to 72 degrees south.
- C-M, southern hemisphere
- N-X, Northern Hemisphere
- (N is the first zone north of the equator)
- No O or I (can be confused with 0 and 1)
- A,B South of 80 degrees south (UPS).
- Y, Z, North of 84 degrees north (UPS).

Band lettering starts at 80 degrees south latitude with C. N is the first band north of the equator. Not all letters are used, O and I are left out as they are too easy to confuse with numbers.

The poles are handled separately (we'll come back to that).



## Grid Zone Designator




Here's a map showing the layout of the zones and bands.

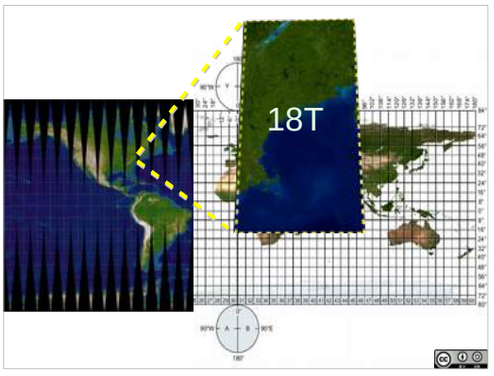
Zone 1 starts at 180 degrees west. The zone 30/31 boundary runs along the Grenwich meridian (at zero degrees Longitude).

(Band letters start with C at 80 degrees south latitude, N is the first band north of the equator. Poles are handled separately (bands A,B, Y and Z).

A Zone number and band letter provide a Grid Zone Designator (e.g. 18S, zone 18, band S)

Locations within each zone are described with a pair of numbers: an Easting, and a Northing.

The poles are handled separately.



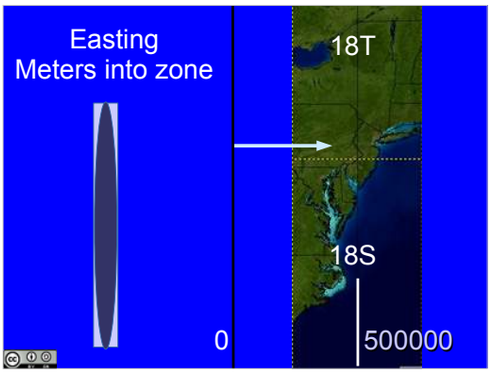

So we've got a Grid Zone Designator.

This describes an area on the surface of the Earth.

But the Earth isn't flat – zone 18 is a curved pie slice (left), not a neat rectangle (left, the distorted projection onto a flat surface), so 18T isn't a nice neat rectangle – it's a piece of a curved pie slice, it gets narrower as we go North.

The problem becomes: how do we describe a position in this curved pie slice with a nice neat rectangular grid (where numbers in the grid represent distances on the ground (unlike latitude/longitude, where one degree of longitude varies in length depending on how close to the poles you are)).



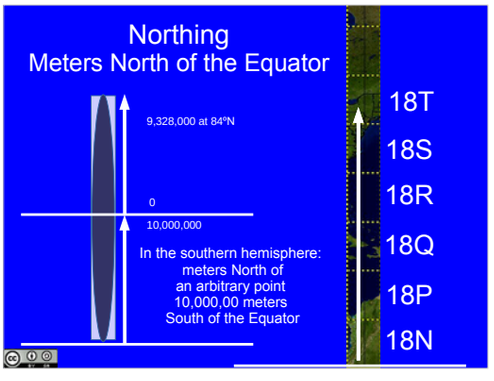



UTM solves this problem with a grid of two distances in meters, the Easting, and the Northing.

The Easting is the distance in meters into each zone from an imaginary base line for that zone, placed so that the 500,000 meter (500 km) Easting lies in the center of the zone.

At the equator, zones are 6 degrees (= 360 nautical miles = about 667 km) wide. They get narrower towards the poles.






Northing is measured as distance in meters north of the equator.

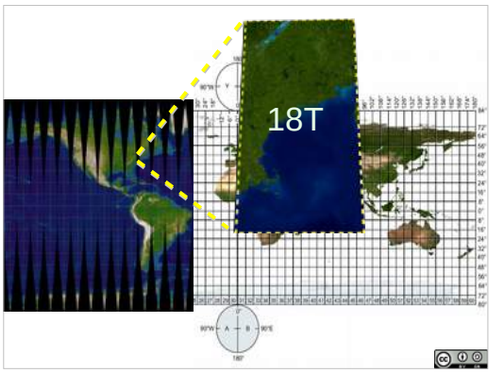
Or, in the southern hemisphere, meters north of an imaginary base line 10,000,000 meters South of the Equator.




Putting Zone, Band Easting, and Northing together let us describe a point on the surface of the Earth to a precision of 1 meter.

Here: 19T 0355000 461350

Zone 19, Band T, easting of 0355000 meters, northing of 461250 meters.




We've laid a nice neat rectangular grid on the curved pie slice.

There are a few consequences of this.

First is the difference between True North and Grid North.

The 500,000 meter meridian runs right up the center of the zone, but the east and west edges of the zone converge on each other – while the grid lines run straight.

Map projection to left: Author: Lars H. Rohwedder
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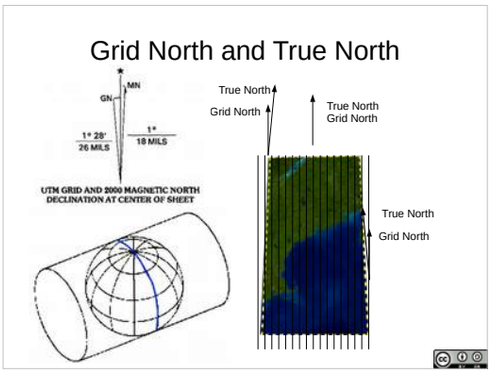



Thus, Grid North (the north of the UTM grid lines) is the same as true north at the 500,000 meter eastings. But Grid North is slightly off from True North near the Zone Boundaries.

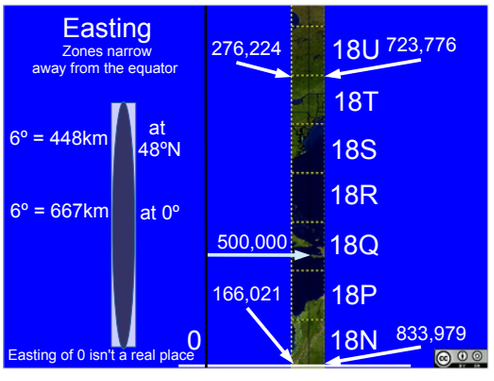
Near the center of a zone (with Eastings about 500000), place your compass along the UTM grid lines and it will be aligned with True North.

Near the edge of a zone, place your compass along the UTM grid lines and it will be slightly off from True North.

USGS Topographic Maps and US National Map maps will have a description of how far off grid and magnetic north are off from True North. In mid-latitudes the difference between grid and true North will be relatively small. It is about 0 at the Equator and larger closer to the poles.

The difference between grid north and true north is a property of the Transverse Mercator Projection – the cylinder the map is projected onto touches the globe at the 500,000 m easting, the further East and West you go from that line, the more distortion there is. UTM is good at reducing distortion, but doesn't eliminate it.





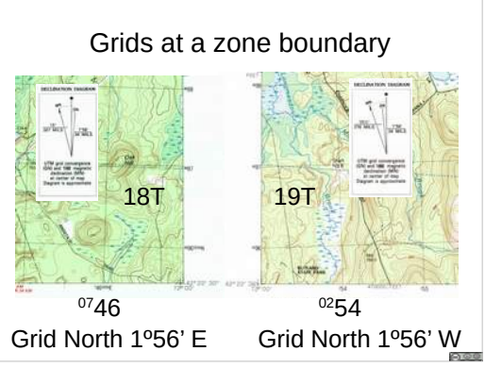

Second consequence of putting a flat grid on a curved pie slice: Since the zones are slices through a spherical globe, they are widest at the equator and narrow towards the poles. Since the UTM grid lines form a rectangular grid, the smallest Easting in a zone gets larger as you move North.

Thus the smallest Easting at the Equator is about 166,000 meters (and the largest Easting at the Equator about 833,000 meters), and each zone is about 667,000 meters (667 km) wide at the equator.

Moving north, the zone narrows, so the smallest Easting within the zone gets larger, and the largest gets smaller. At the north end of band T (48 degrees north) the 6 degree wide zone is down to a width of 448 km, with a smallest Easting of 276224 meters, instead of the smallest Easting of 166021 meters at the Equator.

The 500000 m Easting lies right down the middle of the zone (right on the 75 degree West Meridian for Zone 18).

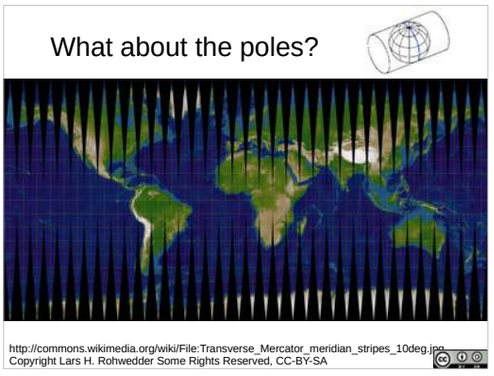





Here's the 18T/19T zone boundary (the 72 degree meridian) in Massachusetts (Barre quardrangle to the left, Sterling quadrangle to the right). Grid North in Sterling is 1 degree 56 minutes West of True North. Grid North in Barre is 1 degree 46 minutes East of True North, about 2 degrees.

Declination diagrams also note the difference in mills (1 mill is 1 meter at 1 km) difference at the edge of the Zone between grid north and true north is 34 mils, thus 34 meters in 1 km of travel, not particularly significant for navigation on foot. (Difference here between true north and magnetic north is about 15 degrees, 267 mils, 267 meters in 1 km of travel, much more significant.)

Easting of last gridline on the left is 0746000, on the right 0254000, largest and smallest of their zones at this northing.

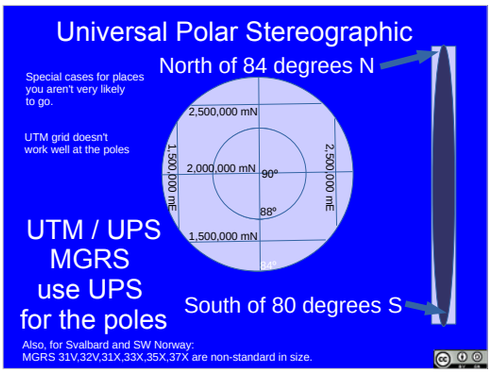



Remember the 60 separate projections onto a cylinder, each 6 degrees wide?

UTM Zones keep getting narrower the closer and closer you get to the poles – short travel distances would move you between zones (at an extreme, near the North pole, a few steps could have you traversing tens of zones).

So, at some point North and South, UTM becomes an ineffective system.



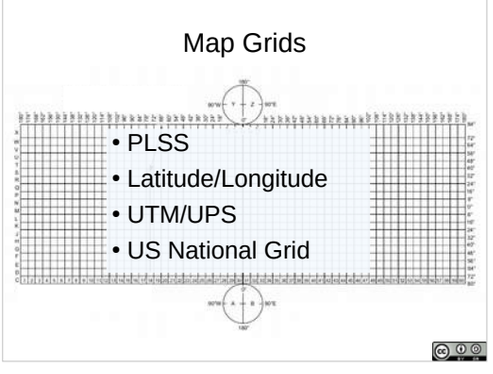



Thus, North of 84 degrees North, and South of 80 degrees South, a different system, Universal Polar Stereographic is used.

In your GNSS, you will have an option for a coordinate system called UTM/UPS.

UPS is a similar sort of system to UTM, there are Bands (A,B,Y,Z), and Eastings and Northings are measured in meters off of imaginary base lines (with the poles set at 2,000,000 meters).



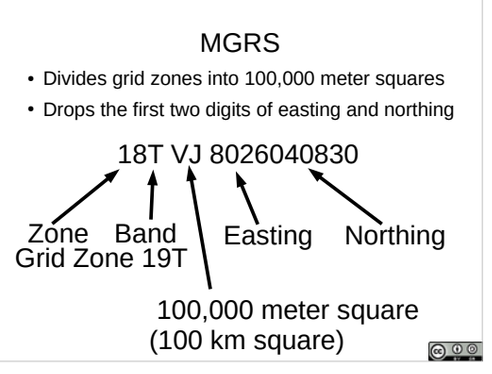



Next coordinate system: a variant of UTM: US National Grid.

UTM allows us to describe a position on the surface of the earth: 19T 0355000 461350 Big long list of numbers.

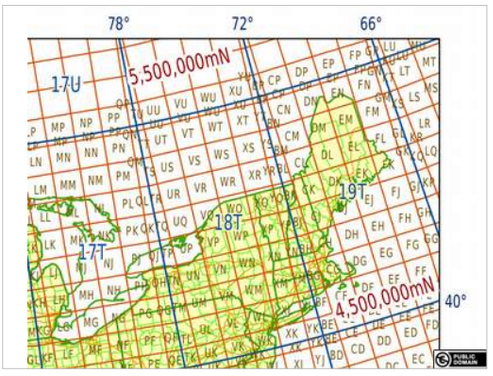
US National Grid allows us to simplify this position to just communicate the minimum amount of information needed for the situation.






US National grid is based on Military Grid Reference System (MGRS). US National Grid coordinates (anywhere in the US) are same as the MGRS.

MGRS and USNG use UTM coordinates, but represent them slightly differently – key difference is that they divide the grid zones into 100,000 meter (100 km) squares, each defined by a letter (VJ in this example), and drop the first two digits of the Easting and the Northing, so that the Easting and Northing have 5 digits each instead of 7 at 1 meter resolution.




Here are the 100 km squares for Grid Zones 18T and 19T. Boston is within 19T CG, the Berkshires span 18T XM and 18T XN.

Note that 18T YN and 19T BH aren't square and are cut off by the 18/19 zone boundary (at 72 degrees (we saw the Barre/Sterling quad boundary earlier)). Note how the 100 km grid lines converge on the zone boundaries as you move North – the 100 km grid lines are Grid North, the 72 degree meridian is True North.



## US National Grid

- FGDC standard: FGDC-STD-011-2001
- http://www.fgdc.gov/usng

18T VJ 8026040830
VJ 8026040830
8026040830
80264083

"USNG coordinates shall be identical to the MGRS numbering scheme over all areas of the United States including outlying territories and possessions."
USNG not defined for N of 84°N, or S of 80°S (UTM and USNG grids differ from MGRS in Svalbard and SW Norway)

US National Grid coordinates are identical to MGRS in any US territory.

(USNG only differs from MGRS off the coast of Norway (where NATO expanded some of the grid zones so that operations off the coast of Norway wouldn't continually change zones) and at the poles where USNG doesn't formally adopt UPS.

USNG defines specific ways to leave out parts of the coordinate to limit how many numbers and letters need to be communicated to just those needed for the situation.



## US National Grid: Simplifying

- 18T VJ 8026040830
- VJ 8026040830
  - Leave off grid zone
- 8026040830
  - Leave off grid zone and grid square
- 18T VJ 802408
  - Leave off some numbers (leave off 2 = 100 m square)
- 802408
  - Leave off grid zone, grid square, and some numbers

US National Grid: **Goal: Keep things as simple as possible.**

For global communication, the grid zone designator and grid square need to be included.
For regional communication, the grid zone designator may be left out.
For local communication, the grid square may be left out.

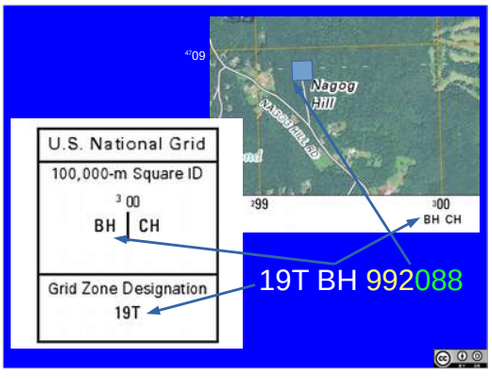
If you don't need 1 meter precision, leave off some numbers.

8026 4083 – to 10 meters

802 408 – to 100 meters

80 40 – a 1km square

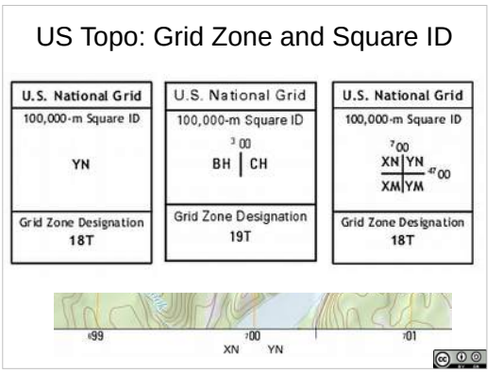





So, how do you work with USNG with maps? The US Topo Map series make things easy.

Border of the map has a box with the Grid Zone Designation and the 100,000 meter square. If (as in this case) the map spans more than one 100,000 meter square, both (or all) will be listed in the box, and shown on the border of the map.

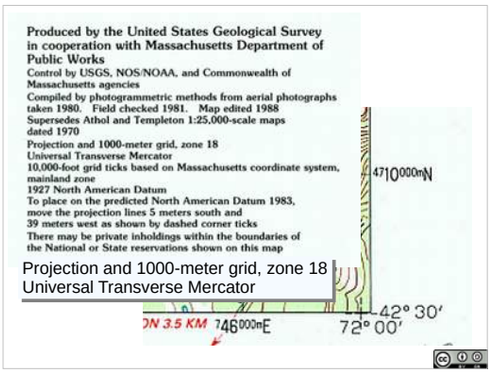
The map border has tic marks every kilometer, labeled with the Easting or Northing for that tick. The first two digits of the USNG position are in large font. Digits before them from the UTM coordinate that are replaced by the 100,000 meter square are in a small font (with leading zeros omitted). Thus the UTM Easting starting with 0399 is shown as $^{3}$99, and would be BH 99... in USNG.




On the border of USGS US Topo maps you can find a box with the US National Grid Grid Zone Designator and Square ID. If the map spans more than one 100,000 meter square, then the Square IDs can also be found at the square boundaries on the edge of the map.

Most maps will cover only a single square. Some will span 2 squares, a few will span 4 squares.






USNG is a bit harder on 1980s 1990s series USGS topographic quadrangles. On more recent maps the UTM grid is shown, and the UTM ticks are marked.

The metadata at the border of the map will contain the Zone Number, but not the band letter or the 100,000m grid square letters.

Easy to use with UTM or with USNG when just communicating local coordinates (e.g. 46830942).

Historical USGS topographic quadrangles tend to not have grids printed on them, and tend to only be marked with latitude longitude (and sometimes other systems like state plane feet).



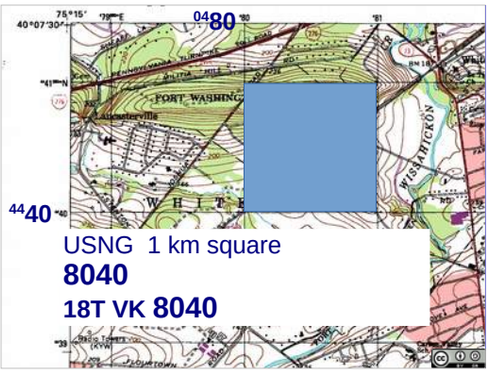

If we are just working on this map (or inside an area ov about 60 miles), we can describe the location of the 100 meter square North of Nagog Hill as 992089 (dropping the grid zone designation, the 100,000 meter square, and the 10m and 1m digits).

This is easy to read on the map. 992 is the Easting. Find the Easting of 99 (in big numbers), then go 2 tenths of the way to the next (00) grid line. 089 is the Northing. Find the Northing of 08, then go 9 tenths of the way to the next (09) grid line.

If we need to communicate outside about a 60 mile area, then add the 100,000 meter square "BH".

If we need to communicate globally, add the grid zone designation: 19T, thus: 19T BH 992089.

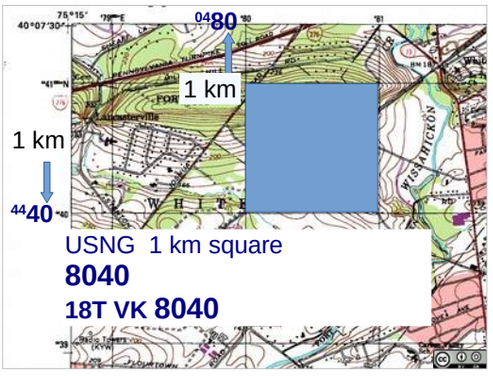





USNG lets us use the big numbers along the edge of the map to easily describe a 1 km square: 8040 (Easting of 80, Northing of 40, dropping the 100m, 10, m and 1 meter digits).

8040 is the point at the lower left of the square (leaving off the digits, USNG means an Easting of 80000 to 80999, and a Northing of 40000 to 40999).

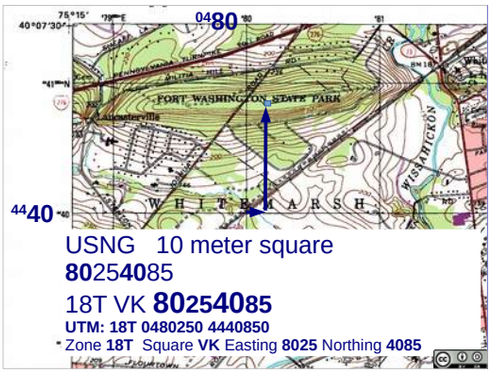
USNG reads off the digits as a single string, so split 8040 into 80 for the Easting, and 40 for the Northing. USNG coordinates will always have an even number of digits.




The big numbers and the grid lines on the map mark 1 km intervals (1km=1000m, thus we've dropped off three digits from the Easting and three from the Northing in the USNG position 8040.

Knowing this makes it easy to find more precise locations.



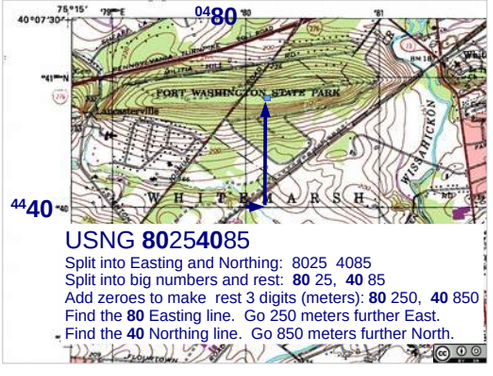



A 1 km square isn't a particularly precise location for navigation for SAR purposes (get into the center of the square and you might be able to hear someone whistle).

A square 10 meters on a side is a nice precise location for most SAR purposes. It approximates the accuracy of modern GNSS receivers, and you should be able to spot a flagged clue within a 10 meter square.

USNG can describe a 10 meter square with just 8 digits: 80254085 describes the square shown on the map. Start on the 80 Easting grid line, go 250 meters further East. Then find the 40 Northing grid line, and go 850 meters further North. There's your square. To communicate globally, add in the grid zone designator and the 100,000 m square letters.






USNG can describe a 10 meter square with just 8 digits: 80254085 describes the square shown on the map. To find this location, first split the coordinate into Easting (8025) and Northing (4085).

Now split the big numbers off from the rest, starting with the Easting 80, 25. 80 represents a 1 km grid line, that means 3 digits should follow it (to get to meters), so add a trailing zero to the 25: 80 250.

Now we know to find the 80 Easting grid line and to go 250 meters further East.

Same thing with the Northing, split into 40, 85, 40 is in km, make the 85 into meters (add a trailing zero to make 850), so go 850 meters North from the 40 Northing grid line.

Or think 80 25: find the 80 Easting and go 25% of the way to the next grid line.



US National Grid
Describing a 10 meter square

Local: 99250895
Regional: BH 99250895
Global: 19T BH 99250895

For GPS: 19T BH 9925**0**0895**0**

So, a reasonable position to communicate in a simple ground search would be just the 8 digit USNG position for a 10 meter square: 99250895.

For regional communication, add in the 100,000 meter square, for global, add in the grid zone designator.

To enter the coordinate into a GPS, add in two zeroes (one at the end of the Easting, one at the end of the Northing) to bring the precision down to 1 meter.

US National Grid
Describing a 1 meter square

Local: 9925308956
Regional: BH 9925308956
Global: 19T BH 9925308956

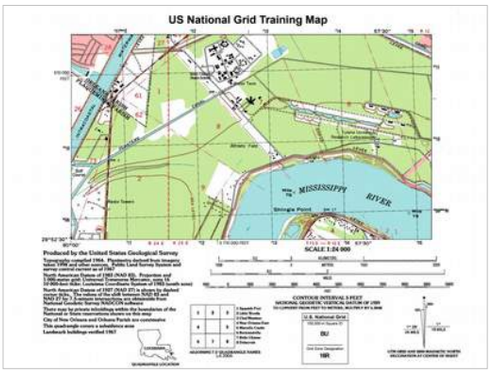
For GPS: 19T BH 9925308956

If you want to describe a location to a precision of 1 meter in USNG, use 10 digits (5 for the Easting, 5 for the Northing).

Add the 100,000 meter square to communicate outside about a 60 mile local area (100,000 m = 100 km = about 60 miles, number alone is a unique position within that distance).

Add the grid zone designator to communicate globally, or to enter the position into a GPS.






Practical Evolution: (1) Determine USNG coordinates of points on a map.

(a) water tank near Planters canal

(b) + that marks Mile 78 on the Mississippi river.



Which Is Which?

(1) 19T 0355000 4612500
(2) T2S R4W S33 NW¼
(3) BH 99250895
(4) 40.1197N 75.2328W
(5) 19T BH 9925308956
(6) 40°07'11"N 75°13'58"W

Assess: Which coordinate systems are these?

How can you tell?

(1) UTM/UPS
(2) PLSS
(3) USNG (could also be MGRS)
(4) Geographic (latitude/longitude) decimal degrees.
(5) USNG (could also be MGRS)
(6) Geographic (latitude/longitude) d.m.s

Which one has the least precision? (2 – specifies 1/4 square mile).



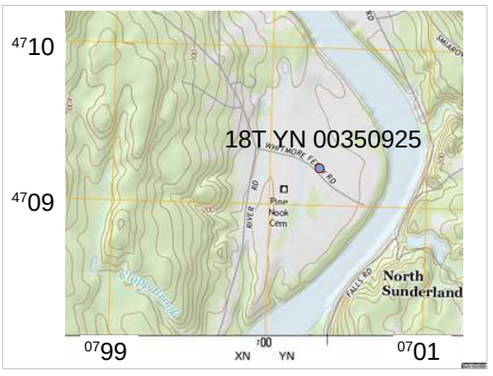
Which Coordinate System do I use?

- MA Land SAR: USNG with WGS84.
- NSARC Georeferencing Matrix:
  - Land SAR Responder
    - USNG Primary, Lat/Long Secondary
  - Land SAR coordination with Incident Command
    - USNG Primary, Lat/Long Secondary
  - Land SAR Responder with Aeronautical SAR
    - USNG Primary, Lat/Long Secondary

Which system to use?

Emerging MA SAR community standard: USNG with WGS84

National SAR Council matrix:
Primary for Land SAR responders: USNG.

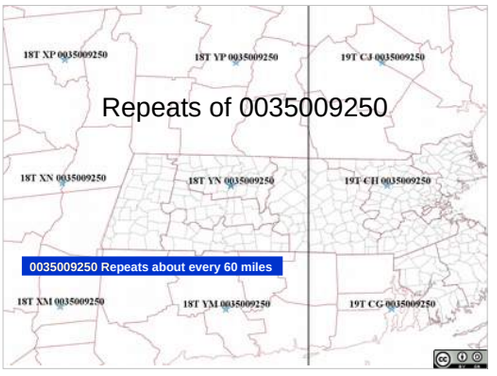



Let's take a location: 18T YN 00340925

What are the pieces of this coordinate?

(Review what we are looking at:
Zone 18, Band T
100,000 meter square YN
Easting: 0035
Northing: 0952 (4 digits, thus 10 meter resolution)






If we just take the Easting and Northing: 003509250 (for local communication), this same local coordinate repeats in each 100,000 m grid square, thus about every 60 miles (100,000 m = 100 km = about 60 miles).

So, local coordinates mean local within a distance of a few tens of miles.

(Black vertical line is the zone 18-19 boundary, map shows outlines of counties and in MA the outlines of towns.)




If we add the 100,000m grid square: YN 0035009250, then this location repeats in each zone where there is a YN grid, about once every 1000 miles.

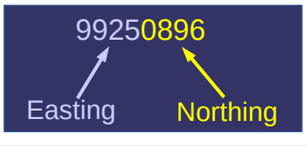
So, including the 100,000 m grid square provides for regional communication, where regional means within a few hundred miles.

(Black vertical lines are UTM zone boundaries, black horizontal lines are bands, the A-Z lettering system for the 100,000 m grid repeats about every three zones, thus zone 16 and zone 17 don't have northern hemisphere YN 100,000 m grid squares).



US National Grid
Local coordinates

100 meter grid square: 992089
10 meter grid square: 99250896
1 meter grid square: 9925308966

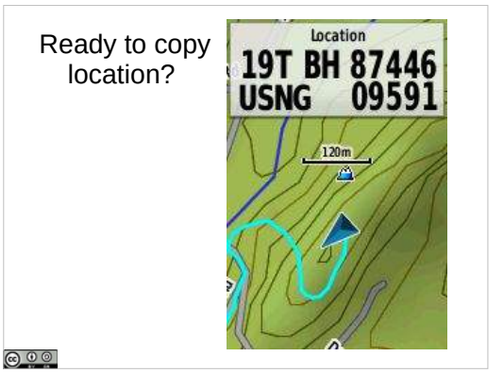



So, to review: In USNG, local coordinates are always an even number of digits. Split in half to get the Easting and the Northing. The first two digits of Easting and Northing will be the big numbers for the 1 km grid on USGS maps.

6 digits, 100 meter square, first 3 Easting last 3 Northing (leaving off the 10 m and 1 meter digits). 992 will be 200 meters East of the 99 Easting line (2/10ths of the way to the next Easting line).

8 digits, 10 meter square, first 4 Easting, last 4 Northing (leaving off the 1 meter digits). 9925 will be 250 meters East of the 99 Easting line.

10 digits, 1 meter square, first 5 Easting, last 5 Northing. 99253 will be 253 meters East of the 99 Easting line.




19Tango Bravo Hotel 8744609591

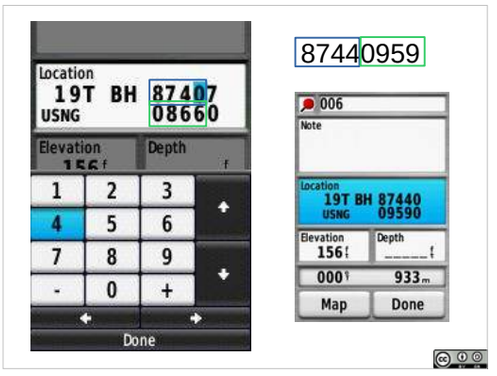
Or (much simpler):

87440959

What did I just give you? (local coordinate, just the easting and northing)

How do you enter this (local) position into your GPS?





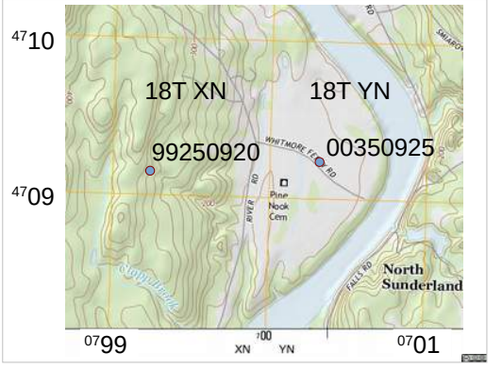

Position transmitted as: 87440959 What do we have?

USNG, Easting 8744[0] Northing 0959[0] (10 meter) (split the position in half, first half is Easting, second half is Northing).

Create a waypoint in your GNSS. Edit to match. If you are working nearby in the same grid square, then the zone, zone letter, and grid square will be the same (USNG has 5 digits after the grid square to get to 1 meter resolution, so start at the leftmost digit and fill in zeroes after you run out of numbers).

If you are working near the edge of a grid square you may need the grid square as well. Working with a map it should be obvious, working with a GPS you may get a location some 60 miles away.





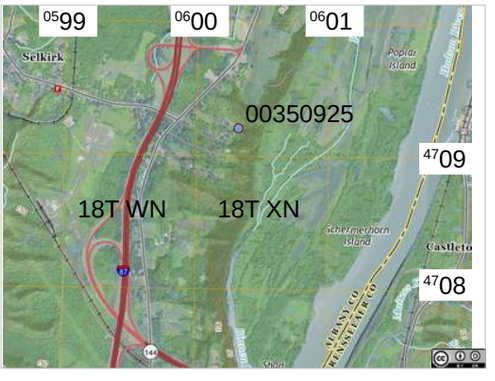

These two points should be about 1 km apart.

Communicate without the XN and YN, and you might end up with 18 T XN 00350925, about 100 km away.

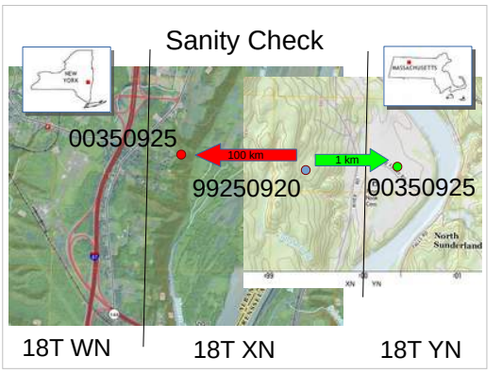
You are in 18T XN. You receive the local coordinate 00350925. You create a waypoint in your GNSS reciever. You edit that waypoint so that the coordinate is 18T XN 00350925. You ask your GNSS to go there, and it says the distance to that waypoint is about 100 km away. That's a point about 100 km away at the far Western edge of Square XN.

When a search area spans a 100,000 m square boundary, you need to be aware of the which grid square a coordinate is in. Working with a map, this is simple. Working with just a GNSS, you may need the full USNG coordinate transmitted to you.






Here's 18T XN 00350925 – about 60 miles away from the search area, across the Hudson river, in New York.




Working near a 100,000 meter Square boundary, sanity check coordinates you enter into a GNSS receiver (that is, how far away is the new point from your current location)

A local coordinate should be in the search area, not about 100 km away.

When working near 100,000 meter Square boundaries, it may be appropriate to include the Square ID in coordinate transmissions – particularly when transmitting to a resource that will be entering the location into a GNSS reciever.



UTM Conventionally:

19 Tango
0287367
Break
4709474


Communicating **UTM** coordinates, conventionally break (say Break, then release the mike and listen briefly) between the Easting and the Northing. Words Easting and Northing usually aren't included.

Common errors: Reading UTM as part of the coordinate. Only reading the Grid Zone Designator and the Easting,

Save a waypoint, or write down the location before you transmit. The meters digit will probably change while you are standing in one place reading off the numbers.



USNG as:

19 Tango
Bravo Hotel
8736709474

or

87450959


UTM is conventionally read with the Easting and Northing as a single string of numbers, instead of separate parts (no pause and no break in the transmission).



42 Degrees
30 Minutes
30 decimal 7
Seconds
North

71 Degrees
35 Minutes
16 decimal 2
Seconds
West


Latitude and Longitude.

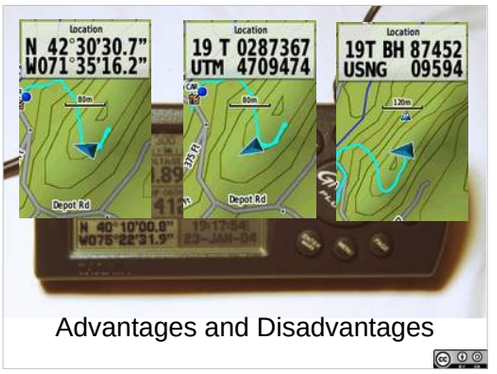
Transmitting the degrees/Minutes/Seconds format takes lots of words.

Decimal Degrees format is less wordy.


Practical Evolution: (2) Communicate USNG coordinates of points on map via radio

(3) Lat/Long, (4) UTM, (5) describing features on the map.






Each system has advantages and disadvantages:

**Latitude/Longitude:**

Single grid for anywhere in the world.
Coordinates are angles and don't readily translate to distances on the ground.
Longitude lines on a map always run true North/South (grid north is true north).

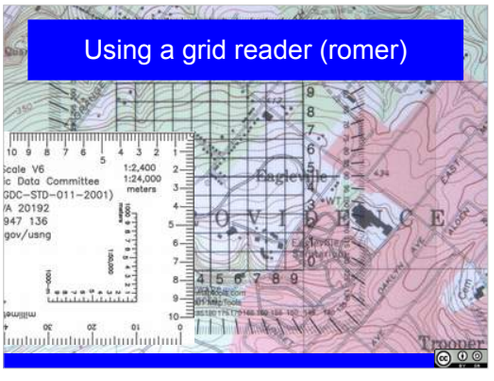
**UTM**

60 separate grids (one for each zone).
Coordinates are distances in meters. Easy to understand distances between two points in the same zone (but not across zones).
Grid North is slightly off from True North near zone boundaries.

**USNG**

Defined way for simplifying the coordinate for the situation.
Distances within the same 100 km square are easy to see from the coordinate (but not across squares or zones) (coordinate on the right is about 150 m NE of the two on the left).



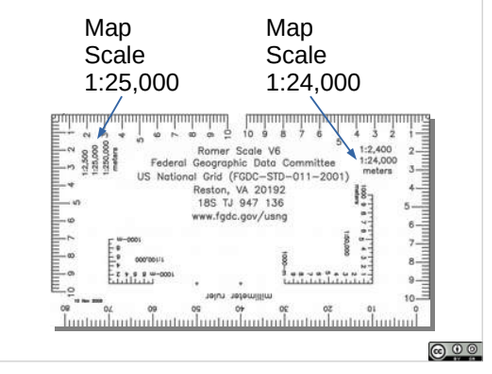



If you have a map printed out at a standard scale (true for the printed USGS topo quads, and US Topo maps, not true for print on demand maps), you can use a grid reader to find locations within 1 km grid squares.

Two different grid readers shown: one transparent 1 km square, with 100 m grid lines; other L shaped, printed with 100m and 10 m tic marks.

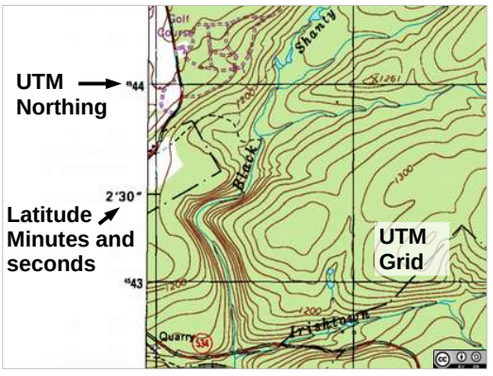
Grid reader must match the scale of the map (which is why the work well for maps printed at standard scales, but not for print on demand maps, which can be arbitrarily rescaled for printing).





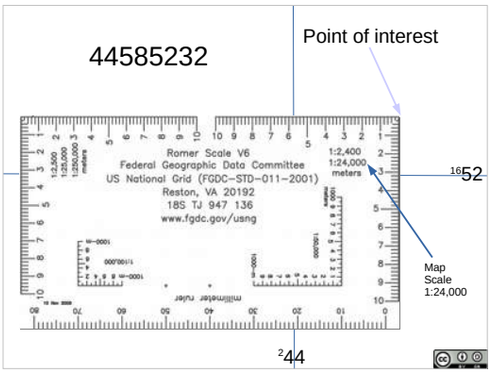

This is the FGDC (Federal Geographic Data Committee) romer (available from www.fgdc.gov/usng). When printed at the correct size, one corner is for use with 1:24,000 scale maps (the distance from the corner to 10 on the scale is 1 km, matching the 1 km UTM grid). The other corner is for use with 1:25,000 scale maps.

The numbered scales running into the corners are numbered at 100 meter intervals, and have small ticks at 10 meter intervals (for the 1:24,000 and 1:25,000 scales).




The romer works with the 1 km UTM grid printed on the USGS topo quad and US Topo maps.



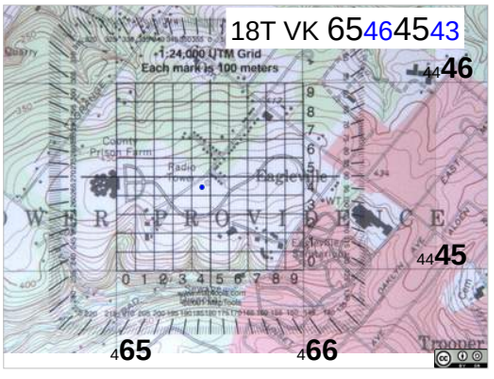



To use the romer, first confirm that when the corner is placed on one grid line, the 10 on the scale is on the next grid line. If that is true, then the romer and the map are at the same scale and you can use that romer on that map.

Then place the corner of the romer on the point of interest, identify the grid line for the easting (here 44 (using USNG so we ignore the small 2)), and read off the number where the roamer crosses that easting line (here 5 and 8 small ticks). Put the numbers together for the easting: 4458 (down to a 10 meter square). Repeat with the northing: find the northing line (52), and read tens of meters off the scale (32) for a northing of 5232. If desired, estimate meters in the distance between the ticks (to go to 5 digits for easting and northing 4458052320),

This works in reverse, given a coordinate, you can use the scale on the romer and the UTM grid to put a point on a map.



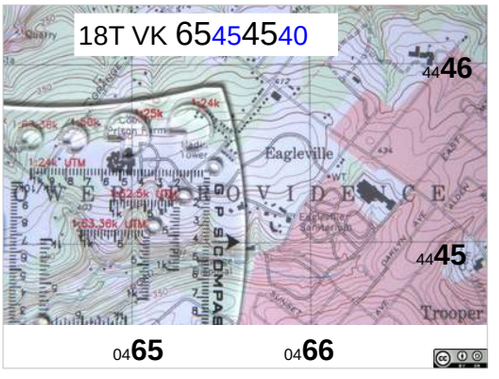



Other grid readers can be a transparent grid 1 km square at the scale of the map.

Use by placing the grid reader on a 1 km grid square, find the number for the Easting line (65), then find which square the point of interest lies in, and read off the 100 m easting digit from the edge of the grid (here 4). Then you can estimate the 10 meter easting digit (6), for an easting of 6546. Repeat with the northing, grid line (45), 100m square (4) and estimate 10s of meters (3) for a northing of 4543, thus USNG local coordinate of 65464543.

Where do we get the 18T VK from?






Some compasses have grid readers printed on the base plate – often with a hole at the corner of an L. Place the hole on the point of interest and read off the easting and northing 100m and 10m digits, or given a coordinate, find the easting line and northing lines for the 1km grid square of interest, line up the compass with the easting line and, move the easting scale to match the rest of the coordinates, repeat with the northing to put the hole over the point (then you can mark the map with a pencil or pen through the hole).

## SDMRT coordinates

- Everyone has identical maps.
- Communicate points on the map from measurements in inches on the map from the edge of the map (read in like Easting, read up like Northing, but in inches measured on the printed map.
- Maps must be exactly identical (they can't be copied in different resolutions or positions).

San Diego Mountain Rescue Team coordinates.

Make a set of absolutely identical copies of a map (can be any arbitrary map, including local trail maps or street maps). Everyone communicating location needs an absolutely identicalcopy of the map (same scale, same position on photocopier, same enlargement, etc).

Mark a point on the map. Measure the distance from the left edge of the map in inches to the point. Measure the distance from the bottom of the map to the point. Communicate these two distances.

If the maps at the receiving and sending ends are identical in every way, then the point on the map can be communicated successfully. Any difference, and the wrong location will be received.





# Land Navigation VIII
# Using GNSS Receivers


Unit 26, Land Navigation VIII:Using GNSS Receivers
Date Last Updated: March 3, 2020





## Some Key GNSS receiver Settings

- Position format:
  - Latitude/Longitude
    - Decimal Degrees
    - Degrees, Minutes, Seconds
  - **USNG**, UTM/UPS, MGRS
- Datum: NAD27, NAD83, WGS84, etc.
  - Use **WGS84**
  - Unless using a map with a different datum
- Units (elevation, speed): English, Metric
- Bearings: Magnetic, True
- WAAS (on, off)

One set of opportunities for **human error** are the GNSS receiver settings. You must be able to locate and change all these settings on GNSS receivers.

You could be working with a combination such as Latitude/Longitude as the position format, NAD27 as a datum, and magnetic bearings.

Or you could be working with a combination of US National Grid as the position format, WGS84 as a datum, and true bearings.

Working with one set of settings, and communicate with someone else using a different set – certain to cause confusion and navigation errors.

Setting bearings to magnetic may be desirable when working with a lensatic compass. Make sure communications follow the convention (magnetic or true) adopted for the search.

Turn on WAAS (Wide Area Augmentation System) for higher accuracy positions, **but uses batteries faste**r.



## Datum (geodetic datum)

- The Earth is not a perfect Sphere
- A geodetic datum is a reference model for the shape of the surface of the Earth
- The same coordinate in two different datums may differ in position by hundreds of meters or even kilometers
- (Distinct from vertical datum for elevation)

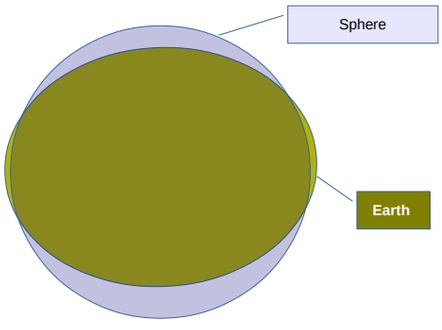
Since the Earth spins, it bulges slightly at the equator – it isn't a perfect sphere. A geodetic datum (like WGS84) is a mathematical model of the shape of the Earth used in producing a map projection.

Some datums were designed to work well in one particular part of the world (and not work well anywhere else). Other datums (like WGS 84, the world geodetic system of 1984) were designed to work anywhere in the world.

If you report a position using one datum to someone else who enters it using another datum, the position might end up as much as 3.6 km off.

Having your GNSS receiver set to the wrong datum is one source of human error.

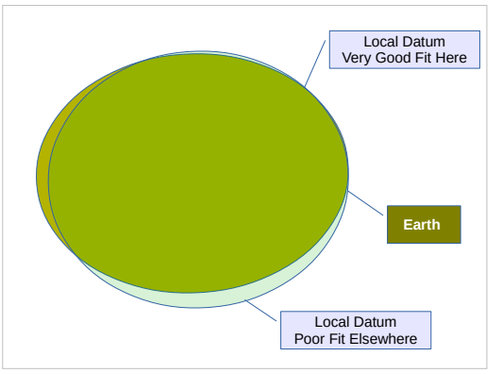





The Earth isn't a Sphere.

We could model it as one (a simple spherical global datum centered on the center of the Earth), but that would be a poor fit just about everywhere.

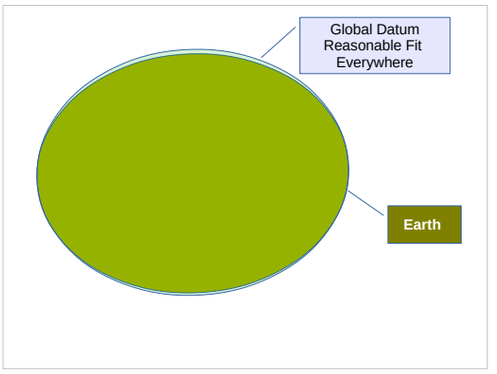
So, we need a better Datum, a better model of the actual shape of the Earth.




We could model the earth as a spheroid, fitted well to some local part of the Earth.

This is what the datum NAD27 does – it is a model of the shape of the earth, centered on Kansas, that fits well in the US, and poorly elsewhere.

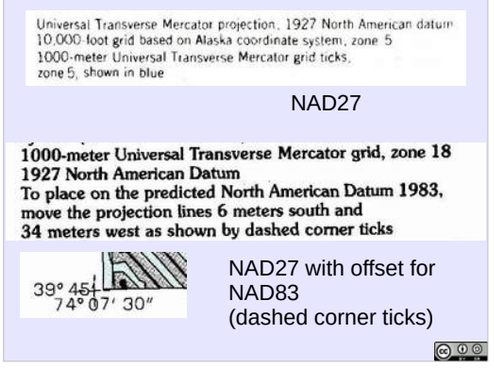





Or we could adjust a spheroid to make a more complex model of the shape of the Earth that is a reasonable fit everywhere.

This is what the datum WGS84 does, it it a reasonable fit to the actual shape of the Earth everywhere on Earth.





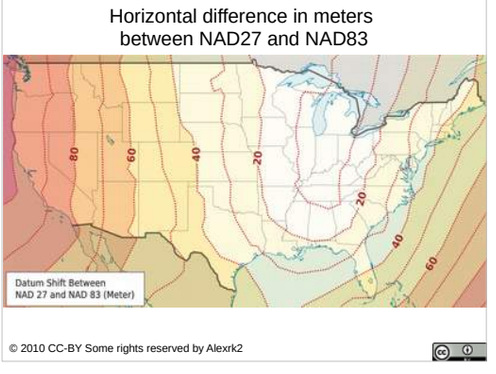

A map is projected using a particular datum. This datum should be included somewhere in the metadata on the border of the map.

At the top is an older USGS topographic quad which used NAD27, the 1927 North American Datum (which is a good fit in the continental United States).

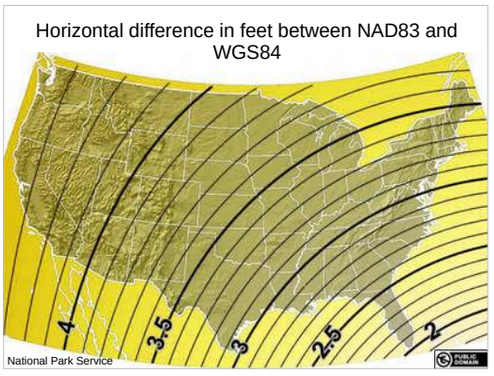
Below is a 1990s USGS topographic map which also used NAD27, but includes markings on the map showing how much positions need to be shifted to between NAD27 and NAD83, the 1983 North American Datum. In this case, the difference is about 36 meters.

Current USGS maps use WGS 84 (and may show the offset between WGS84 and NAD27).





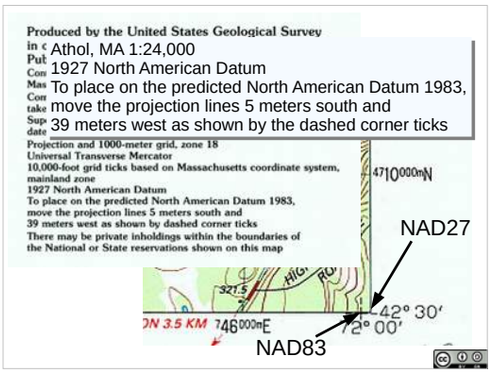

Here's a map showing how much NAD27 and NAD83 differ from each other in the continental US. In New England, these are typically about 40 meters different from one another.




NAD83 and WGS84 are not very different in the continental US. This map shows the difference between them in feet (about 3 feet to a meter).

In New England, NAD83 and WGS84 are on the order of 1 meter different from one another.



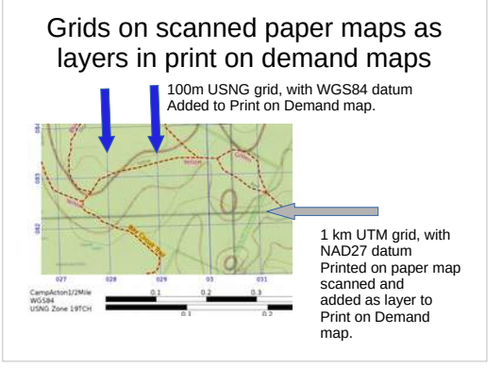



Here is metadata from the border of the Athol, MA 1:25,000 USGS topographic map from 1998. How much difference is there between the grid on the map (NAD27 datum) and WGS84? [39 m west, and 5 m south]

Difference between NAD27 and NAD83 is shown on map (5 m south, 39 m west). Difference between NAD83 and WGS84 in the NE US is just over one meter (previous slide), so for navigating on the ground in New England, NAD83 is effectively the same as WGS84. Difference is just over 40 meters.

So if you have your GNSS receiver set to WGS84, and you are communicating a position in Athol to someone who is plotting it on this map, without realizing the datums differ, they will plot the point about 40 meters east of where it should be. 40 Meters is easy shouting distance, but could be on the wrong side of a stream or other terrain feature if someone tries to navigate to your position using a different datum, and might be too far off from a flagged clue to find the flagging.

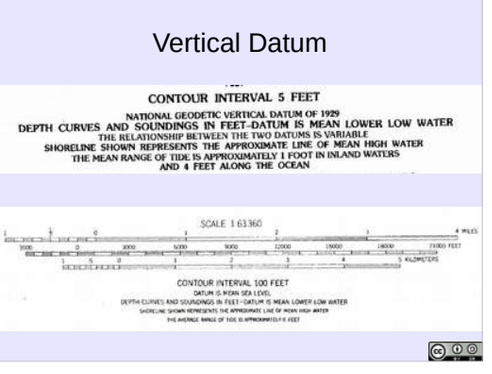





Don't get confused by grids that were printed on USGS topographic maps when scans of those maps are added as a layer in a GIS application to produce a new print on demand map (with its own grid added).

In the print on demand map (e.g. produced from Terrain Navigator or SARTopo) you may not have access to the metadata that tells you what datum and coordinate system was used for the grid on the underlying scanned map. The print on demand map should include the metadata you need to use the grid it added.






Geodetic/horizontal datum is different from the vertical datum (also marked on the edge of maps).

Geodetic datum is a model of the shape of the earth used to project the map.

Horizontal datum is the local zero for elevation, usually mean sea level.

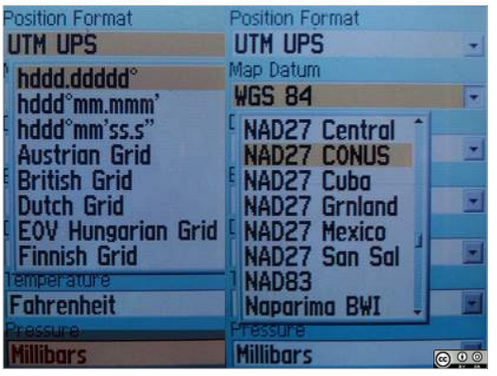
Which horizontal datum is used for the map is usually important to know in coastal areas.


How to get to the settings varies from GNSS receiver to GNSS receiver. Typically there is a main menu with access to units and/or position format settings.

Here, in an older Garmin GPS 60 series GNSS receiver, there's a main menu page with a Setup page with a Units page where you can find the position format, datum, and distance units settings.

Main Menu->Settings->Units



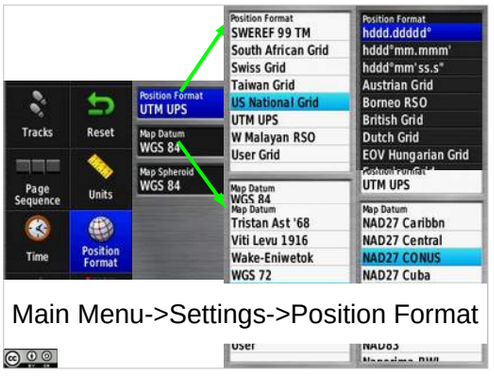



For Position Format and Datum you will have many choices.

USNG, UTM/UPS, or decimal degrees (here hddd.dddddd) are the likely position formats (at the the top and bottom of the very long list).

WGS84 or NAD27 CONUS are the likely Datum choices (again from a very long list).






Here's the menu system for a more recent Garmin GPS 62 series GNSS receiver, with position format and datum accessed from a Position Format section on the main menu.

GNSS receivers vary.

Learn yours. Learn your teammates.



With your GNSS Receiver, Set:

- Position readout to Latitude/Longitude
- Latitude/Longitude Format to Decimal Degrees
- Datum to NAD27
- Units to Feet/Yards/Miles
  - Write down your location

Now change to:

- Position readout to USNG
- Datum to WGS84
- Units to Metric
  - Write down your location

Take out your GNSS receiver.

Practical Evolution: (1) Set datum and coordinate system on a GPS.

Set to: lat/long, decimal degrees, NAD27, units: feet yards/miles.

Then change to: USNG, WGS84, units: metric.

## Plot location on a map

- What coordinate system and datum is used by the map?
  - Does it have a UTM grid?
- Change the GPS coordinate system and datum to match the map.
  - View the coordinates (current, in a waypoint)
  - Plot the coordinates on the map.

Given a location, you can plot it on a map.

What do you need to know to plot a location on a map?

May need to set a GNSS/GPS receiver to the same coordinate system (e.g. USNG) and datum (e.g. NAD27) as the grid printed on the map.

Practical Evolution (2) Mark current location on a topographic map



## Converting with a GNSS


It is straightforward to use a modern GNSS receiver to convert from one position format to another.

With your GNSS receiver set to one position format, record or enter a position. Then using the menu system, change to a different position format.

Here the location is in UTM in the upper left, working through the menus, the position format is change to latitude/longitude, degrees minutes seconds – and the display changes to show lat/long.



## Startup: Practice Good Habits

- Before you start:
  - Check/Change your batteries.
  - Check Datum, Coordinate System, distance units
- When you get out at the drop off point
  - Make sure your GPS has an accurate position.
  - Mark a waypoint with your GPS.
  - Save and clear the current track (dog's too).
  - Make sure that your GPS is recording the track.
  - Calibrate the compass.
- When you start your assignment
  - Mark a waypoint
- When you complete your assignment
  - Save the track for the assignment with clear name.

Reminder: Practice good Habits.



## Create Waypoints By:

- Mark Current Position
- Create a waypoint and enter the coordinates.
- Select a position on the map.
- Project a waypoint.

You can create waypoints in several ways.

You can mark your current location as a waypoint (often a Mark button).

You can create a waypoint, then edit the coordinates to move the waypoint somewhere else.

You can select a position on the map and turn it into a waypoint.

You can project a waypoint some distance on some bearing from the current location or another waypoint.

Let's walk through these.

## Navigating with GPS

- Enter a waypoint, go to waypoint.
  - Self correcting navigation.
  - (Enter a route, follow route).
- Project a waypoint a distance on a bearing.
  - Self correcting navigation
- Backtrack
- Navigate with the GNSS compass on a bearing
  - Errors accumulate.

First, lets think about two fundamentally different ways you can use your GNSS/GPS receiver to navigate.

One is navigating to a waypoint.

The other is navigating on a bearing using the GNSS receiver's compass.

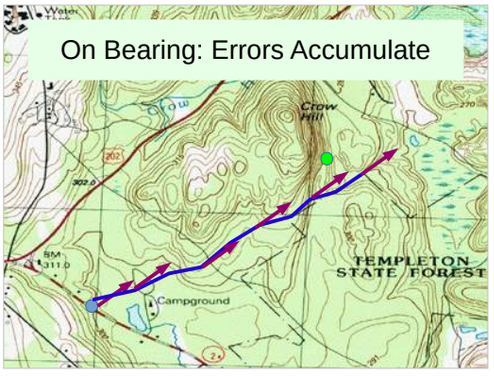


## To Waypoint: Self Correcting


Purple is where the GNSS receiver is telling you to go as you check it along the way. If you are navigating to a waypoint, it will always point you at the waypoint.



## On Bearing: Errors Accumulate




If, however, you are using the GNSS receiver to travel on a bearing, then errors accumulate.

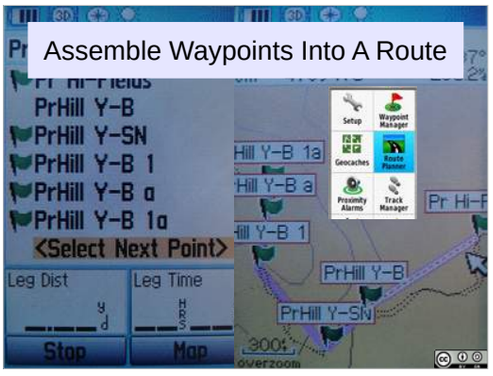
The purple arrows show the bearing the GNSS receiver is pointing you on as you check it along the way.



## Are we there yet?

- Proximity alerts.

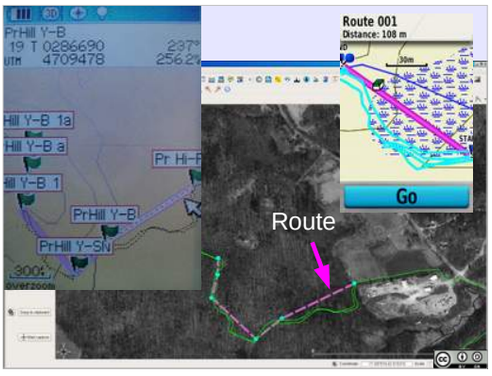

You can set your GNSS/GPS receiver to beep or otherwise notify you when you get within some distance of a waypoint that you are traveling to.




Your GNSS may allow you to build a route out of a set of waypoints.

You may also be able to do this in an external application on a computer, and upload the waypoints and route into your GNSS.





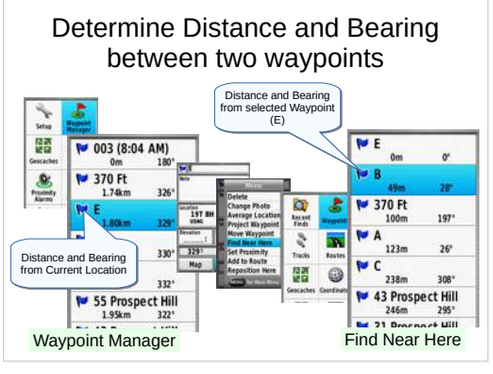

Route connects waypoints with straight lines.

GPS screen and mapping application show a route and the actual track followed while following a trail.

(On the map, trail is in green, waypoints are in blue, and the route is in pink).

In this particular case, the pink route happens to lead through a swamp, the green track around it.





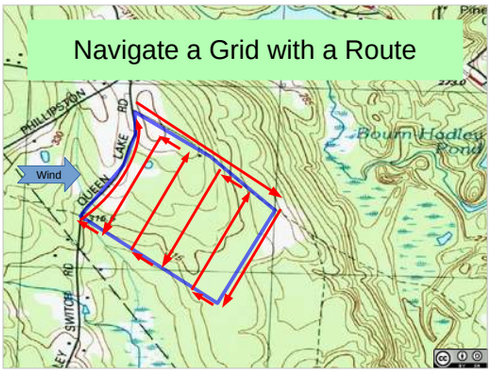

Your GNSS/GPS receiver may allow you to find the distance and bearing between two arbitrary waypoints.

In recent Garmin receivers, the waypoint manager lists waypoints with distance and bearing from the current location.

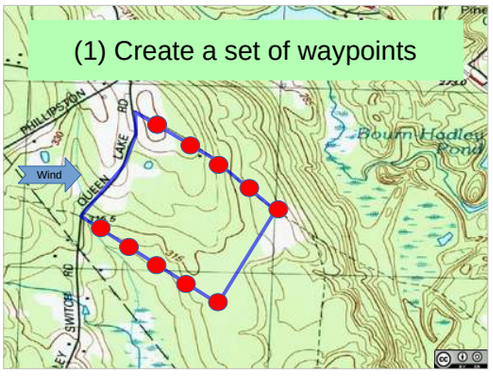
Select a waypoint then: Menu -> Find near here -> Waypoints brings up a list of waypoints with distance and bearing from the selected waypoint (bearings and distances from E). How far at what bearing from E to B?

Practical evolution: (3) Determine the distance and bearing between two waypoints.



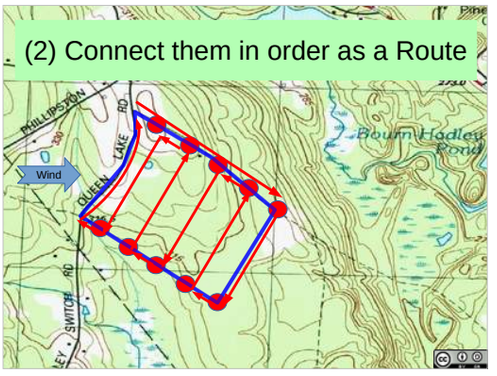



You can create a set of waypoints, then connect those waypoints into a route to navigate a grid of a segment.




First, create them as waypoints.



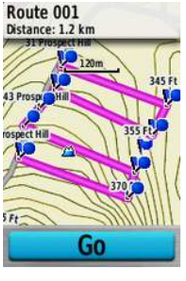



Then assemble them into a route.

(or add them to the route as you create them).



Select the route and navigate it




Then select the route and tell your GNSS receiver to navigate it.

Hint: it is easier to connect them if you give them sequential names as you create them (A, B, C...)

Hint: it is a lot easier to do this in a GIS application and upload into the GNSS/GPS receiver than to create the waypoints for the grid of a segment using the GNSS/GPS receiver.



Backtrack

- Manually
  - Use GPS map and pointer to work out bearings to points along track.
- Automatically (some GPS units)
- You need to be recording the track....


You've been following some route through some complex system of trails and you want to find your way back to your starting point.

If you recorded your track with your GPS, that can help.

Some GNSS units have a backtrack function that will treat your track as a route that you can navigate in reverse.

## Navigation Errors....


"The prudent mariner will not rely solely on any single aid to navigation"

How many ways can navigation go wrong with a GNSS receiver?

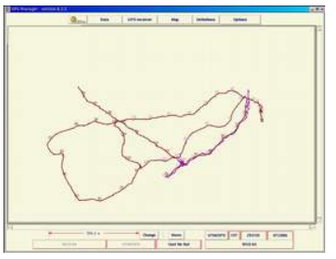
Discuss potential ways navigation errors can happen with GNSS receivers.

Include: Human Error, Wrong Datum, compass not calibrated, magnetic/true north setting, batteries ran out, forgot to record waypoint to navigate back to, entered coordinate incorrectly, particularly near zone boundaries, solar storms, canopy, multipath, forgetting to record track, connecting wrong waypoint sequence into a route, projecting a waypoint too far or in the wrong direction....

Failure to sanity check, sole reliance on GNSS receiver...



## Download Tracks, Waypoints, or Routes from GPS to Computer



You can download stored data (waypoints, routes, tracks) from a GNSS to a computer.

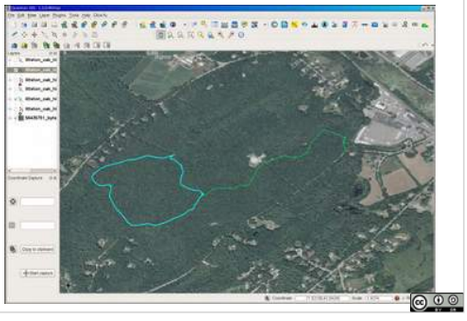
Older models – serial protocols, require software that can talk specifically to the GPS.

Recent models often simply mount the GNSS as a USB storage device and generate GPX files that you can copy directly off of that storage when you plug them in, no special software needed to move data off the GNSS.

You can also upload waypoints and routes from a computer to a GNSS. For example, segment corners as waypoints.

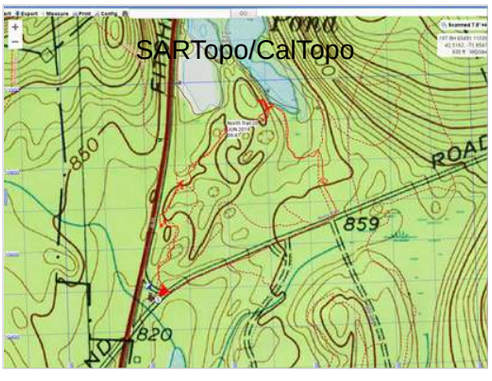


## Add as Layers in a GIS Application

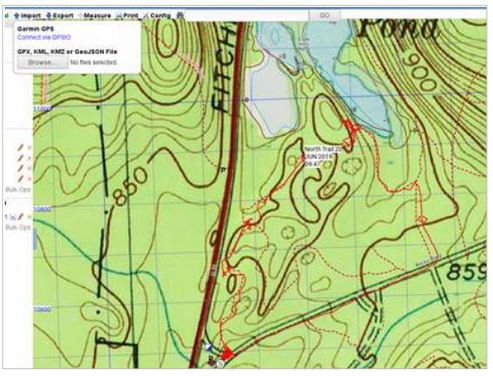


Once you've got data off the GNSS, you can add the data as layers to a geographic information system application.



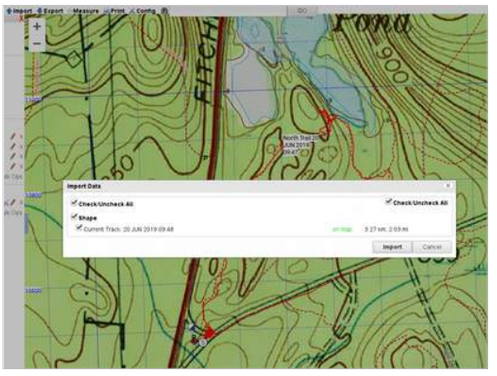



One online GIS application designed for SAR is SARTopo – it can allow you to upload tracks from a GNSS receiver, and edit tracks (split, and delete to remove extraneous before start or after end information (like the track of your drive from home to the search staging area).



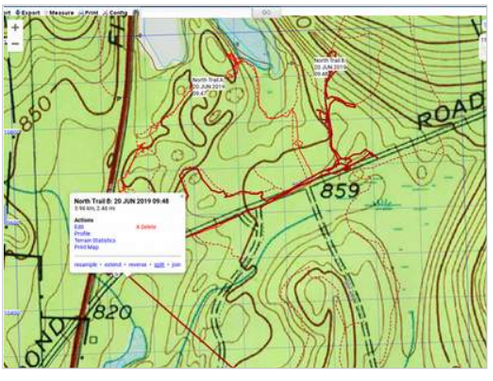

SARTopo, like other GIS applications, allows you to upload tracks, waypoints, and trails from GNSS/GPS receivers. A frequent means for this is by uploading .gpx files.






From which tracks, waypoints, and routes present can be selected for import.






SARTopo allows for the editing of tracks.

A case is if you didn't remember to clear your track before starting a problem, such that the track contains your drive from the last place you had the GNSS/GPS receiver on.
A way to handle this is to select the track, split it, then delete the unwanted portion.

Best to avoid having the GIS specialist from having to clean up your tracks, so:



## Saving Tracks

- Save a separate track for each assignment (documenting your search effort for that assignment).
  - Reduce clutter and work for the Planning Section.
  - Some GNSS Receivers limit the number of points in a track. Saving very large tracks can reduce precision of fit between the track and your route.
- Establish a routine – use on every training.
- Make sure tracking is on, start new/save with each assignment.

Get into good habits of recording and saving clean tracks of your assignments

Save the current track just before you start.

Clear the current track.

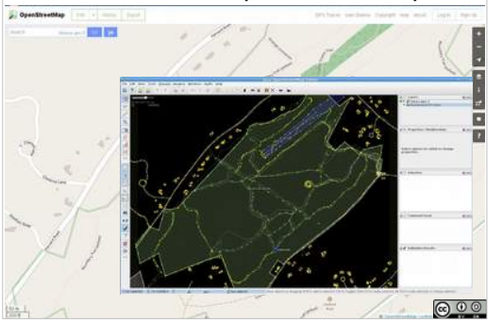
Make sure your track is being recorded.

Carry out your assignment.

Save your track.

You will make the GIS specialist very happy.

## Contribute to Open Street Map



You can also contribute to OpenStreetMap

Improve the world's knowledge of trails and other map features in areas where you train. Travel somewhere that hasn't been mapped, upload the tracks from your GNSS/GPS receiver, then add and edit the map features.



## Load Maps into your GNSS receiver

- Options may include (see your user manual)
  - Maps on a micro SD card.
  - Maps uploaded from a computer.
  - Maps loaded over a wireless connection.

Depending on your GNSS/GPS receivers, you may be able to add maps from external sources to display on your receiver.

With some GNSS receivers you can upload maps and air photos of an area from a computer, with others, you can obtain maps and air photos live with a wireless connection. See your receiver's manual.



NEWSAR SAR Field Team Member: Unit 26: GNSS March 3, 2020



Practical Evolution: (4) Plot the location of a task, direct them to another location.


Unit 27: Rescue
Date last updated: February 19, 2020



This presentation is not a complete manual for search and rescue response. The materials are not meant to replace field training by competent search and rescue leaders or to replace actual experience. NEWSAR and the authors and contributors do not endorse any specific equipment mentioned or shown in this program. The authors, contributors, and NEWSAR take no responsibility for the use of this guide or the information contained within. The authors, contributors, and NEWSAR take no responsibility and cannot be held liable for statements made by instructors who use this presentation. It is the duty of every community, organization, volunteer group, and agency, to obtain the knowledge, skills, and proficiency to perform and maintain effective search and rescue management and operations. The information presented in this presentation serves as part of a beginning outline and body of knowledge for proper search and rescue respons programs at the community level.

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Search phase involves locating the subject, Rescue phase involves accessing them, stabilizing them, and transporting them.

What phase are we looking at here? [Access]

Any of these, including locate, might involve technical rescue environments and resources.




Is this a technical environment?

Sometimes it is obvious.




How about this, is this a technical environment?

Is access dangerous? [yes, confined space]

What do you do here?

**Stay out, report it.**

Recognize technical rescue environments: high angle, confined space, cave, mine, water, mountain rescue.

## Access/Stabilize/Transport

- May be easy, subject may be able to walk out.
- May require lots of people for a litter carry out.
- May require technical rescue resources.
- Decisions to be made.
- The Golden Hour is a concern.

Once you've located the subject, things may be simple.
Or they may not.
Why?

Subject might need medical care [discuss the golden hour].

Subject might need to be carried out. (Are we likely to be able to do that within the golden hour? Consider getting advanced care to the subject).

Subject might be in a technical rescue situation.

Decisions to make.

Let's think about the decision making process.




What is the situation?

Your safety comes first.



## Risk Management Process

- Situational Awareness
- Hazard Assessment
- Hazard Control
- Decision Point: Go or No go.
- Evaluation
  - Individual: experience, distractions, fatigue, attitude
  - Everyone: Changing Situation


Decision making follows a risk management process.

Be aware of the situation.

Assess hazards.

Control hazards (obtain resources to manage them)

Have a clear go/no go decision point.

Continually evaluate.



## Talk it through

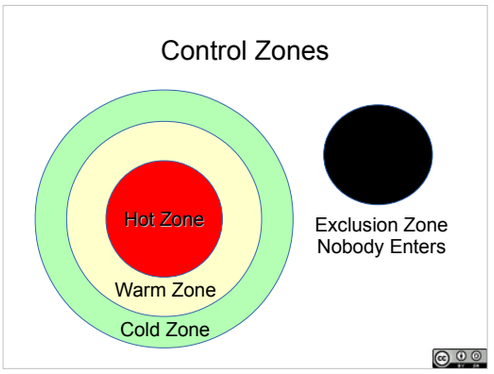
- Out loud
- GAR (Green/Amber/Red Risk Assessment)

Use a formal tool like GAR (Green/Amber/Red) for risk assessment, or not: key is discussing the observed hazards out loud.


What are the hazards here?

How are we going to control the hazards?






One of our tools for managing hazards – keep people out of them....

We could declare a hot zone 10 feet from the edge.

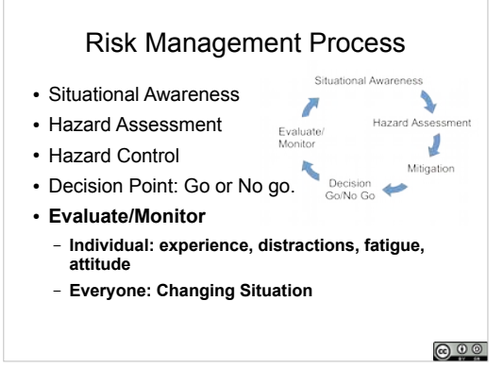
Review: What goes on in each zone?

Cold Zone: ICP, Staging
Warm Zone: Support for entry into Hot Zone
Hot Zone: Enter only with appropriate PPE and with a specific assignment.
General public kept out of the cold zone.

Exclusion zone, nobody is to enter.

Where do you put tag in/tag out access controls? [hot zone]






**Continually evaluate.**

Conditions change.

Suppose it is getting colder, it is starting to rain, the rain turns to freezing rain.

How does that affect our approach to the person at the bottom of the cliff?




Another situation: You've located your subject.
Down in there.
They are unresponsive.

What is the process for figuring out what to do (or not do)?

Practical: Assess Risk with GAR risk assessment tool.

Situation?
Rescue? Recovery?
Hazards?
Hazard Control?
Go – No Go?

What could go wrong here?

## Equipment seldom fails

- Most accidents in technical rescue operations are due to ***human error***.
- Maintain situational awareness.

Very easy to get tunnel vision focusing on the subject – maintain situational awareness.

What can you do to avoid tunnel vision?

And situations change.



## FAILURE

- F – Failure to understand the environment
- A – Additional medical implications not considered
- I – Inadequate rescue skills
- L – Lack of teamwork and experience
- U – Underestimating the logistical requirements
- R – Rescue versus recovery mode not considered
- E – Equipment not mastered

Acronym: Failure: Reasons why technical rescue operations fail.

Particular risks for SAR:

Failure to understand the environment – hazardous environments not recognized as such (tunnel vision, inadequate training).

If there's a door, don't assume there's a floor on the other side.

Inadequate rescue skills, lack of experience, equipment not mastered – call for help – get trained technical rescue resources.



## FAILURE

- F – Failure to understand the environment
- A – Additional medical implications not considered
- **I – Inadequate rescue skills**
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- U – Underestimating the logistical requirements
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- **E – Equipment not mastered**

Highlight: As searchers, this course isn't training or preparation for technical rescue.

Key aspect is to recognize that additional trained and experienced help is needed.



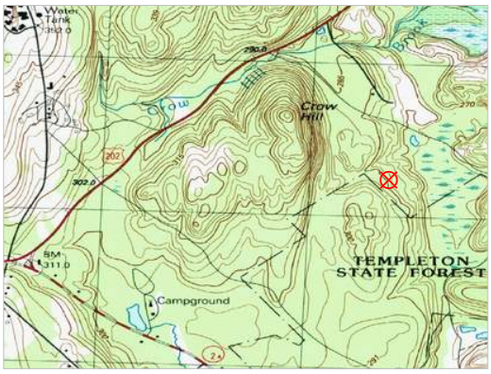

Sometimes getting help is easy. Sometimes not...

If it isn't easy - if the subject can't simply walk out, what will you need? (resources, how do they get there?)

Directing resources to your location.

Planning a route out.

Will the route out be the shortest?




Here's your find.

How are you going to get resources there?

What is your route out?



## Establish a common set of signals

- Example: SUDOT whistle signals
  - One: Stop
  - Two: Up
  - Three: Down
  - Four: Off Rope
  - Long Blast: Trouble.
- Example: OATH whistle signals
  - one: OK
  - two: Advance
  - three: Take Up
  - four: Help

What happens when you don't?

Particularly when people from different agencies and disciplines are working together, important to review signals.



## Communicate for Safety

- Be direct – don't worry about seeming rude.
  - *"Lieutenant – Get away from that edge."*
- Communicate safety concerns by being direct
  - Address relevant person by name (or title)
  - Say: "I" (think/feel/believe)
  - Clear message
  - Demand a response: "What do you think?"
  - "*Nancy: I think that compartment has a low oxygen atmosphere. Responders need SCBA. Don't you agree?*"

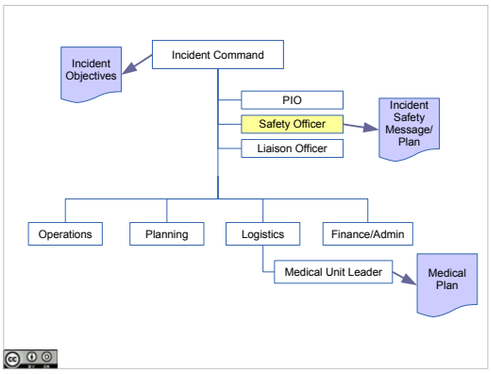
How do you communicate a life safety issue?

Who can communicate a safety issue? (anyone)



Anyone can call **Stop** at any time

Anyone can call **Stop** at any time.



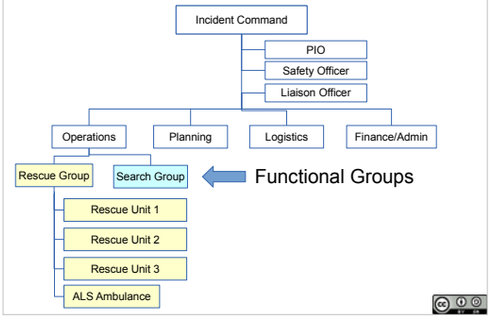

What are some of the things baked into ICS for safety as a priority?

What else?

Discuss.



## Possible ICS Organization




Rescue tends to require tight local tactical control – people who know what they are doing working together on a focused problem.

One mechanism for encapsulating that in ICS is functional Groups – a Rescue Group that carries out the rescue.

Rescue also tends to involve hazards, how can those be addressed? (among others: Site Safety Officer)



## Stabilization

- Physical
- Medical
- Emotional

Three aspects to stabilization:

Physical – is the subject in a physically stable situation?

Medical – is the subject medically stable?

Emotional – is the subject emotionally stable? (suicidal, scared, at risk for catastrophic reaction (autistic, dementia)). How do we reduce the likelyhood of a catastrophic reaction by the subject?



## Approaching the Subject

- **Is the scene Safe?**
- Subject may have a catastrophic reaction
  - Particularly autistic and dementia
- Simplify the environment
  - Reduce noise, turn down radios, etc.
- Approach from the front
- Identify yourself
- Make eye contact
- Ask simple direct questions

When you make a find, what is the first priority?

## Stabilization

- F – Failure to understand the environment
- **A – Additional medical implications not considered**
- I – Inadequate rescue skills
- L – Lack of teamwork and experience
- U – Underestimating the logistical requirements
- R – Rescue versus recovery mode not considered
- E – Equipment not mastered

That's a matter for medical training.

Plan ahead:
What medical training for SAR responders?
What sort of additional medical implications might come into play in a rescue? (shock, golden hour, hypothermia, suspension syndrome, HAPE....)

Multiple functional roles to be filled in an assignment: leadership, clue aware searchers, navigation, communication, medical...

Report what you've got, get skilled help.

If more victims than there are medical resources to treat them, then **triage**.

# Ties and Anchors


Unit 28: Ties and Anchors
Date Last Updated: March 3, 2020



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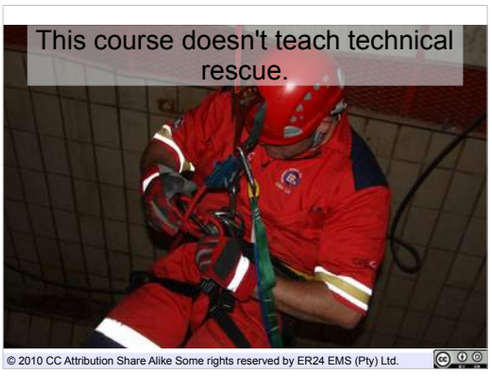



Reminder: This course doesn't teach technical rescue.

This course doesn't teach you how to operate in the high angle environment, just how to recognize it.

It does teach some skills for use on non-technical terrain.

It does teach some skills to assist in the warm zone.

Operate under the supervision of trained technical rescue personnel



## Life Safety Rope Systems

- Mainline
  - Supports the load
- Belay
  - Redundant, takes up the load in case of a failure on the mainline portion of the system.
  - Limited slack, limited shock loads.

Life safety rope systems work with:

A mainline, holding the load.

A belay, kept with minimal slack, backup to take the load if there is a failure in the mainline portion of the system.

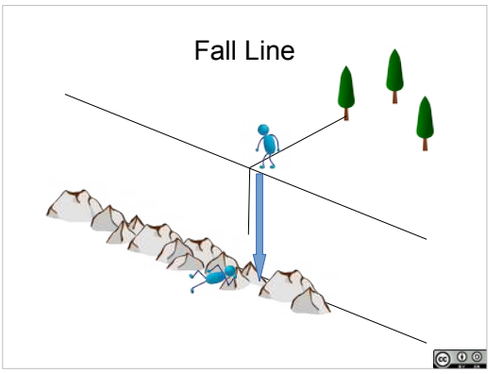
Entirely different from lead climbing systems.



## Some factors in system design

- Loads and Forces
  - System safety factor (10:1 or 15:1)
- Friction
- Anchors
- Fall Line
- Backup/Belay system

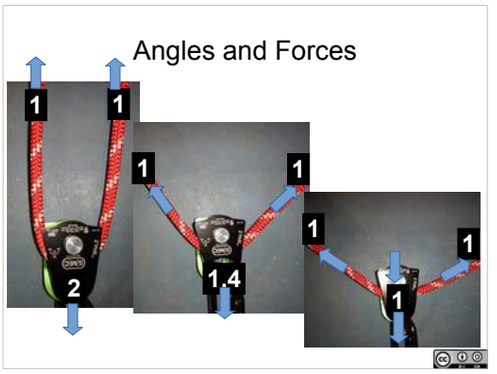
Lets take a very brief look at some of the factors that go into the design of a rope system by a technician.




One concern is the fall line.

Why?






Describe Angles and forces.

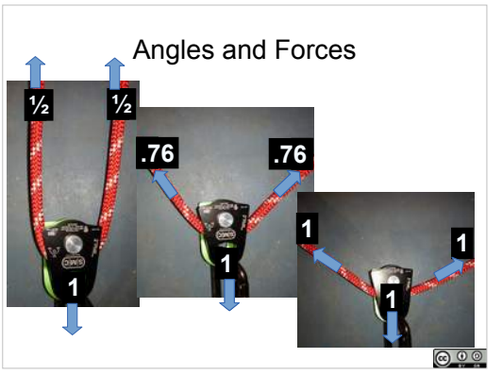
0 degrees, 1+1 vector sum to 2.

90 degrees, 1+1 vector sum to 1.4

120 degrees, 1+1 vector sum to 1, beyond that is lower.

Exact numbers don't matter for the purposes of this class (they do matter to the technicians who are rigging systems). But angles are important, can greatly multiply forces. Generally seek to keep angles small (less than 60 degrees).

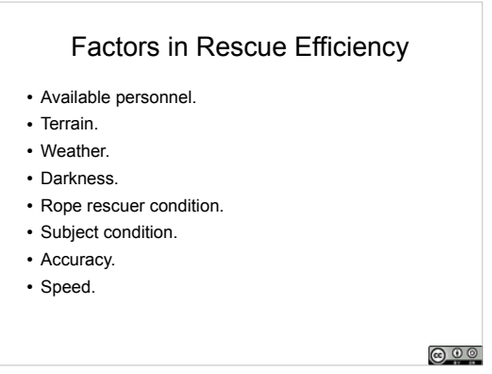





Describe Angles and forces Looking from the other direction.

Load of 1, on 0 degree pulley, 50% on each leg.
Same load, open to 90 degrees, load of 76% on each leg.
Same load, open to 120 degrees, load of 1 on each leg.
Wider than 120 degrees, each leg has load greater than 1.
Demonstration.
Again, exact numbers don't matter for the purposes of this class, though they are very important for technicians designing systems. Generally, keep angles small, less than 60 degrees.






Efficiency of rescue depends on multiple factors.

Knowledge, weather, skills, condition....

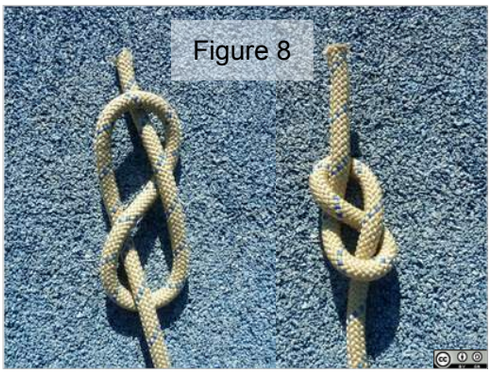
## Practice Ties

- Figure 8 on a bight, with barrel knot safety.
- Figure 8 follow through (tie in), with barrel knot safety.
- Alpine Butterfly
- Double overhand bend.
- Prusik hitch.
- Water knot.
- Square knot.
- Expedient Harness (Swiss seat).
- High strength anchor.

Hand out rope and webbing, demonstrate and have everyone tie each of these ties.

Images of each follow. *[You can use the images while teaching the knots if that is helpful, there are some comments on the knots in the speaker's notes]*

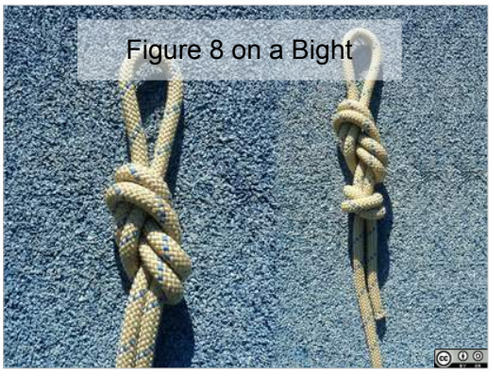





Review: Figure 8 stopper knot.

Foundation life safety knot. Easy to recognize , easy to see that it has been tied correctly.





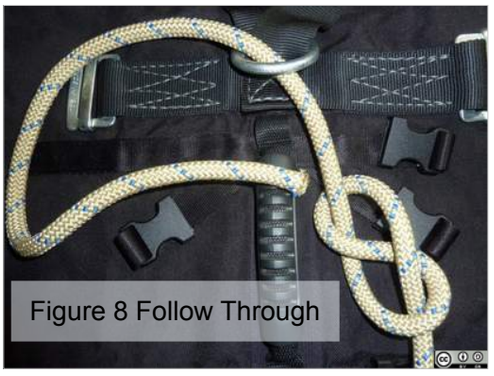

Review: Figure 8 on a bight.

Reminder: Dress your knots. That is important for their strength.




Review: Barrel knot safety (on a figure 8 on a bight).

Reminder: Make the loop on your figure 8 just large enough for its purpose.




Review: Figure 8 follow through

Exactly the same knot as the figure 8 on a bight, but tied in a follow through (to attach to a harness or some other closed ring).

Starts with a figure 8 in the working end, then pass the working end through the closed ring, then trace the 8.




Figure 8 follow through, finished knot

Exactly the same knot as the figure 8 on a bight, but tied in a follow through (to attach to a harness or some other closed ring).




Double overhand bend.




Prusik hitch.

Hitch, joins a rope to something.

Prusik hitch slides, but locks when loaded.

Progress capture device.




Water Knot – bend to tie in webbing.




Square knot at the top, with overhand safeties added on the bottom.

Binding Knot.




Used to make a swiss seat, and expedient harness.

Expedient harness.

## Anchors

- Secure
- Redundant
- Equalizing
- Non-Extensible

Anchors

Describe Selection of materials

Describe Alignment, limitations.




Anchors may be a single point anchor.

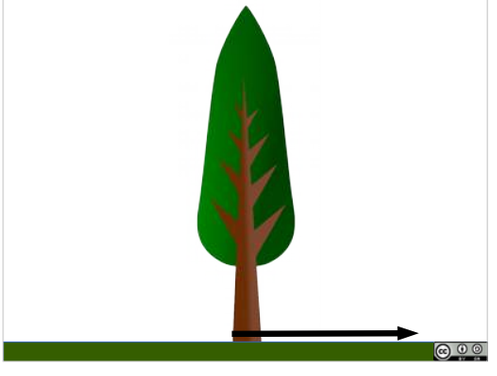
We'll build one sort of single point anchor.



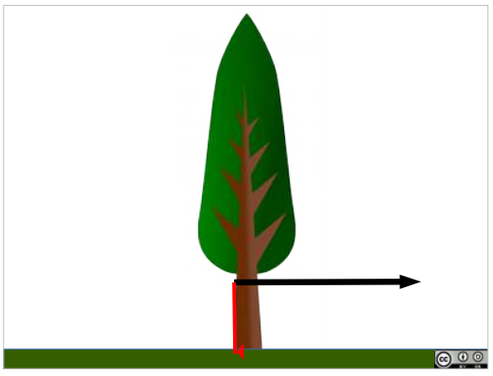

There are also Multi-point anchors.

We won't go into their design.





When anchoring to a tree, anchor low, close to the ground.



Anchoring higher creates a lever and a weaker anchor.

Demonstration.




High Strength Tie-off/Tensionless hitch.

Put edge protection around the anchor.

Precisely three wraps [*See the discussion in "On Rope"*].




High Strength Tie-off/Tensionless hitch.

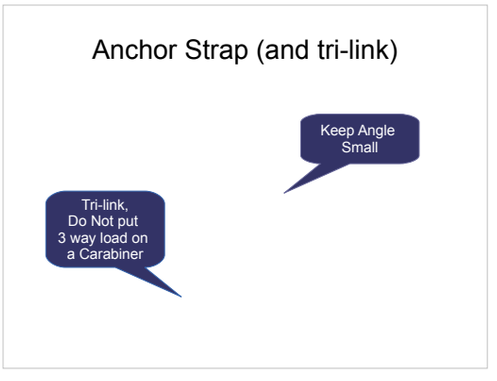
Put edge protection around the anchor.

Precisely three wraps [*See the discussion in "On Rope"*].

Describe Angles and forces – keep straight through carabener.

Note slight angle in this picture, main line should be straight from anchor.





## Team Functions

- Rescue Group Supervisor
- Edge Manager
- Safety
- Belay operator
- Lowering/Haul system operator(s)
- Rescuer/Litter Attendant(s)

Lots of jobs in a rope rescue operation.

Someone in charge.

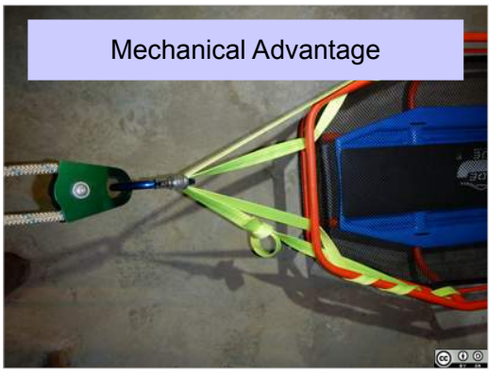
People filling roles, working as a team.




Identify team: Edge manager, belay, haul team.

Haul and lower

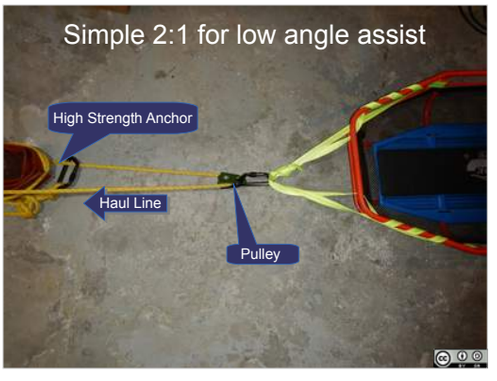




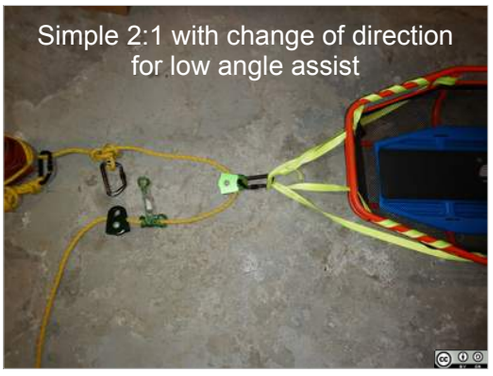

Basic mechanical advantage.

Discuss how a pulley works as change of direction, and how a pulley provides mechanical advantage





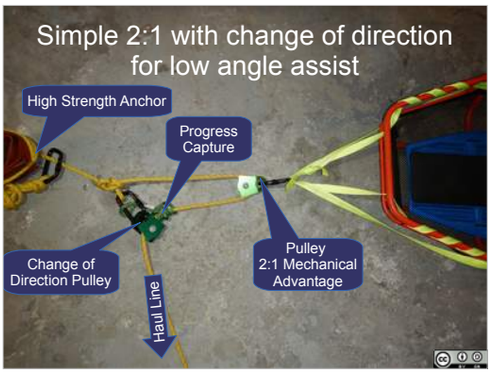

Simple 2:2 pulley on litter for low angle assist




Add a change of direction pulley to let the haul team work from off the line of haul.

Add a prusik as a progress capture device.

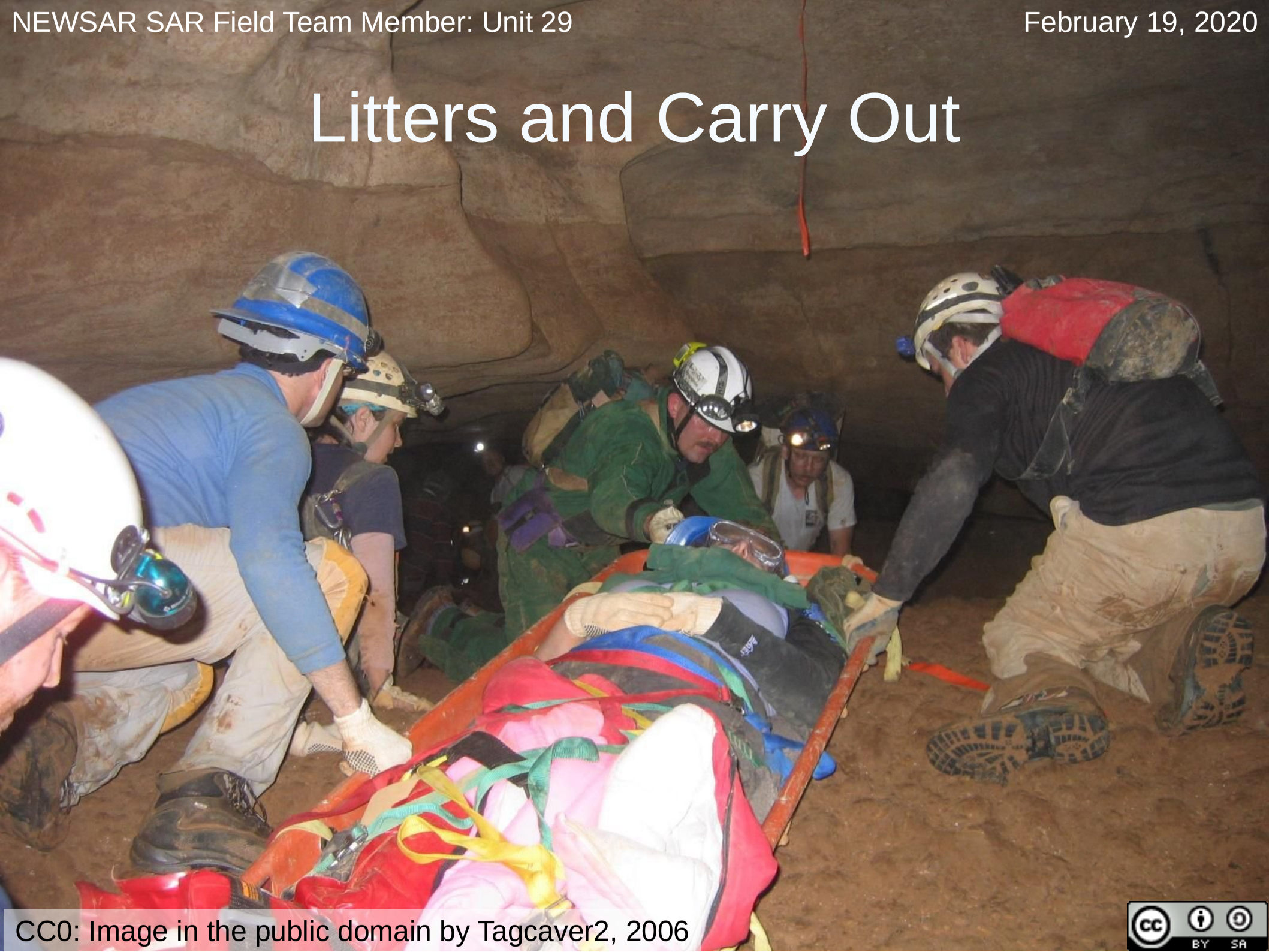





Add a change of direction pulley to let the haul team work from off the line of haul.

Add a prusik as a progress capture device.

# Litters and Carry Out




Unit 28: Packaging and Level Ground Litter Carry Out
Date Last Updated: February 19, 2020





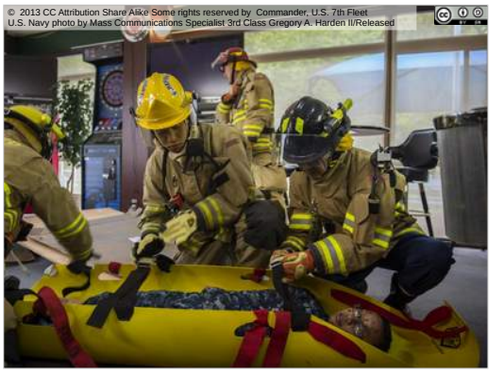

Locate, Access, Stabilize, Transport.

After finding a subject, it may necessary to carry them out of the woods.

Takes lots of people. Litters are good tools for that.

Here's a patient being packaged in a rigid stokes Litter for flat ground carry out (in training).






And here is a flexible litter (a sked).




Use under the direction of medically qualified personnel.

Not all backboards work with all litters.


6 people, just holding the litter (rail or straps) good for short distance flat carry (as is being done here in a transfer to a helicopter).

Carrying like this takes a lot of effort.




There are a variety of designs of wheels that attach to rigid litters.

Here's a two wheel design for sand or soft ground.




Here's a one wheel design for irregular ground. Takes much of the load, but still needs a multi-person team to handle (including keeping it stable).




It still takes a lot of people to carry a litter more than a short distance. Here are two teams rotating.

Think in terms of 18 people (three rotating teams of 6) as a reasonable number for carry outs on level ground. Add more for rigging haul assist systems in low angle terrain.

Safest way to rotate – stop, lower the litter to the ground, rotate out the litter bearers, raise the litter and continue.



It is possible to improvise a litter, but it will take a lot of people to do a carry out.



## Carry out team Positions/Functions

- Leader
  - Brief team on the evacuation plan
- Carry
- Medical care: Designated EMS care provider
- Relief
- Navigation
  - Locate, mark, guide team on carry out route
- Rigging
  - Rope assist for steeper parts of non-technical terrain

Need lots of people, need to be organized.

Have a plan, brief the team on it.

Fill functional needs.

Ensure the litter bearers gets breaks and gets hydrated.

Rotate the litter bearers (side to side and switching out between carrying and accompanying personnel



## Litter Packaging

- Protection from the elements
  - Heat, Cold, Rain, Snow, Sun, etc.
- Protection from the environment
  - Branches, falling rocks, etc.
- Protection from gravity
- Medical Concerns

Multiple ways to package someone in a litter.

Multiple concerns in litter packaging – protecting the patient from the elements, protecting them from branches, rocks etc. (how? (eye protection, head protection, care to avoid disturbing rocks on the fall line, etc.)).

Non-technical terrain carry out, or on a rope system where gravity is a hazard?

Medical concerns for access and monitoring (iv access, vitals, etc).



## Litter Tie-in

- Tie in for a burrito wrap.
  - Protection from the cold.
  - Limited access, limited adjustability.
- Yosemite tie in.
  - Good access and adjustment.
  - Protection from gravity.

We'll look at two methods for tie in – a burrito wrap for protection from the cold, and the yosemite tie in for protection from gravity.

Plenty of other variants.

Long laces or multiple short laces

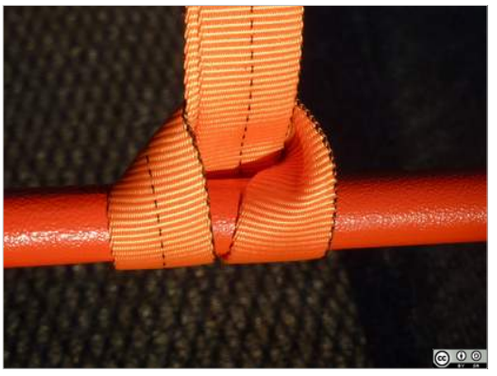
Perform a thorough and appropriate tie in for the situation.

All use similar ties in webbing.

Clove Hitch

End of webbing to rail.





Girth Hitch

Center of webbing or webbing loop to rail



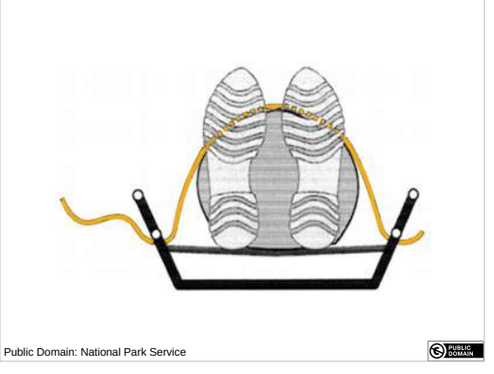

Packaging described here is not adequate for anything other than litter carries on flat terrain.

More training is needed for high angle packaging.

What is missing here?

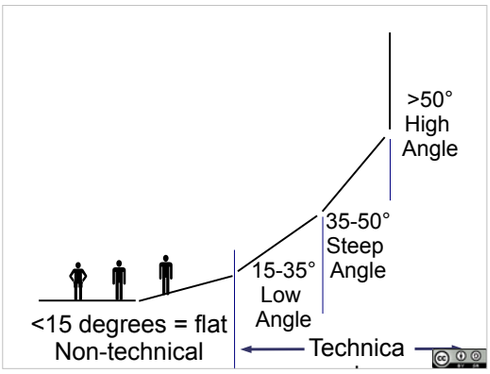
Provide eye protection for the subject.






Tie to the bottom rail – capturing more of the patient's circumference for more control over side-to-side motion of the patient.

Circumferential tie-in – more circumference, more stability.




Definitions for high/low angle conditions vary:
NFPA: High Angle = Weight supported by rope system.
Low Angle = Weight supported by ground.
Common (somewhat variable definition) we'll use here:
Flat ground: 0-15 degrees
Low angle: 15-35 degrees
Steep angle: 35-50 degrees (most dangerous)
High angle: 50-90 degrees

Quality of footing also factors in – poor footing, loose scree, etc, makes for more dangerous conditions.

Anything more that 15 degrees calls for support from technical rescue resources.

We are talking here about carry out on <15 degree (<27% grade, less than 2.7 rise in 10 run), non-technical terrain.



## Litter Packaging

- Protect the subject
  - Environmental protection
  - Protect their eyes
- Comfort
  - Pad between litter and shoulders, pelvis, legs
  - Pad behind the knees
  - Reduce uncertainty: explain the evacuation plan to the subject.
- Medical Concerns
  - Airway
  - IV Access sites
  - Splints/Spine
  - Access (injuries, IV sites, distal neurovascular, vitals)

Concerns for packaging:

Protect the subject from the environment: (heat, cold, rain, snow, sticks in the face...).

Put eye protection on the subject.

Make sure the packaging doesn't interfere with the subject's ability to breath.

Adjust the packaging to support medical needs (splints, airway access, IV access, spinal immobilization, etc).

Fill the patient in on the evacuation plan.



One packaging method for warmth – lay a waterproof barrier over the litter, then put blankets (one for legs, one for upper body), or a sleeping bag over it.



You can lay a reflective thermal layer (space blanket) over the blankets.

Then put the subject in the litter and wrap them in the thermal layer, the blankets, and the outer moisture barrier.

Then lash them in to the litter.

One lashing method – take a 40 foot length of 1” tubular webbing, girth hitch the center to the rail at the feet.



Start wrapping the litter with 1 inch tubular webbing (here with one 40 foot length).

Girth hitch the center of the webbing to the top rail at the foot of the litter.



Criss-cross the litter on the verticals – wrap the verticals to lock the webbing.

Avoid wrapping the webbing around the upper rail, easier to abrade it rubbing on things.



Make sure the webbing isn’t straight across the subject’s neck (or so they’ll slip down onto it). Make a steep V over the shoulders.

Work the slack out of the webbing.

Make sure the subject’s breathing isn’t compromised.

Put safety glasses on the subject (protect their face and eyes).

Tie off the webbing with clove hitches that capture a vertical bar.

Then tie an overhand safety or paired half hitches in the webbing.




Protect from the environment as appropriate.

Hot and sunny, shade may be more appropriate than a mummy wrap.

Is this going to take more people?

If the subject isn't mummy wrapped, tie their hands in a handcuff knot and lash it to the foot of the litter so that the subject isn't able to reach out and grab on to things while being carried (with the potential of throwing the litter bearers off balance).




Here is protection from the rain, in a vertical system. Tarp over patient and head shield over face.




For rope assist on steeper bits in non-technical carry out.

Attachment point for rope to litter.


Or use a 12 foot length of webbing, pass center through top of litter, make three wraps down each side, wrap around vertical post, tie ends with water knot, gather to attachment point.

Can use to put a pulley for 2:1 mechanical advantage on the litter.



You can reduce the effort in a litter carry by holding the litter rail in one hand, and holding a strap looked over the shoulders in the other hand – transfer more of the load off of your arm.

10-12' length of tubular webbing, bend the ends together with a water knot, then girth hitch the loop to the litter rail, and wrap it over your shoulders.

The person in gray in the center is using the litter strap properly, over both shoulder.



Litter carry, assisted with straps over the shoulders – more distributed load.

Lifting off the ground (two of the 6 bearers demonstrating position)

Litter strap over both shoulders, hold in outside hand.
Hold rail with inside hand.
Kneel, back straight.

On command (from person at the head)

**Lift with the legs, not the back.**

Same for lowering to the ground, lower with the legs, not the back.




Likely to encounter obstacles when doing a litter carry out.

Need to pass the litter over the obstacles.

Here's a Hand Pass.

Set of litter bearers on each side of the obstacle. Hand the litter over the obstacle.



Lap Pass. For longer distance over obstacle, need people on the obstacle to pass the litter along.

Here's a form of lap pass in a cave rescue in Worley Cave

There's also a turtle pass (primarily cave rescue technique, one person crawls with the litter on their back through a tight space, with others at each end helping guide the litter).



## Rotate

- Without putting down
  - Like a hand pass, stop, 6 bearers pass forward to 6 new bearers ahead.
- Stop and put down.
  - Switch out litter bearers.
  - Litter bearers switch sides.
- Make sure the litter bearers get to rest and hydrate.

Rotate the litter bearers.

Can do without putting down, pass forward as in a hand pass to a new team of 6.

Or can put the litter down.

Can switch sides, can switch out litter bearers.

Make sure the litter bearers hydrate and get to rest.



NEWSAR SAR Field Team Member: Unit 29: Litters February 19, 2020

# Catastrophic Incident Response

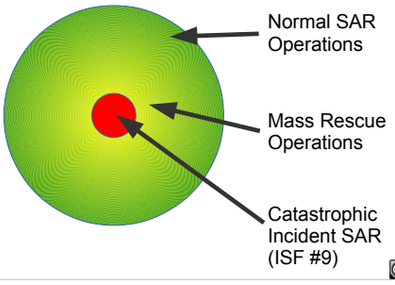


Unit 31: Catastrophic Incident Response
Date Last Updated: February 19, 2020





## The Olive model for SAR incidents




Search and Rescue field team members normally operate in the realm of normal SAR incidents (in the NSARC olive model) in wilderness, rural, suburban, and urban environments with intact infrastructure.

Mass Rescue operations and catastrophic incident SAR expected to involve Triage: More patients than medical resources, decision making about resource allocation.

In a catastrophic incident, search and rescue field team members may be brought in as local resources before USAR resources can be moblized.

This isn't comprehensive training for disaster response, but awareness of how search operations in a catastrophic incident differ from normal SAR operations.



## Wide Area Search

- Large area affected
- Unknown number of victims
- Local resources overwhelmed
- Response requires a variety of resources

Catastrophic Incident Search and Rescue Addendum to the US National Supplement to IAMSAR

One component of the response to a catastrophic incident is Wide Area Search.

Wilderness SAR responders might be called upon as resources in a catastrophic incident response.

Other aspects of a catastrophic incident may include, among many others, technical rescue, mass care, mass casualty response, and security.

Wide Area Search applies when: A large area is affected by an incident, the number of victims are unknown, local resources are overwhelmed, and a variety of kinds of resources are needed for the response.



## Contrast between Normal SAR operations and Wide Area Search

| Missing Person / Wilderness SAR | Wide Area Search / Catastrophic Incident |
|---|---|
| • Large area**, but not affected** | • Large area **affected** |
| • **Known small number of subjects** | • **Unknown** number of victims |
| • Local resources **may be insufficient** | • Local resources **overwhelmed** |
| • Response requires variety of resources | • Response requires variety of resources |

Normal SAR operations differ from Wide Area Search.

In normal SAR operations, large areas can be involved, but they aren't affected, and normal infrastructure remains intact.

In normal SAR operations, there is usually one subject or a known small number of subjects.

In a Catastrophic Incident where Wide Area Search applies, local resources are overwhelmed, in a normal SAR response, local resources may be able to quickly resolve the incident, or additional resources may need to be brought in.

In both cases, a variety of resources are needed.

## Hazards

- Downed Powerlines
- Flooding
- Raw sewage
- Collapsed Structures
- Damaged Structures
- Roads blocked by debris
- Downed Trees
- Weather
- Loose Animals
- Criminal Activity
- Hazardous Materials
- Civil Unrest
- Damaged Trees overhead
- People

All sorts of hazards to consider in catastrophic incident SAR.

What is different from normal SAR operations/missing person response?




What hazards can you see here?

At least: Downed powerlines, collapsed structure, damage structures, debris in road, hazardous materials, potential for criminal activity, people...

This image was taken at a Lowes about 3 minutes after a tornado in Sanford, North Carolina. The vehicles in the foreground are driving under the downed power lines (what does that tell you about the state of mind of the drivers?).




Increased risks of exposures to hazardous material and communicable disease in disaster situations.

What risks of exposure do you think may be present here in this flooded campsite?

Primary means of mitigation of risks are Awareness, Prevention (e.g. PPE), and Exposure Reporting.

Disasters are dirty environments.

Expect the need for decontamination at the end of a shift (for both humans and canines). Ask about decontamination plans when given assignments.



## Mitigation

- Coordinated Response under ICS
- Operational Risk Management
- Lookouts, Communications, Escape Routes, Safety Zones
- Responder Health and Welfare
  - Fatigue: work/rest cycles, sleeping areas
  - Water
  - Sanitation
  - Food
- Personnel Accountability

A coordinated response under ICS is critical for risk management in catastrophic incidents.

Think about the communicable disease exposures – water, sanitation, and food (get water and food only from clean sources at base). Maintain work/rest cycles.

## LCES

- A tool to help you maintain situational awareness

- Lookouts
- Communications
- Escape Routes
- Safety Zones

In a catastrophic incident search, use LECS as a tool on assignments.

Establish lookouts to watch for hazards.

Maintain communications.

Identify escape routes.

Identify safety zones where you are going to escape to.



## Accountability

- Sign in
- Personnel Accountability Reports (PAR)
- Nobody goes anywhere alone.

Accountability is critical. The incident will be chaotic.

Sign in/Demobilization – know who is deployed to the incident.

PAR – know where and the status of deployed resources.

Nobody goes anywhere alone.



## Initial Response/Management

- Intelligence
  - Information that can be used to set operational objectives
- Reconnaissance
- Master Map
- Manage By Objectives

- What is the affected area?
- What is the Scope and Complexity of Damage?
- What Resources are needed?

Initial response:

Gather Intelligence – information that can set operational objectives.

Perform Reconnaissance

Develop a master map.

What is the affected area?
What is the damage like?

Develop objectives.
What resources are needed to meet them.



## Reconnaissance
## **Information Gathering Only**

- Organized, Structured Survey
- Preliminary, and Cursory
- Timely Reporting
  - Communications – runners if necessary.
- Immediate and Continuous
- Methods driven by incident and resources
  - Air, Water, Ground (windshield survey).

Reconnaissance isn't search or rescue, it is limited to information gathering.

Preliminary, Cursory, timely reporting.

## Reconnaissance Teams

- Small, Mobile, Flexible
- Inconspicuous
- State Of Mind:
  - Not Search, Not Rescue
  - Not Providing Treatment
  - Goal: Provide a snapshot of the entire event in order to drive the response effort
  - Goal: Do the most good for the most people by rapidly and efficiently determining the scope of the event and resource needs for the response.

Use older, “have seen it all” folks for reconnaissance, not in uniform.

State of mind is to efficiently provide a snapshot of the entire event to drive the response effort.

The greatest good for the most people can be done by not searching, not rescuing, not providing medical treatment, but by efficiently determining the scope of the incident and the resource needs.



## Overview of Response

- Scope of incident, Resource Needs
  - Intelligence, Recon, Master Map
- Segment Map
- Objectives, Resource Requests
- Hasty Search (hasty **area** search of segments)
  - Locate
- Special Response Teams
  - Targeted known concentrations of victims or special needs
- Primary Search
- Secondary Search

Then, once the objectives and resource needs have been identified, search response can involve:

Hasty (area) search of segments, focused on locate.

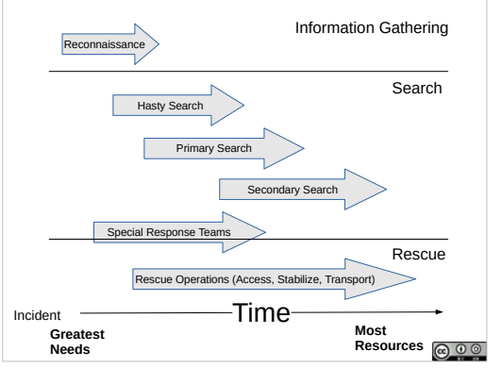
Special response teams to targeted known concentrations of victims or special needs.

Primary search

Secondary Search

And Rescue Operations






Over time, looks like this.

Rescue operations probably start early and last through much of the response.

Note – greatest needs are early in the incident, more and more resources will arrive over time.



## Hasty (rapid WAS) search

- Fast paced, methodical
- Locate and send to collecting point easily extricated victims
- Mark victims that need extrication and move on
- Document and report

Hasty (in the sense of Rapid Wide Area Search) search is:

Fast paced and methodical.

Locate easily extracted mobile victims and send them to a collecting point.

Mark victims that need extrication and move on.

Document, document, document, and report.

Why document?

## “Hasty”, similar, but different

- Lost Person Incident
  - Hasty Search:
    - Primarily Route Searches
    - Can be area searches near IPP
    - Can be point searches.
    - Search effort is typically coverage of 1 for areas searched.
    - Sound Sweep/Hailing depending on subject behavioral profile
- Catastrophic Incident
  - Hasty Search:
    - Area Searches
    - Locate Only
    - Fast Paced
    - Hailing Search
  - Special Response Teams
    - Similar to Lost Person Hasty Search to points of high probability/risk.

The concept of Hasty search is similar, but different between the normal SAR incident and catastrophic incident response.



## Hailing Search

- Spread around structure/area
- Close eyes and listen to background noises
- One person calls out
  - Identify as searchers
  - Tell victims to call out or make noise
- Everyone else listens and points at noises.
- Leave people pointing in place, move others and repeat to localize source.

Hailing search is a good technique for Hasty (and Primary) search.

Key bit, listen (before and after).



## Special Response Team

- Targeted Response to likely high concentrations of victims or special needs
- Examples
  - Hospitals
  - Nursing Homes
  - Evacuation Shelters within the affected area
  - Areas of last refuge
- Team composed for the specific task

Special Response team – targeted to likely high concentrations of victims/needs.



## Primary Search

- Quick Search, Exterior
- Walk (or boat) around structure
- Look in windows/openings
- Scan surface debris
- May be Physical, Canine, or Technical
  - Physical including Hailing search
- Treatment of immediate life threatening injuries
- Mark victim locations, call in additional resources to rescue victims

Primary Search:

Exterior, surface debris.

Physical (including hailing) or Canine (or technical)

Provide treatment for immediate life threatening injuries (think triage).

Mark (and report) victim locations.

Additional resources will perform rescue.

## Secondary Search

- Systematic search of enclosed areas
  - All rooms in all structures.
  - All void spaces in all collapsed structures.
  - Tornado Shelters

Secondary search

Goes inside.

Systematic search of all enclosed spaces.



## Search Squads/Strike Teams

- Functional roles:
  - Leader
  - Medical, Communications, Documentation
  - Local area knowledge
  - Force Protection
- Maintain Span of Control
- Search: Fast, Agile, Mobile

Search Squads or Strike teams:

Each person with an assigned functional role.

Maintain span of control.

For Search: be fast, agile, mobile.



## Task Status Reporting (Typically Hourly)

- PAR
- Current location
- Percentage of assignment completed
- Estimated completion time

PAR checks, typically hourly.

Include current location, percent assignment completed, expected time of completion.



## Search Techniques

- Physical – human ground searchers
  - visual
  - hailing
- Canine
- Technical
  - Listening Devices
  - Viewing Devices

Search techniques (expect to be told these as part of your assignment) are:

Physical, that is human ground searchers performing:
Visual search
Hailing search

Canine

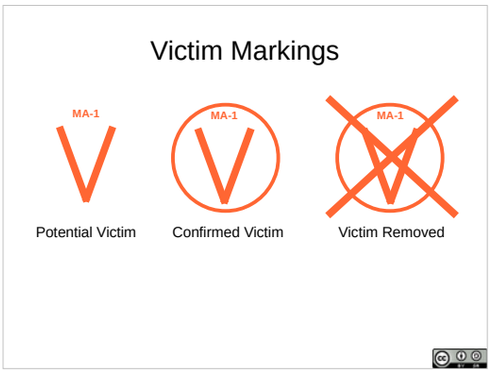
Technical
Listening devices
Viewing devices (including FLIR and TIC)


With repeated phases of Hasty, Primary, and Secondary Search, and separated Search and Rescue activities in large complex messy setting, findings are marked as searches are carried out.

(Note: not drawn to current standards, shouldn't have a square around the X, no entry time).

[(some)TF-3 did the search exiting on 8/16, hazards roof and wall, found 0 victims.]



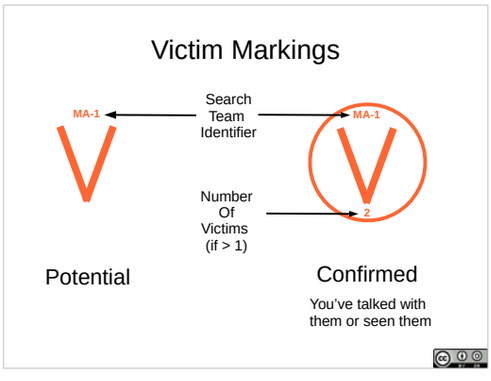



One type of markings is for victims.

This is for victims who need extrication.

Someone sitting in their house and able to walk away doesn't get a victim marking.





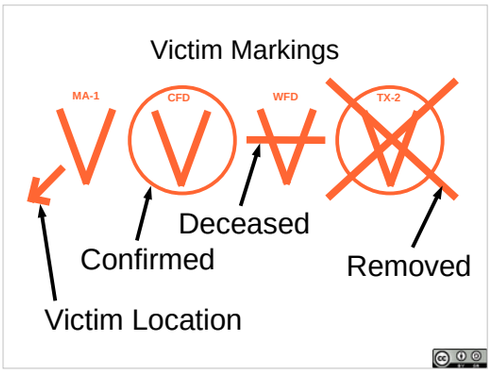

V for victim

Identify the search team at the top.

Count if more than 1 at the bottom.

Circle if they are confirmed (you've seen them or talked to them).

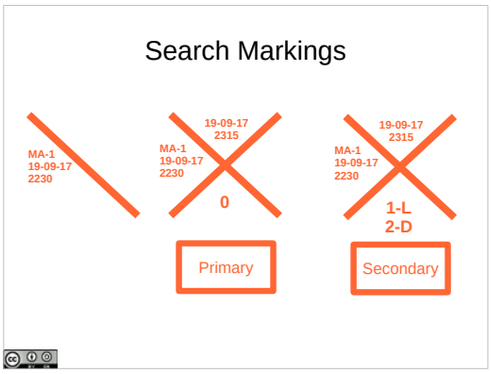





Arrow to point to the specific location.

Line through the V if the victim is deceased.

Rescuers draw a big X through the marking when they remove the victim (rescue or recovery).




Then there are search markings, to indicate what form of search was done by whom when, what they found, and what hazards were observed.

Walk through the marking.

Slash with who when on left on entry.

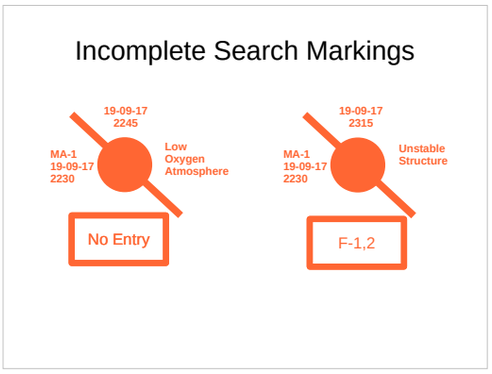
Finish X with exit time on top.

Findings (live or dead or 0 below). Hazards to right.

Can mark additional information in box below.

Incomplete search, solid circle in center. What was completed in square below.



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Slash with who when on left on entry.

Finish X with exit time on top.

Findings (live or dead or 0 below). Hazards to right.

Can mark additional information in box below.

Incomplete search, solid circle in center. What was completed in square below.




Here's a search marking (not drawn to current standards, doesn't include times.).

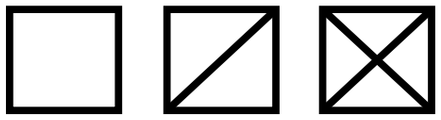
What can we read from this?

[CA-3 did the search exiting on 9-12, no hazards noted, found 0 victims.]




X for search can be used inside as well.

## Structure Markings
(made by USAR Structural Engineers)



Low Risk For USAR Operations

Medium Risk For USAR Operations

High Risk For USAR Operations

USAR task force structural engineers will also mark structures for hazards.

Medium and high risk need additional hazard mitigation measures to enter to perform secondary search.



## Further Training

- Wide Area Search Course (TEEX)

Seek further training.





Practical Evolution - Markings

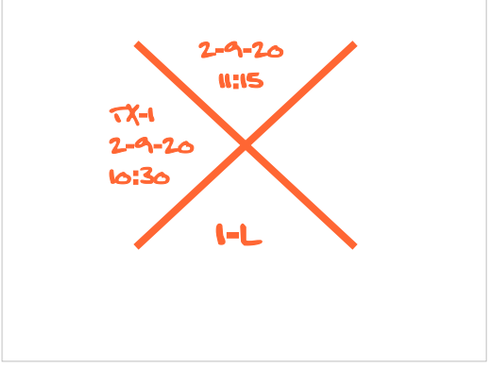
What markings can we see here?

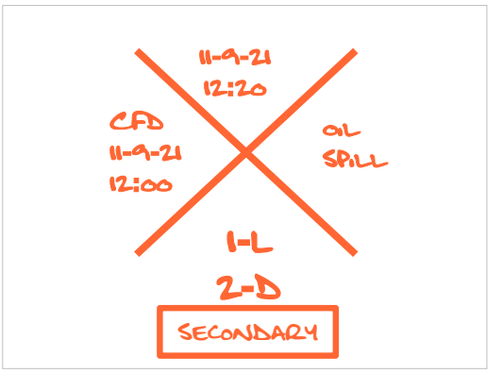
Tornado damage in Springfield, MA.

[Some search was carried out (faint orange X).

Later marked by [MA?]TF as high risk.]



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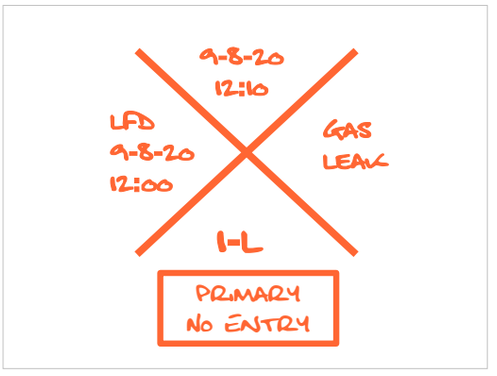
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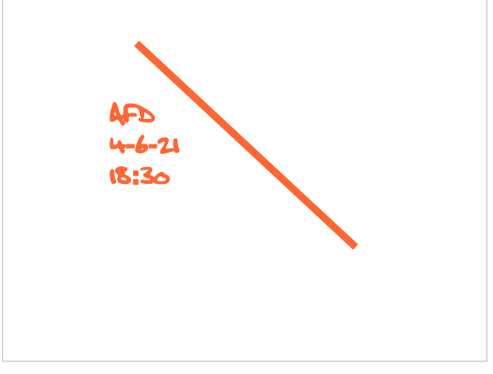
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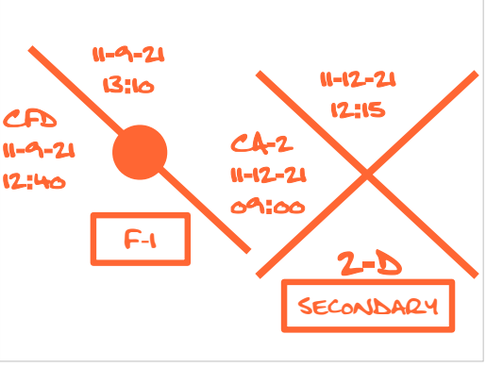
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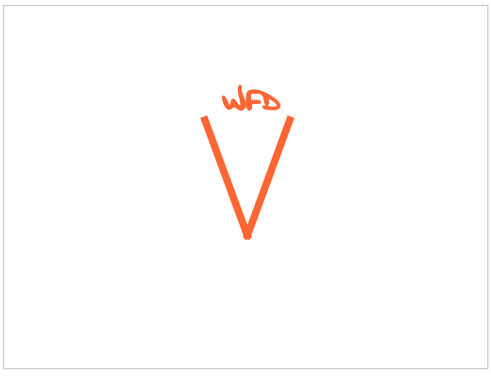
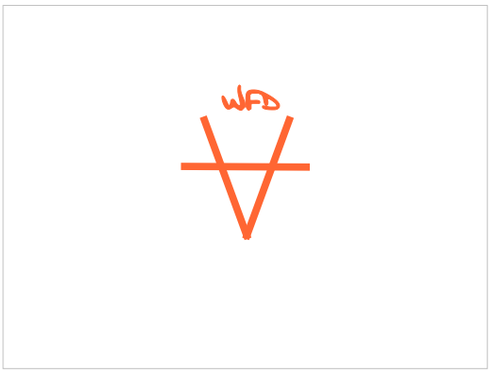
2-D
SECONDARY


WFD

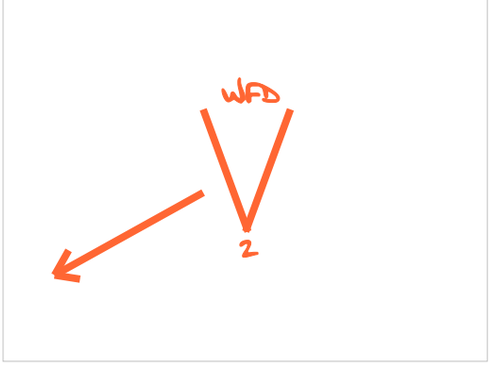


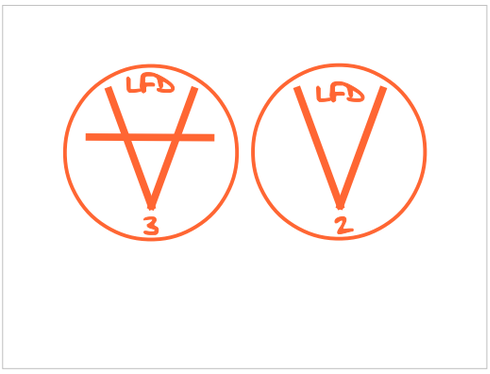

WFD



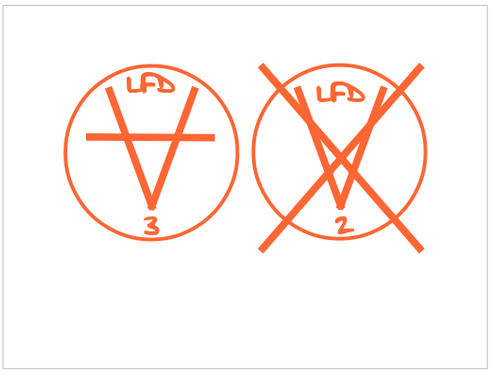

WFD



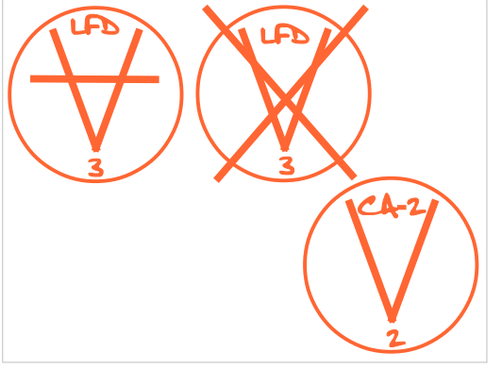

WFD
2










## Draw the Marking

- Secondary Search Entry by Acton Fire at noon today.
- Search exit at 12:30
- Found no victims

X. AFD, entry date and time to left. Date and time of exit at top.

No need for a 0 underneath, implied 0 from blank.

## Draw the Marking

- Secondary Search Entry by CATF-1 at 16:00 today.
- Search exit at 16:30
- Found one live and two deceased victims.
- Hazardous materials

X. CA-1, entry date and time to left. Date and time of exit at top.

Hazmat to Right.

L-1 and D-2 beneath



## Draw the Marking

- Knocking noises consistent with a Live Victim heard in response to a hailing search by Lancaster Fire.

V with LFD over.



## Draw the Marking

- One Live Victim seen trapped by Lancaster Fire.
- One Live Victim self extricated and walked out to collection point while Lancaster Fire was doing a hailing search.

V within a circle, LFD above.

No marking for the extricated victim (no need to pass the location on to rescue resources).



## Draw the Marking

- Two Live Victims and 3 Deceased Victims Seen by Ayer Fire.

V in circle, AFD above 2 below.

V with a line in a circle, AFD above, 3 below.

## Draw the Marking

- One Live Victim and 2 Deceased Victims Seen by Ayer Fire.
- Live Victim removed by Cambridge Fire.

V in a circle, AFD above, X through the V.

V with a line through it, AFD above, in a circle, 2 below.