AMC Boston Mountaineering Committee

Ice Climbing Program Handbook

Updated 2014

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This guide has evolved each year. It includes text by Chris Dube (1985), Paul Dale (1989), Matt Harris (1994), Jamie Leef (2001), Dave Yee (2005), Ian Springsteel (2006), John Roberts (2013) and others.

First Weekend Curriculum

Waterfall Ice: Fundamentals of Ice Climbing and Anchors

1) Water Ice Techniques

a) Reading the Ice: What color is it? Is it white? Or blue, yellow, brown? What does its color tell you? Is it primarily snow ice, neve, or water ice? What is the ice like lower or higher, or to the left or right? What about in early season, midseason, and late season conditions? Is it thin or fat? Is it brittle (dinner plate) or plastic? Is it bonded to the underlying rock, covering snow, aerated, dense? How does temperature change effect ice formation and characteristics? The guidebook says the route is WI3; what grade is it today?

b) Placing the Axe:

- Find your spot. Some spots are better than others (look for concave spots, above or below bulges – not at the bulge, places other people have already swung, etc.).
- Aim high (but not a full arms length which may cause you to lose your crampon placement or make it difficult to remove the tool if you need to replant it.)
- Swing with the triceps and shoulder. Then flick with the wrist, keep elbows in, and relax the hand. Keep a steady wrist.
- Pick setting – not too deep, not too shallow.
- Conserve energy. Hook if you can. Look for "kicked out" or natural shelves and pockets.
- Test your placement – Listen, feel, pull, etc., then move.
- "Swing, test, trust, forget" – Alex Lowe.

c) Removal Techniques:

- Up and down, not side to side.
- Steady does it, avoid tool recoil.
- Try grabbing the tool higher, near the adze or hammer instead of the handle.
- Be aware of the tool placement as you move, being wary of dislodging the tool (e.g. by pulling up or out on the tool as you move.)

d) Footwork:

- Front-point, keep heels down, distribute your weight, lean out to go over bulges – be aware of your feet at all times. (When pulling bulges, especially, it's good practice to be able to see your foot placement at all times. Resist the temptation to move tool up to soon – move up on feet first.)
- Conserve energy. Step, rather than kick, if the ice permits. Look for, and use, "kicked out" or natural shelves and pockets, even your own tool placement divots. Look for, and use, rest positions and stemming opportunities.
- When kicking, look where you kick and kick from the knee. Engage the secondary points – heels down – to establish a stable tripod.

e) Movement on Ice:

- Separate your tool placements.

- Conserve energy: you can minimize tool placements on steep ice by placing tools one above the other, i.e. the upper tool and feet form a tripod. This may help with balance and avoiding the "barn-door". Hang straight armed from the upper tool.
- Bring feet up high – probably in multiple small steps – using both tools for pulling and balance. Establish a rhythm.
- If the ice dictates: choke up on tools and mantle off their tops or flat step for rests and traction on top of bulges, shelves, pockets, etc.

f) Practice Drills:
- Two tools, one tool, no tools
- Low angle; clearing a steep bulge; steep climbing
- Hooking for efficiency
- Leashed vs. leashless climbing

2) Anchors: Ice Screw Placement and Removal, and Other Stuff

a) Placing an Ice Screw: Pick a spot between shoulders and waist. Place in a dish or other thick solid ice, not on a bulge. Clear bad and lumpy ice with pick or adze. Start screw with one hand with twisting motions. Place screw perpendicular to or at a negative angle (hanger downward), not angled upward (unless ice conditions – e.g. soft – suggest otherwise);
Tie off screws that extend more than 2in (5cm) from the ice – otherwise, use a shorter screw.
Consider use of load limiters (e.g. Screamers) and multiple screws (or other anchors like pins) equalized in bad or shallow ice, mixed climbing, etc.

b) Removing an Ice Screw: Unclip the draw from the screw. Use tool (pick) as a lever on stubborn placements. Clean the ice from the screw core before resuming to climb. Why should you do that? You may tap the screw on the hanger end only (never abuse the threads or points) to remove the ice core. (A plastic V-thread tool may come in handy to clean out the ice screw – never ream the screw core with abrasive items. Rack the screw and draw.

c) Natural Pro: Slinging ice shafts, trees, rock horns and in situ V-Threads all can be okay but inspect the ice and the thread. If clipping an in-situ V-Thread, ensure you clip into the proper segment of the thread! Give that last point a little thought now.

d) Other anchors: Ice Hooks (useless for all but body weight unless used as a piton). Pitons, the ice climber's friend – pound till you hear the high ring.
Bolts – wait for your first M5.
Rock gear, often a small selection can be quick and handy in gullies with rock walls.

e) What is a good ice belay? Typically, two screws, separated by about two feet diagonally – narrow angle to belay master point – in bomber ice, or a rock belay, or a combo of these, equalized and maybe even tied off (for no extension).
Note: see the section "Ice Protection: It's All About the Ice" below for more info on ice protection.

Alpine & Multi-pitch Techniques

1) Self-Belay

The first line of defense: driving the shaft into the snow while ascending, using both hands and one hand

2) Self-Arrest (Reminder: No crampons during this drill)

a) Forward, with axe
b) Upside down, with axe
c) Both without ax (handed off while sliding)

3) Uphill French Techniques:

a) Footwork: marche (straight), canard (duck or 45 degrees), a plat (or sideways to fall line), or front-point.
b) Ice Ax (piolet): canne (cane position holding the adze), panne (pick in, hand on top), ramasse (across the body, pick in), ancre (with pick driven in)
c) Common Combos: troisieme, or American-style (one flat, one front-point), panne/front-pointing (neve scrambling), rest positions
d) Two Cane positions: self-arrest (pick to back) vs. self-belay (pick to forward) and when to use each

4) Down-climb Techniques:

a) *Marche* & *cannard* with cane & anchor
b) *A plat* with *ramasse*
c) Reverse front-pointing

5) Belay and Roped Travel Techniques

[Note: Some of the following techniques may be optional or for discussion only.]
a) Hip belay, seated and standing (remember to clip the rope through 'biner on harness!), and with ax back up, ice ax belay (optional)
b) Ledge cutting with pick and ax: for belays and setting anchors
c) Munter and self-locking belay device (reverso) use (optional) *Reminder: leave the Gri-Gri at home!*
d) Simul-Climbing and Short-Roping (traveling in coils with a Mountaineers Coil or Kiwi coil) These methods employ a "Running Belay" where protection is placed between the (usually two) climbers as they simultaneously climb, secured to each other at both ends of the rope. Short-roping is more likely to be used over more technical terrain. Simul-Climbing is sometimes used on very long pitches. Be aware of, and discuss with your partner, the likelihood simul-climbing is an option or even a necessity. In such a situation, the belayer should be prepared to climb as and when the leader's movement dictates. Of course, a high degree of care, caution, and competence is required with these methods. If running belays are not possible, solo climbing may be the better and safer choice.

6) Rappel Anchor Techniques

a) V-thread (demonstrate) and other natural anchors, and why a few tied runners on the rack are a good idea.

b) Body rappel and carabiner brake rappel: for when the rope is too icy to use a regular device (use at practice area)

7) Multi-pitch techniques

Much of this will be for discussion, then practice later in the Program

a) Putting it all together: Climb efficiently and quickly on lower angle terrain, hooking in hard ice to save time and energy, cleaning screws and reracking gear as you go
b) Finding safe, comfortable belays; hip belays and other techniques for fast movement.

Ice Protection: It's All About the Ice

Here is a summary of key points from published research (sources below) about ice protection and ice anchors. First and foremost, it's all about the ice. Just about every statement can be qualified by adding phrases like "in good ice".

1. The longer the screw the better
However, in the practical realm, it doesn't seem to matter. 13cm screws (in good ice, to the hilt) were shown to be able to protect likely extreme falls (approaching 10KN). Test data showed 13cm screws performing better than longer screws in some cases. But, don't necessarily extrapolate that as a universal truth. Also, test data showed that when testing the system to failure, a carabiner (or sling, or hanger, etc) can sometimes fail even before attached screw fails. Often the test forces were well above a likely extreme leader fall.

2. A good A-thread is as good as a well placed screw.
V-threads are typically used to build a rap station in ice. Vertically oriented threads (A-threads) tested stronger than horizontally oriented threads (V-threads). It's not clear from the data why one orientation is better than the other. The recommendation is to offset the A-thread by up to 20 degrees. Furthermore, the recommendation is to use your longest screw (22cm) and set up a 60 degree triangle thread placement.

3. Rebored ice screws perform as well as first placement screws
A rebored ice screw is one placed in an existing screw hole. The analysis qualifies this in saying that the rebored screw must "fit". That is, the hole should not have significantly melted out - become larger Inspect the hole and the placement. Remember, it's all about the ice.

4. Raised threaded screws (e.g. BD Turbo) placed in a negative orientation are stronger
That is, stronger than neutral or positive placed screws – In Good Ice. A negative orientation is hanger down, in the direction of the fall. Place them up to 15 degrees down. Caveats:

- This does not apply to pound-in type screws, which don't have raised threads.
- In poorer ice, neutral or positive angle placements may prove better.
- Many of the 'experts' still seem to prefer placing screws at a zero degree angle.
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"Tied-off screws are pretty close to worthless from all the data I've seen. I carry mostly 13cm screws with one 19 for threads, maybe a few 16s for grins, and some stubbies." – Will Gadd

Gear - Equipment List for the Program

Warm clothing

- Polypropylene, wool, or capilene long underwear
- Wool, Schoeller, micro-fleece or wind-bloc climbing pants
- Wind pants or Gore-Tex type pants or bibs
- Heavy polypropylene, capilene, or DryClimb style shirt
- Sweater of fleece for extra-cold days
- Wind proof parka or Gore-Tex type jacket – should have a hood
- Gloves or mittens and waterproof shells – bring extra pairs so you can experiment with what works when climbing.
- Hat or balaclava that fits under your helmet. Bring a spare.
- Insulated plastic or winter/ice-designed leather boots. If you are not renting these, you must have an instructor check them out.
- Socks: Silk or synthetic thin liner and a thicker layer of wool or synthetic, sized to help your boot fit well. It is worth experimenting with vapor barrier socks if you plan to climb at altitude or over long expeditions.
- Gaiters: They need to be large enough to cover the tops of the large mountaineering boots and generally do not need to be insulated in New England.

Daypack items

Gear

- Synthetic or down belay coat: not too bulky, stuff sack can be helpful
- Spare mittens and clothes: keep weight and bulk to a minimum
- Glacier goggles or sunglasses: Ski goggles and facemask are usually only needed for above treeline, like in Huntington Ravine
- Headlamp with spare battery and bulb: LED lamps last long and are light enough
- Two water bottles insulated in wool socks or foam lined containers
- Food: lunch and high-energy munchies; meats tend to freeze solid
- Knife
- Small first aid kit: ace bandage, tape, pills, etc.
- A watch is useful
- Hand warming packets
- Cell phone
- Thermos bottle of tea, cocoa, miso soup or something good
- Toilet paper, handi-wipe, matches, and baggie

Climbing gear

- Helmet: A hard hat must be worn during all instructional days. If you don’t own one, make sure to get a club helmet to use.
- Ice tools: If you have them, bring them, but the program has ice tools to lend to all participants. Tools can often be borrowed from leaders.

- 12-point crampons, either rigid or hinged: The actual point count varies more today than before. The key aspect is that there are front-points pointing outward.
- Kahtoola microspikes have become increasingly popular by providing significantly improved traction in situations where wearing 12-point crampons is not convenient or desirable
- Slings and carabiners: A locking ‘biner on a sling, PAS (personal anchor system) or daisy chain girth hitched to your harness is handy for clipping into belays. (Each loop in a PAS is rated to take a fall while loops in a daisy chain are not.) Also bring a couple lockers and shoulder slings. Ice clippers or ‘biners are useful for racking screws when you are seconding.
- Climbing harness: Adjustable leg loops are handy but not a necessity. Just be sure your harness fits over all of your layers.
- An ATC, Reverso, tuber, or large belay plate of some kind. Belay devices that require a sharp bend in the rope do not work well on iced up ropes. **Gri-gris are not o.k. – leave them at home.**

Boots and Crampons

IME, EMS, Ragged Mountain Equipment, and REI all rent boots. ***If renting, call early to reserve boots in your size, as you may be disappointed if you don't reserve a pair.*** You will likely need to go to the store to size them.
If you have boots but just want to rent crampons remember that crampons need to be fitted to the boots that you are using. This can take as little as 15 minutes or long frustrating hours (even without drinking!) so plan accordingly.
Crampons come either rigid or flexible, and have three different mounting schemes: step-in bindings, straps or a hybrid of the two. Rigid crampons climb better on steep water ice than flexible crampons. Flexible crampons "walk" better, especially nice for trekking on a glacier. Most crampons today use the step-in attachments; some flexible crampons have straps so they can be used on a wider variety of boots. Step-in bindings hook onto the welt ridge above the sole of the boot. Strapped crampons have the advantage of fitting leather boots or boots that don't have significant welts for the wire bales to clip onto. Hybrids have tension levers in the rear and straps in the front.

The best set-up for this class is a step-in rigid crampon, either dual-or mono-point, on a plastic or leather boot made for ice climbing.

Tools

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- It is traditional to climb with one ice axe (adze) and one ice hammer. More recently, water ice climbers often use two hammers.
- When climbing with a single tool (lower angle climbs), an adze may prove more useful than a hammer, e.g. to cut belay ledges, clear anchor stations, etc.
- Ice hammers enable the climber to hammer objects such as pitons.
- Tools longer than 60cm tend to be difficult to swing.

- Tools shorter than 50cm tend to be too short for general mountaineering, snow climbing, etc., and are not as good to use for self-arrest.
- Tools are most commonly sold with a removable pick, and there may be alternative picks of different styles available for each tool. B rated picks are thinner and thus flex easier than T rated, but they do better on pure ice. T rated picks are beefier and handle the abuse of mixed better, but displace more ice.
- The composition of tool shafts is mainly a matter of personal preference in terms of feel and design. Composite (e.g., carbon fiber) tools tend to have a dampened feel, while aluminum shafts can be more stiff and sensitive.
- Recent developments in climbing style have led some climbers to abandon leashes on tools, especially on shorter steep and mixed climbs. Leashless climbing can be more fluid and flexible. Leashed climbing can be more secure and comforting on longer climbs, especially in the mountains where losing a tool can have dire consequences.
- A compromise may be to attach tethers to leashless tools.
- Carrying a spare pick in your pack and the proper tools to change a broken pick can either lengthen your climbing day (when cragging), or substantially shorten it (if in the middle of a long route).

Environmental Conditions

Conditions in the mountain regions can be severe. If you are on Mt. Washington, Cannon, or at Lake Willoughby, you can expect to get cold. Consider this excerpt from a local guidebook:

> *During the winter months, between December and March, the weather in the mountains of northern New England can only be described as Arctic. Mount Washington [elev. 6,288'], the highest mountain in the northeast, has often been described as having the worst weather in America. High winds, below zero temperatures, and low visibility are common on Mount Washington in the winter. The land wind speed record of 231 mph was recorded on the summit in 1934, before the meter blew away! With "normal" winter temperatures of -10 degrees to -30 degrees Fahrenheit on the mountain, the wind chill can easily drop to below -100 degrees Fahrenheit. When there is an unfavorable weather forecast or avalanche danger on Mount Washington, it is prudent to climb in the more sheltered areas of the Mount Washington valley or Crawford Notch.*
>
> *Avalanche, falling ice, low temperatures and high wind, are the major objective dangers of which the winter mountaineer must remain vigilant when climbing in New England. Wind slab, powder snow, and wet snow avalanches are all possible depending on the conditions and circumstances. Likewise, climbing below other parties, warm spells of weather, or a south facing location could result in great danger from falling ice. Low temperatures and wind chill are constant problems, yet easily dealt with if you wear the proper clothing. Just remember that a rapid change in the weather can transform a casual, minor climb into the epic of the year.*
>
> - S. Peter Lewis and Rick Wilcox, *An Ice Climber's Guide to Northern New England*

Conditions in the valleys, where many ice crags are, are usually milder. Normal daytime temps are 15 to 30 degrees and the trees usually break the winds. But you are out in the cold nonetheless.

Philosophy of Staying Warm

In the winter, staying warm and comfortable while you are outside requires you both to generate heat and to keep it from dissipating. You generate it by feeding your internal furnace with adequate food and water. You maintain you warmth by insulating your body from the elements.

If you feel cold it is usually the result of not eating enough food or drinking enough water. Most climbers find that three liters of water is about what they use during a full day though this is somewhat dependent on body type. Drink as much as you would in summer for the type of activity you are undertaking – more for long slog days, less for cragging. Consider the following a baseline for average days. Start by tanking up at breakfast with a half-liter. Carry two during your day out climbing and try to finish them. Rehydrate before and after dinner. You will find that you stay warmer, climb stronger, and recover faster if you are diligent in staying hydrated. A little powdered energy drink in your water can help you feel strong.

Eat breakfast and especially lunch, even if you do not feel hungry. Lunch might just be a couple energy bars, but you need something. Find a mix of protein and carbs that feels good. Keep your bars in your pocket, or in your water bottle warmer.

Remember that your metabolism will create more heat if you are more active. If you find that you are often too cold, maybe it is because you are not moving fast enough. Ramp up your mental energy, motivate yourself to climb with an enthusiastic attitude, and you will be warmer. Judicious use of caffeine and sports gels, like GU, can quickly boost your energy and attitude.

Even high tech modern clothing does not work so well when wet. In New England you will get wet mostly from sweat. You must make a conscious effort to prevent your clothes from getting soaked with perspiration during heavy exertion. Pay attention to that feeling of beading sweat on your forehead and in your pits. As soon as you feel it, stop and strip off a layer or two.

If you have ever watched a runner out in the cold early morning in Boston you will note that they are often just wearing a pair of tights and a dry-clime shirt, maybe a hat. Think about that when you are hiking up hill with a pack in deep snow to approach your climb. Set out from the car a little underdressed for how cold you feel then. You can bet that in a couple minutes you will be ready to strip yet another layer off. Shoot for the 'comfortably cool' feeling when hiking and climbing, and you will avoid the 'freezing your ass off' feeling at the first belay. If you usually sweat a lot, consider carrying a spare base layer on days with a long approach and swap it out before you start climbing. That brief moment of cold will be worth it when you're dry the rest of the day.

A layering system will allow you to easily adjust the amount of clothing to correspond with the work being performed. Think about the two basic states of ice climbing: a) hiking in with a pack and climbing steep ice, and b) sitting at a belay. When you reduce the day into these two basic states the details of the layering system follow easily. Wear light insulation layer like a capiline shirt under a Gore-Tex or soft shell for movement times. Pull off the shell if it is too warm. Throw on a belay jacket when sitting around. Your hat, gloves, pit-zips, and pant side zips make for small tweaks.

Sometimes, even the best layering system will be inadequate for some people to stay warm, especially in New England during a cold spell. Learn how to spot the early signs of frostbite and hypothermia in yourself and others. Cold toes can become numb toes can become missing toes. Wind, especially above treeline, can multiply the effect of cold and quickly damage exposed skin, or even prevent movement in short order. Prudent planning, alternative exit routes, and a willingness to turn around are the best and lightest first aid kit you can carry.

Eye Protection

When on snow in bright sun and especially at higher altitudes, eye protection must be worn. These glasses should have side guards and the lenses that block out ALL (100%) ultra-violet rays. Ski goggles are sometimes useful during high winds and blowing snow.

For regular cragging, a pair of cheap sunglasses with a keeper string is great. You will not care too much when you step on them with your crampons. Helmets with visors can be the best protection for your face if they do not fog up. Some climbers wear impact resistant safety glasses (the kind used for carpentry for example) when they are climbing difficult thin and mixed routes, to protect the eyes from tools that pop off hold unexpectedly.

Traditional Snow Climbing Technique

We do not cover much French technique or snow climbing technique in the weekend sessions so the following information is an addendum to the curriculum for those with interest in general mountaineering technique. From more complete treatments, see Yvon Chouinards' book *Climbing Ice*, and *Mountaineering: Freedom of the Hills* (listed in appendix).

Terminology for snow & ice climbing

French technique is a series of methods to ascend using the bottom points of the crampons. The motivation to use this technique today is that it is easier on the leg muscles, more sustainable for long climbs of a modest angle. Historically, the original crampons did not have front points so these were the only techniques used short of cutting steps.

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piolet:	ice axe
piolet canne:	ice axe held as a cane or walking stick
pied marche:	normal walking motion
pied en cannard:	feet splayed, duck like motion
pied a plat:	feet pointed in same direction; ascend by side steeping diagonally
German technique:	straight kick stepping: climbing on toes or forward part of feet, front-pointing on crampons; sometimes called Austrian Technique
pied en avant:	same as German technique.
American technique:	one foot straight in kick step, the other en cannard.

Recommended Readings

Many of the books listed below are published by “The Mountaineers” (Seattle). See mountaineers.org

- ***Mountaineering: Freedom of the Hills*****,** edited by The Mountaineers – The latest edition is the “50th Anniversary” 8th Edition. It’s a well respected general mountaineering text with solid sections on ice and snow craft. No climber’s bookshelf is complete without a copy.
- ***Climbing Ice*** by Yvon Chouinard -- Emphasis on classic climbing techniques and mountaineering skills. Great photos that illustrate techniques and principles. The text gives a good sense of the mental attitude and "feel" of the sport, written by the climber who practically invented the modern iteration of the sport 35 years ago. (Supposedly out of print, but still seen in stores.)
- ***Ice and Mixed Climbing: Modern Technique*** by Will Gadd – There is plenty in this book for everyone from beginner to expert from one of the best. Also see willgadd.com
- ***Training for the New Alpinism, A Manual for the Climber Athlete*** by Steve House and Scott Johnson. “[they] translate training theory into practice to allow you to coach yourself to any mountaineering goal.” So says the news release for this book due out in March 2014.
- ***Extreme Alpinism*** by Mark Twight and James Martin – A useful collection of insights, guidance and stories that may help you take your climbing into the mountains onto longer routes. Twight’s treatments of speed, light-weight ascents and training are especially insightful.
- ***Winter Climbing +, The Positive Approach to Improving Your Climbing*** by Neil Gresham and Ian Parnell. Skills, technique, training, mental preparation, etc.
- ***The Ice Experience*** by Jeff Lowe – Excellent text that stresses techniques for climbing steep frozen waterfalls. The associated video is great, but Jeff’s monotone can get to you after a while.
- ***Ice World: The Techniques and Experiences of Modern Ice Climbing*** by Jeff Lowe – Another Excellent text that details techniques for climbing and protection, particularly in mixed ice and rock terrain. Great photography and close ups of protection and gear usage.
- ***An Ice Climbers Guide to Northern New England*** by S. Peter Lewis and Rick Wilcox (3rd Ed.) – The guide book you will want for the New England area.
- ***Secrets of the Notch*** by John Sykes – “A Guide to Climbing Rock & Ice on Cannon Cliff and the Crags of Franconia Notch.
- ***Blue Lines*** by Don Mellor – “An Adirondack Ice Climber’s Guide”
- **Climbing in the Adirondacks** by Don Mellor – A guide to the rock and ice routes in the Adirondack range.
- **The ABC's of Avalanche Safety** by Ed LaChappel – A handy pamphlet providing the very minimum of information and ice climber should know about the metamorphic and mechanical phenomena associated with snow avalanches. Required reading for a long and safe climbing career.
- ***Glacier Travel and Crevasse Rescue*** by Andy Selters – Another excellent publication from The Mountaineers.
- **Cold Climbs,** edited by Ken Wilson – Description of classic British ice climbs with terrific photographs. Great to impress your friends with.

On-line resources

- report@neclimbs.com and http://www.neclimbs.com – Maintained and authored by Al Hospers, a fun and reliable monitor of recent ice conditions, new climbs and other info
- http://groups.yahoo.com/group/AmcBoston_IceGrads/ – For you, by you
- http://mountwashingtonavalanchecenter.org – Updated avalanche conditions
- http://amcbostonclimbers.com – The Mountaineering Committee's very own site
- http://www.neice.com – Another, broader based ice conditions site, more forum based
- http://www.chesslerbooks.com – A great long-standing source for mountaineering and climbing books, guidebooks and movies, based in Colorado