Portable Milling Reference Guide v1.1

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This reference guide is intended to educate new mill owners on the full spectrum of issues related to onsite milling, primarily with bandmills. The guide does not cover basic milling techniques or specific operating and maintenance procedures, which are typically included in manufacturer trainings and manuals.

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NORTHWEST CERTIFIED FORESTRY™

Note: See Glossary on last page for definitions

1. Safety

Clearly, safety is the main concern in all aspects of mill operation. There are many hazards and the risk of severe or fatal injury is very real. Understanding the potential for these risks and planning for their prevention is critical to a safe working environment.

1.1. **Safety equipment** – Generally, safety equipment will be very similar to that required for felling or other chainsaw work. As a chainsaw is often used to prepare or modify logs going onto the mill, it's a good idea to dress for both. Essential clothing includes:

- Hard hat
- Safety glasses (not just a helmet screen)
- Headphones (not earplugs)
- Tight fitting gloves (rubber coated cotton recommended)
- Heavy leather boots (steel toe optional)
- Heavy pants (chaps if operating a chainsaw)
- Heavy leather gloves (for changing and coiling blades)
- Comprehensive first aid kit, including eye wash
- Mobile phone or other communication device
- Passenger vehicle for emergency evacuation

1.2. **Cutting risks** – Never put hands, feet, foreign material, or any other object near the cutting head while the mill is running. Blades break during operation on a regular basis, so take extreme care to not stand at least 10' from either end of the cutting head. Also keep in mind that bandsaw blades are extremely sharp and can cause severe injury during handling. Rotary cutting or debarking blades can also cause blunt cutting injuries.

1.3. **Crushing risks** – Potentially fatal crushing risks are usually related to support equipment or logs, so use caution in moving either. Avoid steep slopes, pinch points, or other common danger zones. Avoid piling logs high; keep decks no more than one or two logs high. Less severe injuries, typically to the hands, can also easily occur in handling cants and lumber on the mill deck or in stacking.

1.4. **Other safety concerns**

- Operating a mill demands total concentration. Do not run the mill if you are sick, on medication, or otherwise mentally or physically impaired.

- Milling is very physically demanding. Be careful not to overexert yourself through fatigue or over-lifting, drink plenty of fluids, and spend ~10 minutes stretching at the beginning of the work day. A shortened work week (ie five six hour days) is generally recommended.
- Do not modify the mill in any way that compromises safety features.

2. Personnel

2.1. **Roles & Responsibilities -** Milling is a team effort, with a team of two - a sawyer and assistant - typically working best. If an onsite edger is being used a third person is also recommended.

2.1.1. Sawyer – The sawyer operates the mill and is the head of the milling team. The sawyer's responsibilities include:

- Judging and milling the material for maximum benefit
- Balancing speed and safety
- Tracking output if necessary
- Ensuring that maintenance is performed on schedule

2.1.2. Assistant – For safety's sake, the assistant needs to follow the sawyer's directions, but the assistant also has primary responsibility for several aspects of milling:

- Generally keeping the site running smoothly so sawing isn't unnecessarily interrupted
- Preparing upcoming logs, including trimming, coarse debris removal, metal detection and removal, and positioning
- Assisting the sawyer in adjusting for log taper
- Offloading and organizing milled material and by-products
- Spotting and dealing with any safety hazards.

2.2. **Communication** – Portable mills are extremely loud and verbal communication is often not possible while the cutting head is engaged. Milling teams should form basic, but definitive, systems of sign language to avoid unnecessary down time. Particularly during training and the first year of working together, do not assume anything if communications are unclear. Err on the side of over-communicating to avoid problems. Hundreds of work interruptions for the sake of good communication easily outweigh one significant accident.

3. Logistics

3.1. Support Equipment

3.1.1. Log handling – A wide variety of techniques can be used to handle logs at a milling site. If log decks are well constructed (see section 3.3.2) and the site well organized, equipment needs can be minimized. Possible options include:

- Various hydraulic forestry or construction equipment (Note: Placing logs directly on the mill with heavy equipment is strongly discouraged as it can easily damage the mill frame)
- Tractor with front loader or forks and rear hoist or winch
- Self loading flatbed, stump truck, or log truck
- Low range 4WD truck with heavy duty bumper, hitch, or winch
- Horses or other draft animals
- By hand with peaveys and rollers. This option requires a flat or slightly down-sloping site.

3.1.2. By-products – Milling generates large quantities of wood, dust, and bark byproduct. Depending on volume, this material may be easily incorporated into the site or will need to be hauled off site. Make sure the site is safe for anyone picking up materials. See section 4.5 for by-products uses.

3.1.3. Lumber hauling – If materials are not used or stored on site, they will need to be transported to a storage and/or drying facility. A flatbed truck or trailer is strongly recommended for transport to allow for forklift offloading.

3.2. Tools & Accessories

- Maintenance and communication logbook
- Mill and engine manuals
- Two peaveys
- Two debarking 'spuds' (flat steel blade on full length handle)
- Mid-size chainsaw and all support accessories
- Comprehensive tool kit, including specific tools recommended by manufacturer (combo wrenches, screwdrivers, etc)
- Hitch lock for overnight security
- Hatchet or small axe
- Hammer and chisels
- Small sledgehammer
- A variety of plastic wedges
- Various nail pulling tools

- Grease gun and extra grease
- Several rags
- 10 gallons of fuel
- 2-3 quarts of oil
- 2-3 quarts of ATF for cleaning and lubricating mill chains and rails
- 5-20 gallons of water (depending on timber volume and water availability)
- 2-3 roller logs (~4" diameter x 3' long, often available on site)
- If cutting on a slope, cut or bring two log 'brakes', roughly 1x1x1' square blocks for controlling log roll
- Several sizes of wood shims for adjusting mill stabilizers
- If cutting urban trees or salvaged timbers, a metal detector is also essential (see section 3.4.2). Use a high quality ring head design with strong signal and a visual indicator (audio signals will be drowned out by the mill). Wand type detectors used for security will not penetrate deep enough into the log.

3.3. **Site set up –** Good site set up leads directly to efficient production. Try to locate milling operations where the ground is clean and there is plenty of space. Pastures or other grassy areas work well. If your site is muddy or uneven, spend some time prepping so your logs stay clean and can be moved easily. Wood chips make an excellent working surface if they're available. Logs can also be decked on sleepers (half buried logs) to keep them out of mud and rock.

3.3.1. Constructing the log deck – A clean, well constructed log deck is the single most important factor in maximizing efficiency. For safety's sake, decks should NOT be piled high. Small logs that can be easily controlled can be stacked in two or three layers – large logs should not be stacked. Cut logs to length prior to positioning them and balance the centers in line with the mill's log loader (see Figs 1 & 2). If your primary concern is material efficiency, it works best to have the large end of the log facing the operator. If you are concerned mostly with speed and are less concerned with yield, you will prefer to have the small end facing you.

3.3.2. Mill positioning – Moving the mill is not difficult, but certainly interrupts production, so construct as few log decks as the site allows. Position the mill parallel to the logs' length and within a few feet the first log. Make sure there's no more than a foot or so of elevation difference between the front and back ends of the mill.

Fig 1. Aligning the mill and logs

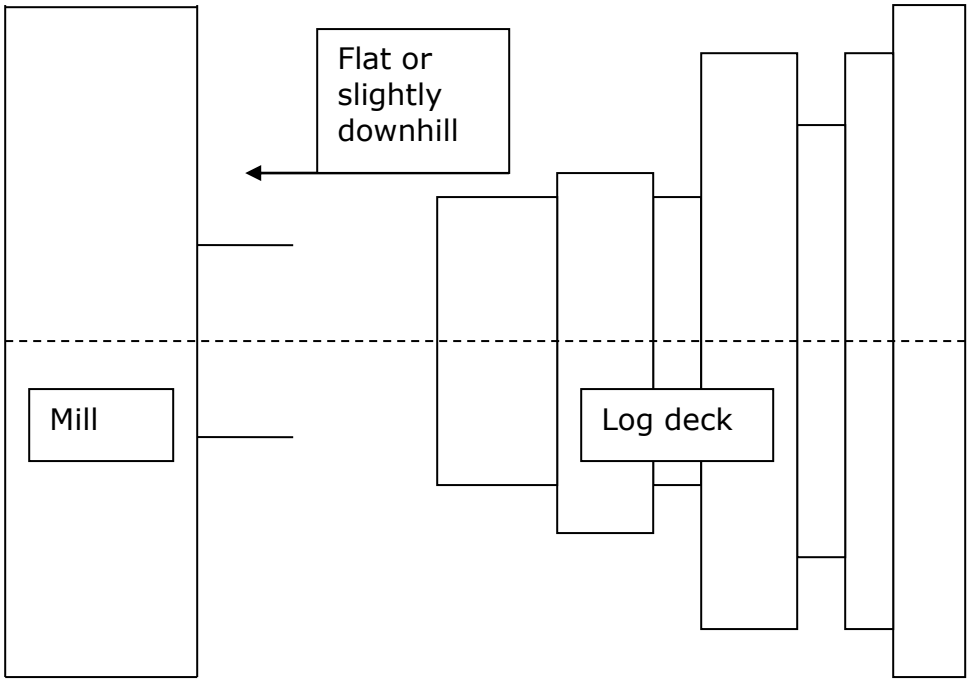

Fig 2. Vertical view of mill and log alignment

3.4. **Log handling and preparation -** Milling teams should strive to spend as little time as possible handling logs. A well designed log deck in a decent location should enable the assistant to prepare and load logs with little or no help from the sawyer

3.4.1. Log manufacturing – Invest time in creating quality saw logs. Cut logs to remove sweep and yield desired lengths in the process. Trim ends to be clean and perpendicular to the length. Leave 4-6" of trim length to allow for end checking during lumber drying.

3.4.2. Metal detection and removal – If cutting urban logs, salvaged beams, or other material with a high risk of metal, metal detection is an absolute requirement. Steel and other hard metals dull and damage blades, though they can usually be resharpened. Lead bullets are not a risk to blades, though steel shot is. Steel will leach a black color into wood. If you cut through a black wood pocket, stop and remove the metal. Very old small diameter nails may rust away completely.

3.4.3. Debarking/debris removal - Keep logs as free of dirt, rocks, and other debris as possible during felling and yarding. Mill mounted debarking devices provide only minimal removal capacity and any significant debris must be removed by hand with a debarking 'spud', a very labor intensive process.

3.5. **Advanced milling principles**

3.5.1. Wood behavior – Wood is not a static material. Depending on species, growth characteristics, and other factors, wood can be extremely dynamic during milling. Hardwoods, leaners, and poorly formed trees in particular will 'move' in response to internal tension being released. Conifers, particularly cedar, tend to react less.

3.5.1.1. Balancing tension release – When logs clearly have tension you'll need to balance the removal of that tension to avoid degrading the lumber. Not balancing tension release leads to inconsistent thickness, heavier than necessary sweep, and thus much lower recovery. The best way to balance tension release is by carefully rotating the log between cuts, taking off an appropriate amount of material at a time. Doing this well takes practice and experience with a wide variety of material.

3.5.2. Advanced cutting strategies

3.5.2.1. Quarter sawing – Large butt logs (20”+) can yield high value, very stable lumber through the technique of quarter sawing. Rather than the traditional technique of quartering a log, most quarter sawing on portable mills is done by cutting large, flat sawn cants that are then flipped 90 degrees and resawn.

3.5.2.2. Through and through – Many woodworkers prefer certain species like walnut, figured maple, cherry or yew logs to be cut in slabs, often referred to as ‘through and through’ cutting. This method leaves a ‘live edge’ of wane which is often used in a finished piece. Special care should be taken to protect live edges when using this method.

3.5.2.3. Free of heart center – The center of the tree, or pith, is the center point of internal tension. Cutting lumber or timbers that are ‘free of heart center’ (FOHC) greatly reduces twisting and checking and increases dimensional stability.

3.5.2.4. Boxed heart – When the pith is purposely left in a timber, it is best to ‘box the heart’ to center it and reduce sweep or other drying defects.

3.5.3. Handling oversized material – Oversized logs (24”+), while yielding an enormous amount of lumber, present their own set of challenges. They are heavy and therefore dangerous. Treat them with the respect they deserve.

3.5.3.1. Open grown trees – Large trees that have grown in isolation often have significant defects that lead to poor wood quality and milling difficulties. Wind shear forces lead to growth ring separation which, if found throughout the log, can render the lumber useless. Conifers, particular large Douglas-fir, will also produce enormous quantities of pitch to fill these wounds and will quickly gum up blades.

3.5.3.2. ‘Pumpkins’ – Very large trees (32”+) present difficulties for milling at all as most band mills have maximum height and width allowances. Utilize gaps in buttresses that allow for the mill head to pass. If no gaps exist, a lengthwise channel can be cut using a chainsaw. USE EXTREME CAUTION IF USING THIS METHOD. Logs can also be ripped lengthwise into halves or quarters to enable milling, though handling becomes much more difficult and a significant amount of material is wasted in the process. For any

significant lengthwise cutting with a chainsaw, a ripping chain is recommended.

3.5.4. Production efficiency tips – More than anything, experience will teach you how to mill efficiently. Make sure to compile and share lessons learned with other sawyers through good notes, photos, video, meetings, etc.

3.5.4.1. In describing what dimensions to cut material to, use actual dimensions only. Intermixing actual and nominal dimensions is extremely confusing and will inevitably lead to a miscommunication.

3.5.4.2. Be sure to account for material shrinkage when deciding on dimensions, especially width. Lumber does not shrink significantly in length.

3.5.4.3. Practice milling on low quality logs by making large quantities of dunnage and stickers for later use. Construct easily movable carts for these materials at your drying and storage site.

3.5.4.4. Work in regular patterns so the assistant can predict what the sawyer needs next

4. Highest and best material use

4.1. **Logs of questionable worth** – Judging whether a log is worth milling is an important skill and will come with experience. Some general rules include:

- Logs under 8” diameter typically aren’t worth milling, unless they’re a very valuable species.
- Logs less than 8’ long take much longer to mill and should only be cut if their value is evident.
- Logs that are riddled with metal should be rejected, particularly if you suspect metal deep within the log.
- Large open-grown trees, particularly Douglas-fir, may have ring separation and pitch pockets that cause a severe loss in recovery (see section 3.5.3.1).
- Certain species simply have poor properties and should only be used for dunnage, sleepers, firewood, or other low-quality uses. These include Lombardi poplars, many willows, and various softer or poorly formed urban hardwoods.

- Logs that have started to rot or reveal insect damage should be accepted with caution, particularly if the material is only to be air-dried. An exception is spalted material, usually alder or maple, where early stages of bacterial and fungal infection cause an attractive and marketable pattern without compromising hardness.

4.2. **Marketing high value material** – Always be on the lookout for valuable material. Take time to know what you're dealing with before processing it.

4.2.1. High value logs – Certain species such as figured maple and pacific yew are best sold as logs. The skill and equipment required to mill them for highest value is very specialized and individual logs can be worth several thousand dollars. Don't compromise their value through improper milling.

4.2.2. High value species – Particularly in the context of urban forests, where trees often reach significant size and quality, a broad range of species have excellent value: walnut, cherry, figured maple, yew, red and yellow cedar, locust, some oaks, dogwood, fruitwoods, elms, chestnut, and many others.

4.2.3. High value cuts – Within a particular species, quarter-sawn material is typically the most valuable, followed by flat-sawn clears. Clear or nearly clear timbers are also very valuable. Rejected portions of some species can also hold excellent value, such as crotch pieces in walnut or cherry for craving or turning.

4.3. **Material curing and storage** – An essential component of any milling operation is an efficient drying and storage facility.

4.3.1. Air-drying options – Ideally lumber is pre-dried in a covered space that has a concrete floor and good air flow. An open ended pole barn or breezeway works well. If piles are constructed outdoors they will need to be planer (flat, but not level) and have a vapor barrier underneath and a rain resistant cover above. Do not stack lumber in a closed space with bad air flow, low temperatures, or high humidity.

4.3.2. Constructing lumber piles – Place dunnage and stickers 12-18" on center, being sure to align all dunnage and stickers vertically (see Fig 3). Use 1½ x 1½ or larger stickers for timbers to allow sorting with a fork lift. Most hardwoods will need to be stacked for drying within days or even hours of being milled. Alder in particular is highly susceptible to rot and sticker stain. Species with strong reactive tendencies, primarily hardwoods, will benefit by being in tall, heavily weighted stacks. Additional

weight can be placed on top of piles to reduce reactivity in the upper lumber layers.

Fig 3. Stacking lumber
(Note: Outdoor stacks should have a cover and vapor barrier)

4.3.3. Judging moisture levels – Depending on the end use, wood may be used green, air-dried to 12-18% moisture, or may need to be kiln-dried to 4-8% moisture. If moisture levels are critical, purchase a high quality microwave moisture meter. Do not use a pin style meter as these only test surface moisture. Ambient Puget Sound weather conditions typically only allow moisture levels of 12-14% and only in summer. Also remember that moisture levels will always adjust to ambient conditions, even if material was kiln-dried.

4.4. **Grading** – Lumber that is to be used in a structural application must either be graded by an approved agency or otherwise qualify for ungraded use within a given jurisdiction.

4.4.1. Grading agencies – A grader can be hired on contract to grade lumber in any condition – rough or surfaced, green or dry. Make sure to have a substantial inventory available to

make this service cost effective. Also provide the support staff and equipment to help the grader work as fast as possible. Contact the Western Wood Products Association, West Coast Lumber Inspection Bureau, or Pacific Lumber Inspection Bureau for more information.

4.4.2. Some jurisdictions allow a variety of loopholes for using 'native lumber' in on-site construction. Check with the appropriate agency to determine if these types of alternatives are available. Common examples include:

- A 5000 board foot allowance for lumber from on-site trees that is visually graded by the building inspector
- Oversizing lumber to the next largest dimension (ie using 2x8 studs when 2x6 are required).

4.5. **By-product uses** – Milling produces several secondary products: slabs, edge trimmings, rounds, bark, chips (assuming a chipper is available), and dust. All of these are usable in some form, even if only to biodegrade and be reincorporated into the site. Think of these secondary materials as resources, not waste, and be sure to include them in your planning. Suggested uses include:

- Slabs – Firewood, cheap or 'natural' looking fences (cedar or locust only)
- Trimmings – Temporary stakes, kindling, lattice
- Rounds – Firewood
- Bark – Site remediation, landscape material (if chipped)
- Chips – Site preparation or remediation, landscaping mulch, pathways, animal bedding.
- Dust – Compost component, animal bedding
- Look for highest and best uses of other parts of the tree: cedar or locust poles for posts, oak poles for shitake mushroom production, birch bark and branches for crafts, etc.

Glossary

Cant – A squared off section of log, typically intended for resawing

Checking – Surface or end cracks in lumber that are the result of moisture imbalance and tension release during drying

Dunnage – Short timbers (ideally 3½ x 3½ x 52”) that allow forklift access under or in piles of lumber, logs, etc.

Flat-sawn – Lumber cut along the lengthwise face of a log (tangential to the radius)

Peavey – A hooked hand tool used for moving and turning logs

Through and through – A simple technique for cutting slabs and retaining the wane

Quarter-sawn – Lumber cut along the log’s radius so that annual rings are 45-90 degrees relative to the width of the board

Stickers – Small milled pieces for stacking lumber for drying (ideally ¾ x 1½ x 52”)

Wane – The cambium and bark edge left on a cut slab

For a complete dictionary of forestry related terms, we recommend ‘Terms of the Trade’, published by Random Lengths, ISBN 1-884311-10-5, www.randomlengths.com.

If you have any recommended changes for the next version of this document, please contact the author at ian@nnrg.org.

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