Reel Technology Study Guide

revised 8/12/02
revised w/questions 8/19/02
revised 11/4/02 with
preface, Q&A, etc.

Simplex·Ideal·Peerless

Equipment & Engine Training Council

BUSH HOG

TURF EQUIPMENT TECHNICIANS ASSOCIATION OF AMERICA TETAA

neary TECHNOLOGIES

JOHN DEERE

TEXTRON Golf, Turf & Specialty Products

Reel Technology Training Purpose

The purpose of this training course is to provide the student with a working knowledge of reel terminology, proper maintenance techniques, and troubleshooting guidelines for reel operation.

Why this course been developed

Reel technology has changed dramatically in the last 25 years. Although there are schools today that are teaching technicians how to work on golf course equipment, the majority of our technicians have been field trained by others in the industry or in many cases have been self taught. This has, in many cases, been an evolutionary process where a person that was field trained taught another person entering the business and so on. In many cases only the mechanical knowledge needed to perform the maintenance tasks were taught, and the basis for understanding theory of reels and reel maintenance has been neglected. As the mowing technology changes and the quest for improved quality and reduced maintenance costs continues to prevail, there is a need to provide a basis of understanding theory and proper maintenance practices.

There is no simple correct methodology that is correct 100% of the time. To be able to know when to apply the best practice for the situation at hand, reel technology theory must be completely understood. In addition it is recognized that formal certification is important to prove accomplishment and knowledge in any given topic area. Much like the GCSAA certifies superintendents to prove they have the knowledge needed to perform their tasks, technicians can realize benefits from obtaining this certifiable training.

Additional References

Bernhard & Co.: www.bernhard.co.uk 888-474-6348
Bushhog; www.bushhog.com 334-874-2700
Foley United; www.foleyunited.com 800-225-9810
Neary Technologies; www.nearytec.com 800-233-4973
Simplex-Ideal-Peerless; www.sipgrinder.com 800-888-6658

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Eric Kulaas
Renaissance Vinoy Resort & GC

W. M. “Lucky” Luchsinger
Turf Equipment Technicians Association of America

What is EETC certification testing?

The Engine & Equipment Training Council (EETC) certification tests are designed to measure the technician's knowledge in several areas; including basic skills orientation, interpersonal relationship skills, reel technology fundamentals, theory, aftercut appearance analysis, troubleshooting and repair. The EETC Reel Technology test has 150 multiple-choice questions. Testing time is limited to two hours.

Who is the EETC?

The Engine & Equipment Training Council (EETC) is a non-profit professional organization who's objective is to promote and support the education and training of Equipment Technicians in outdoor power equipment, agriculture, commercial, golf course & sports fields, and heavy Equipment Technology. The organization is made up of manufacturers and their service and training personnel, technical school instructors, equipment distributors, equipment dealers allied associations and other industry and educational leaders.

Why certify as an EETC technician?

The benefits of being EETC certified are both personal and professional. Meeting the industry standard of professionalism by obtaining credentials through certification will enhance the technician's long-term prospects for income. Recognition of professional competence by a recognized body adds to the prestige and credibility of the individual who exhibits the interest, initiative and qualifications to attain certification.

Who certifies the EETC technician?

The tests are administered throughout North America by the Outdoor Power Equipment & Engine Service Association (OPEESA), Through their distributor network. EETC members are the test writers, OPEESA is the test administrator for our industry and supervises testing locations, dates and handles the collection of fees, registrations, and inquiries. OPEESA provides the registered technician with all pertinent details before testing and notifies the test taker of scores after testing. OPEESA handles the dissemination of certificates, arm patches, and maintains individual records on all applicants notifying technicians when to re-certify.

When will I need to recertify?

Certification is valid for three years. OPEESA monitors technician's records and notifies them when to renew their certification. You can maintain your certification for an additional three years by retaking the certification test, accumulating continuing education units (ceu's) by attending manufacturer/distributor update seminars, attending one semester at a technical school, and presenting copies of certificates of completion. Contact EETC for details.

Who may take the test?

Anyone may take the test at any scheduled testing session if they have registered 30 days prior to the test date. Technicians can apply to take the test at a location that is convenient to them. Tests are administered at OPEESA approved locations throughout the North America. Registration will not be accepted by telephone or at test locations.

What is the cost of the test?

The registration fee to take a test is $45 per test. Test fees are subject to change. Contact OPEESA or EETC and request the most current registration form. Test fees must accompany the registration form in order to complete the registration process. Applicant passing a test Will be certified and receive an arm patch bearing the EETC logo, a smaller test-specific patch, and an 8x10 certificate suitable for framing.

Does the study guide cover all test items?

The study guide is meant to complement the technicians studies to see how well they understand what they have learned. Sample test questions and answers in this study guide are similar to those found on the certification test. These sample questions are included to familiarize the technician with the testing format. In addition, the answers to many questions are expanded upon so the technician can compare their breadth of knowledge to experienced professionals.

What other EETC certifications are available?

EETC offers certifications in Two Cycle, Four Cycle, Compact Diesel, Electrical, Drivelines/Hydraulic/Hydrostatics, Portable Generators, Reel Technology, Sprayers/Chassis/Brakes (2003) and Certified Equipment Manager (late 2003).

Whom do I contact for additional information?

Outdoor Power Equipment & Engine Service Assoc.
210 Allen Drive
Exton, PA 19341
Phone 610-363-3844 Fax 610-363-3817
Web www.opeesa.org

Engine & Equipment Training Council
P.O. Box 648
W307 N5480 Anderson Road
Hartland, WI 53029
Phone: 262-367-6700, Fax: 262-367-9505
E-mail eetc@eetc.org Web www.eetc.org

OUTLINE FOR REEL TECHNOLOGY CERTIFICATION

The History of The Reel Mower and Reel Mower Grinders

The reel mower came into existence in England in 1830 as a device to cut the nap of carpets. Obviously close tolerances were required. After much trial and error, the reel and bedknife setup became the industry standard. The bedknife held the carpet nap upright, in exactly the same position so as to insure uniformity. The reel, designed to duplicate the action of a many bladed scythe, cut with a sideways slicing action traveling at a great speed along the bedknife to face, much like a straight razor being slashed along its length, or in effect, a similar action to a pair of scissors.

The concept of the reel mower goes back to the 1800's. It evolved out of a need for groomed turf areas being maintained on a regular basis.

With the industrial revolution in full swing, and the higher standard of living it brought, people had begun to take more of an interest in the appearance of their surroundings, particularly their residences. Part of the appearance was the groundcover around their house which was developed to what we now call a lawn. In the beginning these areas were mowed using a conventional scythe.

Golf course development during the 1920's and 30's brought about design improvements in engines and mower drive systems.

Carpet production took place primarily in England where the reel and the bedknife were developed by copying the carpet shearing process. In the early 1800's a local engineer named William Budding developed these machines, modified them, made them smaller, and with a wheel drive assembly, used them to cut the lawn. The machine was granted a patent in 1830. The machines used to manufacture the reels were also modified to sharpen the new lawn mowers. These machines were similar to what we call "Spin Grinders".

These improvements continued, allowing for lighter weight and easier to use equipment.

In the early 1900's there were several manufacturers of mowing equipment in the United States. In the 20's there were several companies that were starting to realize the potential of a market for mechanized machines to perform sharpening operations on all kinds tools requiring sharp edges. Until this time almost all sharp edges were maintained through a hand process of filing and honing. However along

with the ingenuity of power tool development through the industrial revolution, there was a need to develop new methods of sharpening that were less time consuming and would handle larger volumes of tools. There were many new machines introduced during this time for sharpening, of which reel grinders were one application that was addressed. These first machines were very simple in nature due to the limited knowledge of automation at the time and the limited budgets that were available for such machines. As Sharpening shops grew throughout the U.S. the single blade grinder became the standard for sharpening reels and remained the standard for many decades.

The development of hydraulics during the 50's and 60's improved the reliability, safety, operator comfort and lowered maintenance costs.

In the fifties and early sixties the residential reel type lawn mower in the US had been replaced by the rotary mower, making the demand for sharpening shops to have machines for sharpening reel mowers very limited. Grinders were used primarily on the golf courses, schools, and municipalities for mowing very large grass areas that needed to have a high quality. This changed the nature of the grinder, as the use became very specific to a specialized type of reel cutting units. Again the ingenuity kicked in and there were new machines starting to appear in the US market that were able to spin grind these specialized reels. These machines were also quite simple in nature, and were limited to only performing the operation of spin grinding.

Although dramatic improvements have been made in reel type mowers, some of the same frustrations that developed working with reel cutting units years ago are still present today. If reel mowers unique characteristics are not understood and responded to, the end result will be a poor quality of cut and expensive down time and repairs.

As quite frequently happens in product development, there are methods developed that are revolutionary at the time, offering vast improvements to the market place. However until these new methods evolve, they quite often don't offer the best solution to the entire problem. Hence there was a point in time where we had two standards evolving, single blade grinding and spin grinding.

It wasn't until the early 80's that there were machines introduced that actually combined the process of spin grinding and the single blade grinding methods to accomplish the entire task of spin and relief grinding. These machines finally gave the operator the flexibility to perform any needed task, at any given time, to resolve any problem that they were faced with. Today there are machines that can address the process in many different manners and with functions that have been refined and developed to utilize the automation technology that is available in the manufacturing world to further reduce the workload and improve the accuracy of the grinders. Most of the machines sold today are capable of performing all types of grinding that may be required with the accuracy of machine tools used in precision machining operations.

Reels have also taken on many changes in the thousands of rpm to meet the quality of cut requirements that are now common place. The height of cut has also decreased significantly making the job of mowing even more difficult. These units are still continuing to change as turf grass development continues. Hence the maintenance requirements of these cutting units has changed, and will continue to change, along with the development of new reel technology.

Advantages of Reel Cutting Units Versus Rotary Cutting Units.

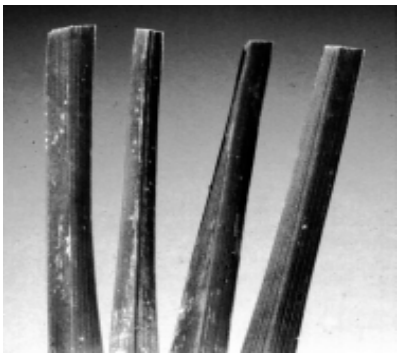
ADVANTAGES:

1) You get a cut that is exactly at the height you want, with a minimal number of stragglers, thereby providing a smoother, more level surface.
2) You get the best "quality-of-cut" that is possible where there is a clean, uniform cut. This makes the grass less susceptable to disease, and promotes a much more rapid growth recovery in the plant structure.

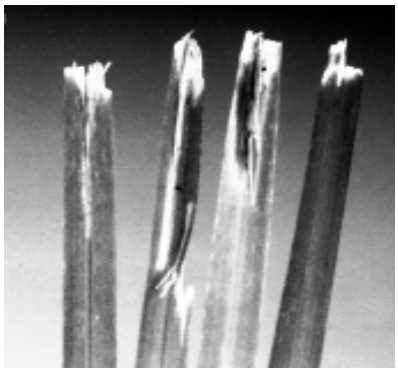
DISADVANTAGES :

1) The initial cost of the reel & traction type cutting unit requires a much larger investment, and the component replacement parts of a reel is much more expensive.
2) The reel type cutting units require more maintenance, and because of the complex technology, a more skilled technician is needed for optimal performance.

Quality of Cut



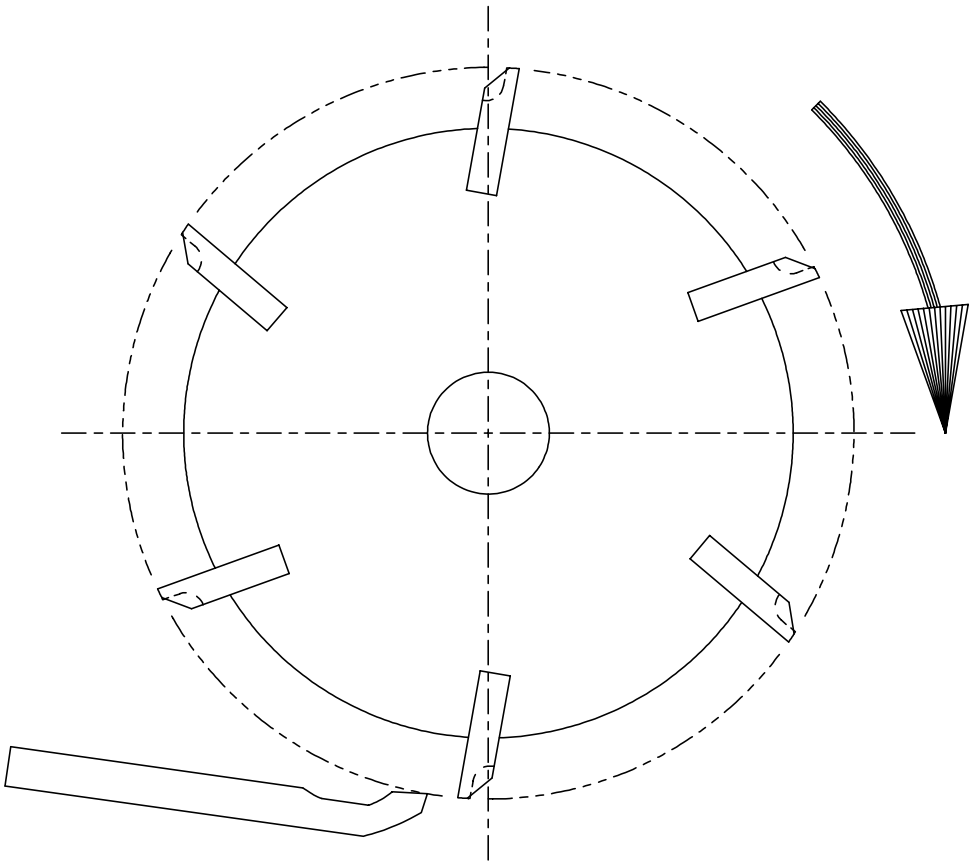
B LADE OF GRASS CUT WITH A SHARP REEL TYPE CUTTING UNIT (STRAIGHT/CLEAN)



BLADE OF GRASS CUT WITH A DULL REEL TYPE CUTTING UNIT, OR A ROTARY TYPE CUTTING UNIT (SHREDDED)

These images illustrate the difference in the QUALITY OF CUT with a "sharp" reel type cutting unit, versus a "dull" reel or rotary type cutting unit. A dull reel will cut grass, but the damage that it does to the grass tissue will give a different appearance once the frayed edges dry out. This will make a difference in the aftercut appearance as you strive for a consistently green & healthy playing surface.

Reel Cutting Unit



A REEL CUTTING UNIT HAS TWO WORKING PARTS:

1) The Bedknife Leading Edge.
2) The Reel Blade Leading Edge.

This diagram shows how these parts work. The bedknife is a stationary cutting edge, while the reel blade serves as the moving cutting edge.

The bedknife has two functions:

a.) It pushes against the blade of grass and stands the grass up in a vertical position.
b.) Then, the Bedknife edge acts as half of a scissors.

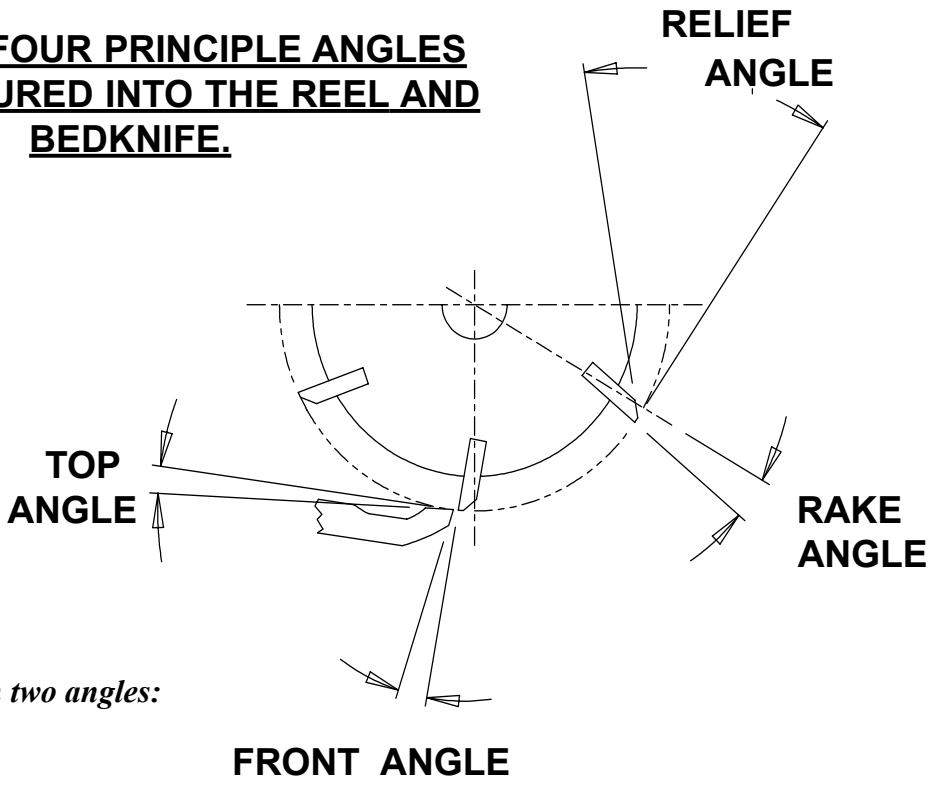
The reel blade has two functions:

a.) The reel blade rotates across the bedknife performing the cutting action, as the second half of the scissors.
b.) The reel blade gathers the grass and discharges the clippings as it rotates over the edge of the bedknife.

REEL DESIGN

The desire for tighter clip rates and smoother surfaces has evolved, and the technology of the traction unit and drive components have changed in order to meet these desires. Now, most all manufacturers use hydraulically driven units and reel design plays a significant role in the overall optimum efficiency of the machine.

THERE ARE FOUR PRINCIPLE ANGLES MANUFACTURED INTO THE REEL AND BEDKNIFE.



The bedknife is associated with two angles:

1) Top Face Angle
2) Front Face Angle

The reel blade is also associated with two angles:

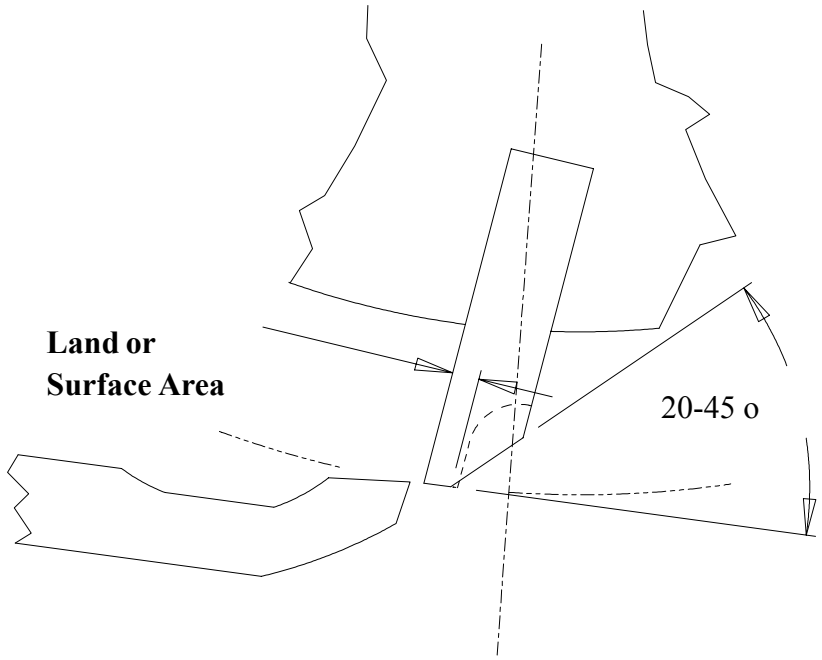
1) Relief Angle
2) Rake Angle

The reel back relief angle is ground to remove the cross section of the blade leaving approximately 1 mm (.040"). This 1 mm of cross section provides some strength in the cutting tip. When this blade cross section wears to 1/3 to the blade thickness, it is time to regrind the reel. This angle is set at 20 degrees. The industry ranges from 20-45 degrees.

Deere recommends relief grinding the reels for these reasons;

1. Relief grinding removes metal from the trailing edge of the blade forming an angle (relief angle) to reduce the contact area of the cutting edges. This reduces blade contact area resulting in less friction.
2. Ensures longer wear life.
3. Less time is required to backlap.
4. Reduces squeezing and tearing of the grass as the unit gets dull by use.
5. Provides an area for backlapping compound to be trapped to more effectively backlap reels.
6. Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is .001" to .002" too high.
7. Requires less horsepower to drive the reel. **This para from JD**

REEL BLADE ANGLES



Reel blades have a back "RELIEF ANGLE" where approximately 75% of the blade is removed. The OEM reel blade configuration has two basic process designs:

1) FAIRWAY/ROUGH mowers have a much thicker blade design and a "***ground-in-relief***" is produced to reduce friction.

2) GREENS/TEE mowers have a thinner blade design, which utilizes a "***milled-in relief***" manufacturing process. Recently, some OEM's have "***ground-in***" additional relief on these milled blades for optimum cutting unit performance.

These "relief angle" values and the percentage of back blade removal are approximations. For the correct angles and percentages for your specific mowing unit, refer to the mower manufactures specifications.

Ground Relief  Milled Relief

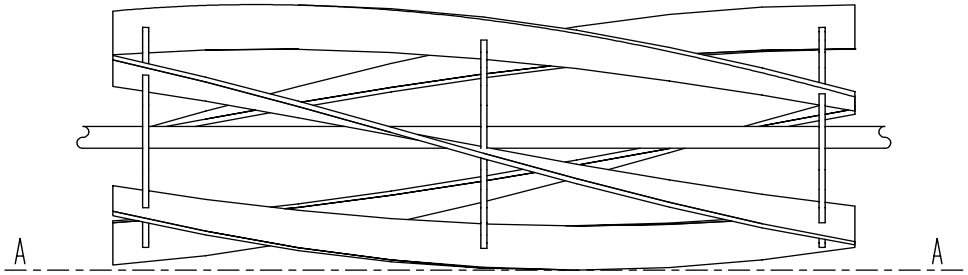
Rake Angles

RAKE ANGLE

The reel RAKE ANGLE is created by the slot in the spider which locates the blade on an angle: this ensures that the front cutting edge is always forward of the blade body, which in turn cuts, not pushes, the grass. The rake angle is fixed at the manufacturer and cannot be revised.

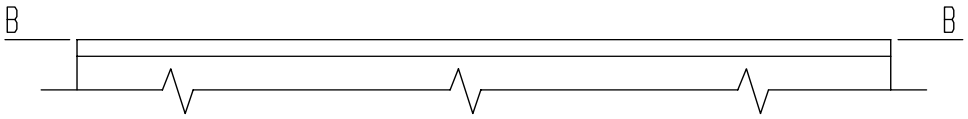
If you view the end of the reel blade along the axis of the center shaft of the reel, you will notice that the flat ground surface that passes over the bedknife has an apparent angle in relationship to the blade body. This angle should not be confused with "relief" that is normally associated with back blade removal that can only be acheived with a seperate and secondary grind process.

OEM CUTTING UNIT CONFIGURATION



REEL IS CYLINDRICAL IN TWO PLANES

1) All reel blades are on the same cutting circle.
2) Reel diameter is equal from end to end.



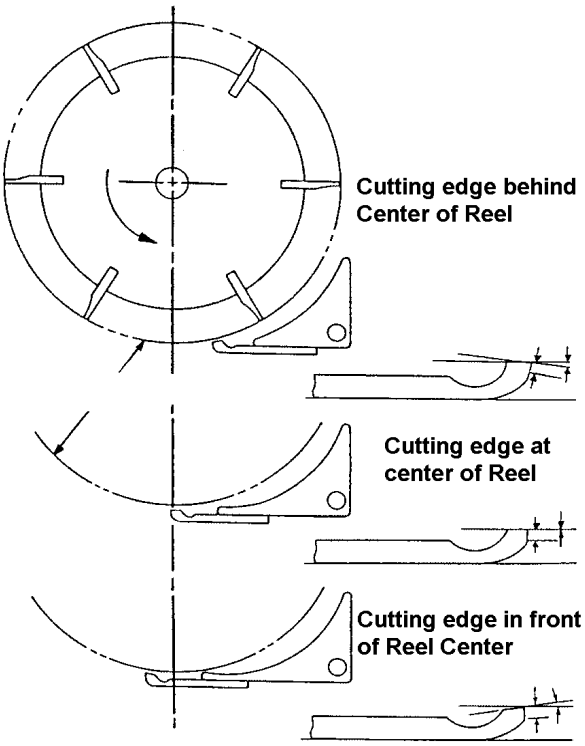
BEDKNIFE IS STRAIGHT AND TRUE

"OPTIMUM" QUALITY OF CUT & CUTTING UNIT PERFORMANCE IS ACHIEVED WHEN THE CIRCULARITY OF REEL SURFACE "A - A" IS STRAIGHT AND PARALLEL WITH BEDKNIFE SURFACE "B - B".

The reel must be perfectly straight and the bedknife must be straight and flat in order for them to work properly, as illustrated.

Total tolerance between reel and bedknife can only be .002+/-.001 to provide a quality reel to bedknife clearance that does not require backlapping.

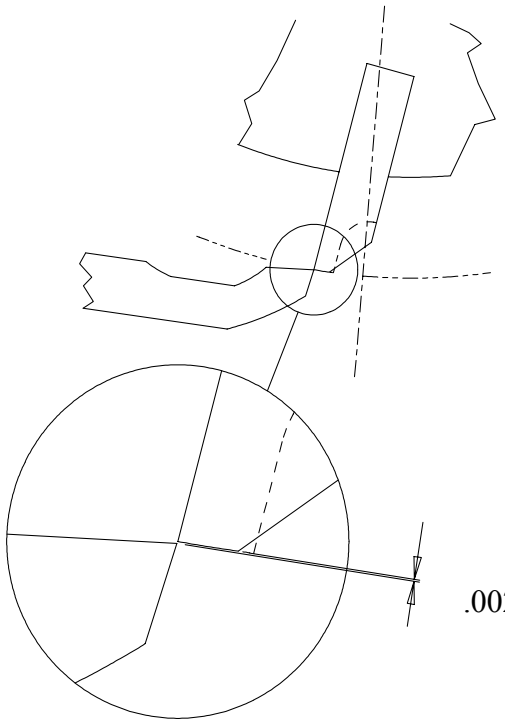
BEDKNIFE ANGLES



Today, most cutting units are constructed with the cutting edge of the bedknife at the center or behind the center of the reel. This allows for a more aggressive position of the bedknife and a lower height-of-cut with greens type mowing units.

The attitude of the bedknife, which is the angle that the bottom surface of the bedknife is positioned in, will have a direct effect on how aggressively the mowing unit cuts.

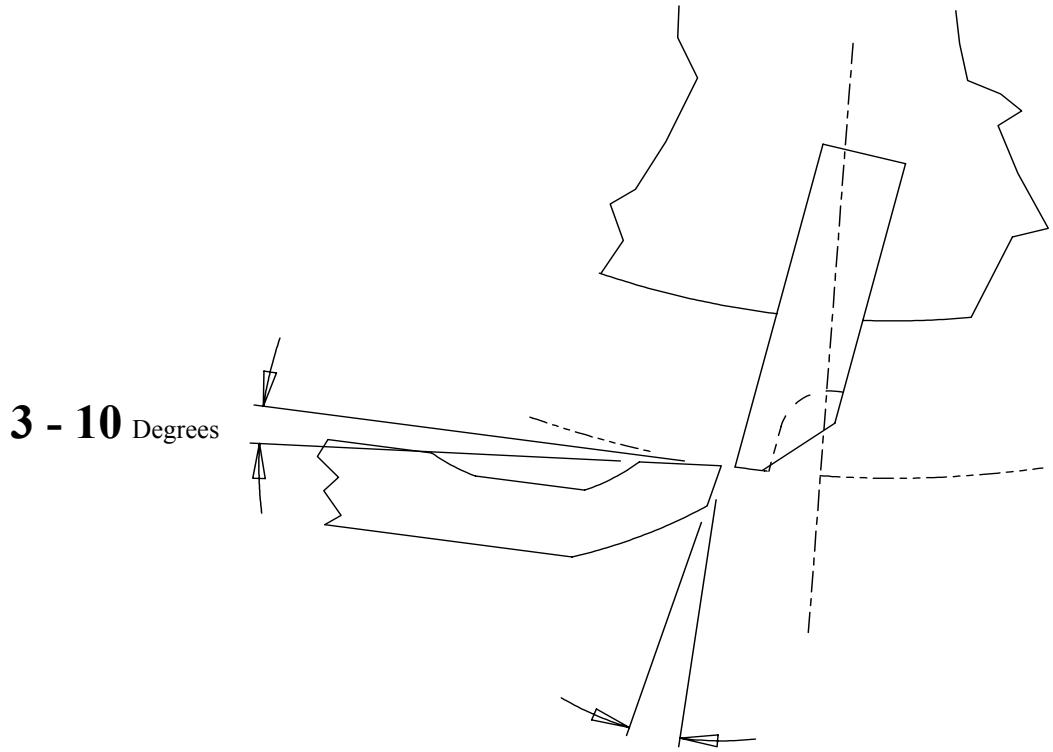
The picture to the right shows the rake angle coming into play, and how the leading edge passes the edge of the bedknife.



The bottom picture illustrates that a .002 gap between the reel and the bedknife is the preferred setting. It is not necessary to have any or much metal contact. Heavy metal contact hinders good mechanical operations.

.002 +/- .001

BEDKNIFE ANGLES



This diagram gives the range of angles that are found on the bedknife.

1) **BEDKNIFE TOP ANGLE:** Ranges 3 to 10 degrees, serves two purposes:

- ***Reduces metal contact***
- ***Allows cut grass to be ejected from the cutting unit***

2) **BEDKNIFE FRONT ANGLE:** Normally set between 3 to17 degrees. This angle assures that the front edge will stand the blade of grass up in position, and contributes to the ability to attain an exact height of cut with minimal stragglers.

The bedknife has two angles; the top and front angle.
The top angle, set at 5 degrees ,except on greens mowers which have a Top angle of 6.5 degrees, is there to reduce metal contact, and it allows cut grass to be ejected from the cutting unit. This angle must be present for the bedknife to work properly. The industry range for this angle is 3-10 degrees.

The front angle is set at 5 degrees also. It assures that the front will stand the blade of grass up perpendicular. Without a relief angle the blade of grass will contact the lower edge of the bedknife and be bent over at too much of an angle prior to being cut. In the case of mowing greens, where very small cuts are being taken, the reel may not capture the grass at all, and no grass will be cut. The industry range for this angle is 3-17 degrees.

AGGRESSIVE VS LESS AGGRESSIVE

The 'aggressiveness" of a cutting unit is determined by the distance between the front edge of the bedknife (cut point) and the center line of the reel. Commonly referred to as "Attitude" for the bedknife.

As the reel turns in the cutting unit the reel blades actually go **below** the front edge of the bedknife (cut point). This is how the reel gathers the grass to be cut. If the bedknife edge was directly under the center point of the reel the reel blades would not gather the grass and the cutting unit would have a poor quality of cut.

The further back the bedknife is moved from the center of the reel the more aggressive the cut. Meaning the reel blades are going further below the cut point.

The closer the bedknife is to the center of the reel the less aggressive the cut. Meaning the reel blades are not going as far below the cut point.

What determines the cut quality of a cutting unit?

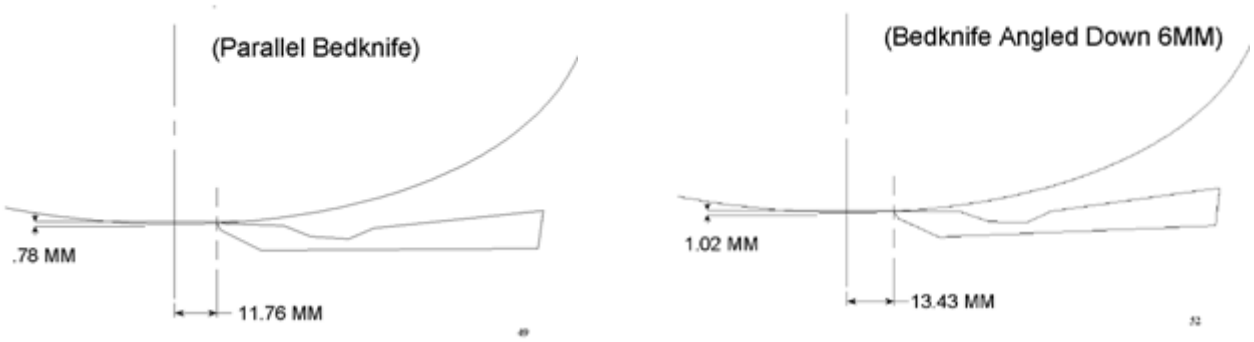
The aggressiveness or non aggressiveness of the cutting unit. The more aggressive the cutting unit the better job the reel is doing in gathering the grass to be cut. This provides a good cut quality with less uncut grass(stragglers). The down side or the fine line, is the more aggressive the cut the more risk you run of over stressing the grass. Especially at lower heights of cut. This usually shows up first on the overlap stripe. So moving the bedknife further from the center of the reel does have a down side. It can be moved to far. The opposite is also true. Moving the bedknife closer to the center of the reel the uncut grass(stragglers) are increased because the reel is not gathering the grass as well.

What adjustments and maintenance practices can change this relation ship?

Facing of the bedknife is a common practice for maintaining cut quality. But each time a bedknife is faced material is being removed from the front edge of the bedknife. This moves the cut point further from the center of the reel making it more aggressive. Caution needs to be used when facing a bedknife. A hand file is recommended.

Roller set up on the cutting unit can also change this relationship. Having a cutting unit with the rear roller set lower then the front gives the cutting unit a pitched forward appearance thus moving the bedknife away from the reel center. Making it more aggressive. When the the front roller is lower then the cutting unit is pitched backwards moving the bedknife closer to the center of the reel. Making the cutting unit less aggressive.

Bedknife/Reel Relationship



Cutting units using a roller bracket location in the frame to determine the HOC range of the cutting unit. It is possible with these cutting units to obtain the same HOC in different height ranges. The difference is, in this case, is the location of the front and rear roller heights. One range will make the cut more aggressive……

When stressing of the grass is seen there are points that need to be checked.
1) Make sure reel and bedknife are sharp.
2) Bedknife relationship to reel. Roller settings…are we too aggressive
3) Replace bedknife to reestablish the proper bedknife to center of the reel relationship.

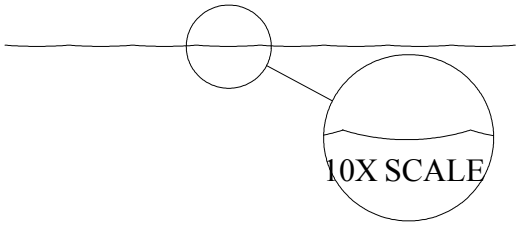
Clip Rate

Clip rate is the rate at which the reel blade to bedknife scissors action occurs as the cutting unit travels across the terrain. Clip rate is determined by:

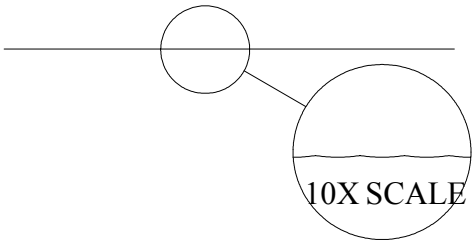
- The number of blades in the reel
- The RPM of the reel
- The travel speed of the cutting unit over the terrain.

The application the mowing unit is used for determines the best clip rate.

Example: To mow roughs, the top surface of the grass can be wavy. Therefore a 5 bladed reel at lower RPM is acceptable and a close-up view of this grass might look as follows.



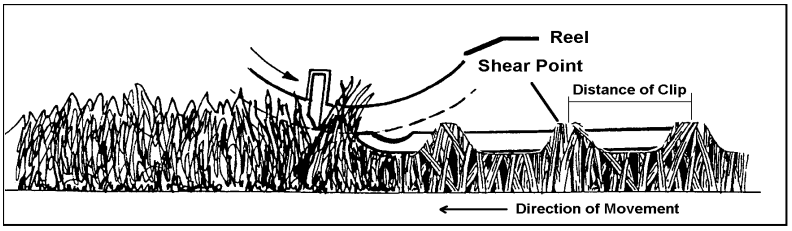
Example: To mow a greens, the top surface of the grass should be very smooth. Therefore an 11 blade reel at high RPM is best. A close-up view of the grass might look as follows.



For optimum reel operation and performance, the clip rate will be equal to or less than the desired height of cut.

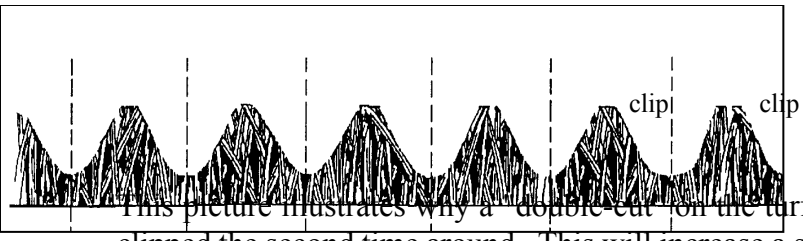
CLIP RATE & EFFICIENCY

The number of reel blades selected for an application can effect several variables: CUTTING EFFICIENCY, THROW PATTERN, LENGTH OF GRASS BLADES, CLIP SPACING, SPEED, and MOWING FREQUENCY.



As the reel rotates, the front edge of the reel travels along a "BLADE PATH" and gathers the grass in a clump as illustrated above. The end result of this cutting action leaves 20-30% of grass mass that is not cut at the "shear" point. Different diameter reels will have their own unique "blade path", thus a unique surface clip based on blade count, RPM, and mow speed.

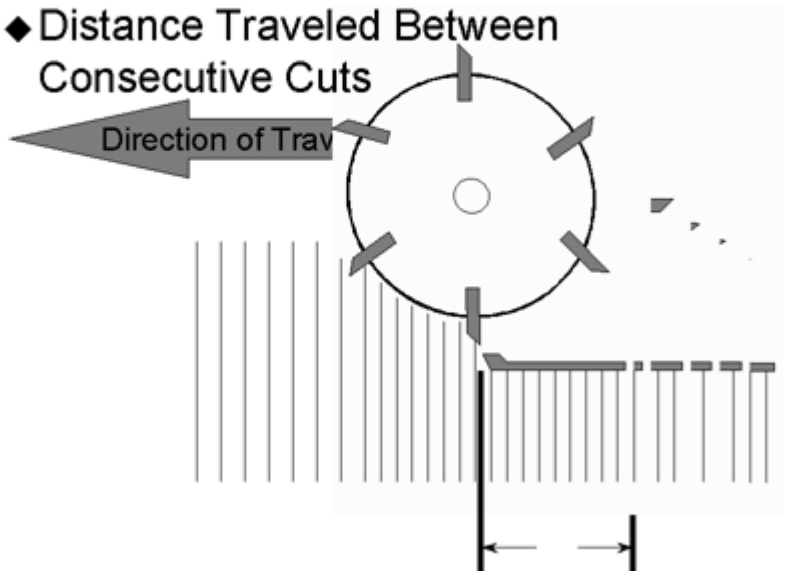
(Exagerated)
Peak Point of



This picture illustrates why a "double-cut" on the turf will yeild more grass in a basket as "Peak Points" are clipped the second time around. This will increase a stimp meter reading as the playing surface is made more smooth and the cut more level.

Fanning and marcelling are two examples of what can occur when an incorrect blade count, incorrect RPM, or incorrect mow speed is used for a particular application. There is a line that can be crossed when trading off quality for productivity.

Frequency Of Cut (FOC)



Frequency of Cut (clip ratio) … The forward distance traveled between successive cutting contacts

at any one shear point.

FOC Negative Effects

FOC Too Slow (Higher Number)

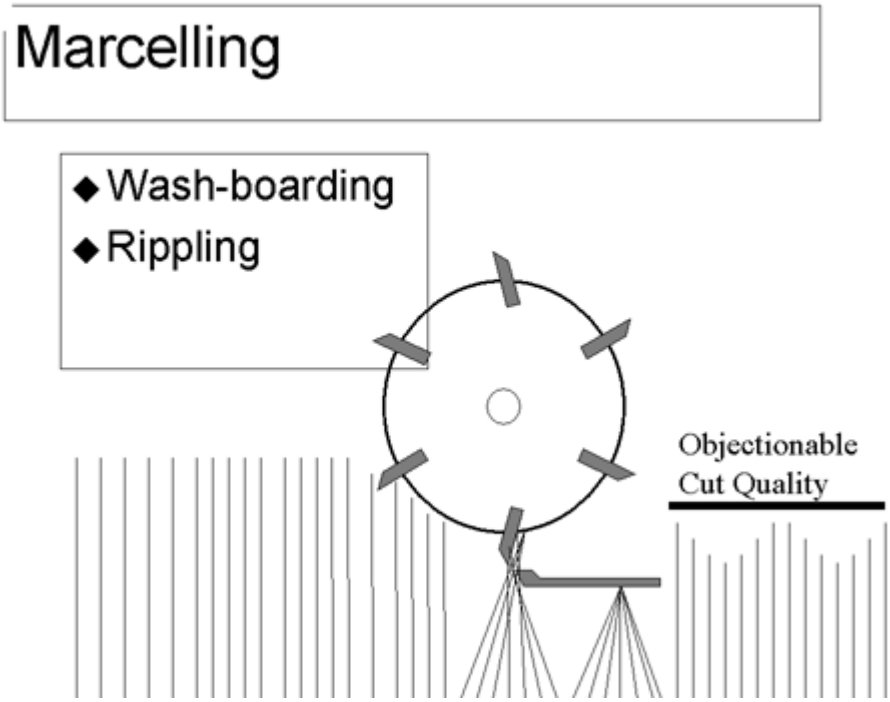
Marcelling (Wash Boarding)(Rippled Effect)

FOC Too FAst (Lower Number)

Over Stressed Grass

Stripes and/or Brown Tips

Accelerated Component Wear



FOC "Guideline"

The Lower the Height of Cut (HOC)
The More Blades That are Required

The Higher the HOC
The Less Blades That are Required

From Turf Grass Management, A.J. Turgeon, pending approval:

Mowing quality is also influenced by the relationship between mowing height (MH) and the *clip of the reel* (CR), which is defined as the *forward distance traveled between successive clips.* The CR is determined by the number of blades on the reel, the rotational velocity of the reel blades, and the forward operating speed of the mower. Usually, the most uniform cut occurs when CR = MH. If the CR is appreciably longer than MH, the turf surface takes on a wavy appearanc, called marcelling, as illustrated above. Marcelling usually occurs when the forward speed of a mower is excessive. With other factors being constant, doubling the forward operating speed will also double the CR. Reels on greens mowers are smaller in diameter and have more blades than reels used for mowing lawns and other higher cut turfs. The larger number of closely spaced blades on the reel makes a greens mower more suitable for mowing at very short heights.

If the CR is appreciably shorter than the MH, the efficiency with which reel blades direct leaves to the bedknife is reduced, and a ragged, nonuniform cut may result. This is due to the air movement generated by the reel, which prevents proper gatheriong of the grass leaves by the reel blades. Thus a greens mower adjusted up to provide a 0.75 - inch height of cut would be unsuitable for mowing lawn or fairway turf.

The inverse of CR is the *frequency of clip* (FC). This is defined as the number of clips per unit distance (inches) traveled. A mower with an FC of 2 clips per inch has a CR of 0.5 (the inverse of 2 is 1/2 or 0.5) and is well suited for moweing turf at 0.5 inch.

The phenomenon of marcelling can be explained by some simple geometry. With clipping, turfgrass shoots are drawn together to form an isoceles triangle. After clipping, the shoots return to an upright orientation, resulting in a marcelled surface with measurable peaks and valleys. The height difference between peaks and valleys is called the *restitution height* (R). When CR and MH are known, R can be computed by first determining the hypothenuse formed by shoots rooted farthest from the position where the clipping occurs:

$$c^2 = a^2 + b^2, \quad c = \sqrt{a^2 + b^2}$$

R equals the difference between *c* (hypothenuse) and *a* (MH)

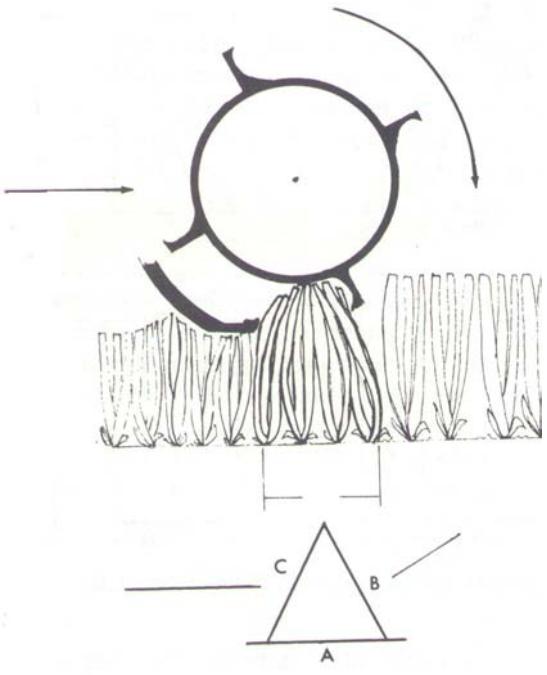
$$R = c - a = \sqrt{a^2 + b^2} - a$$

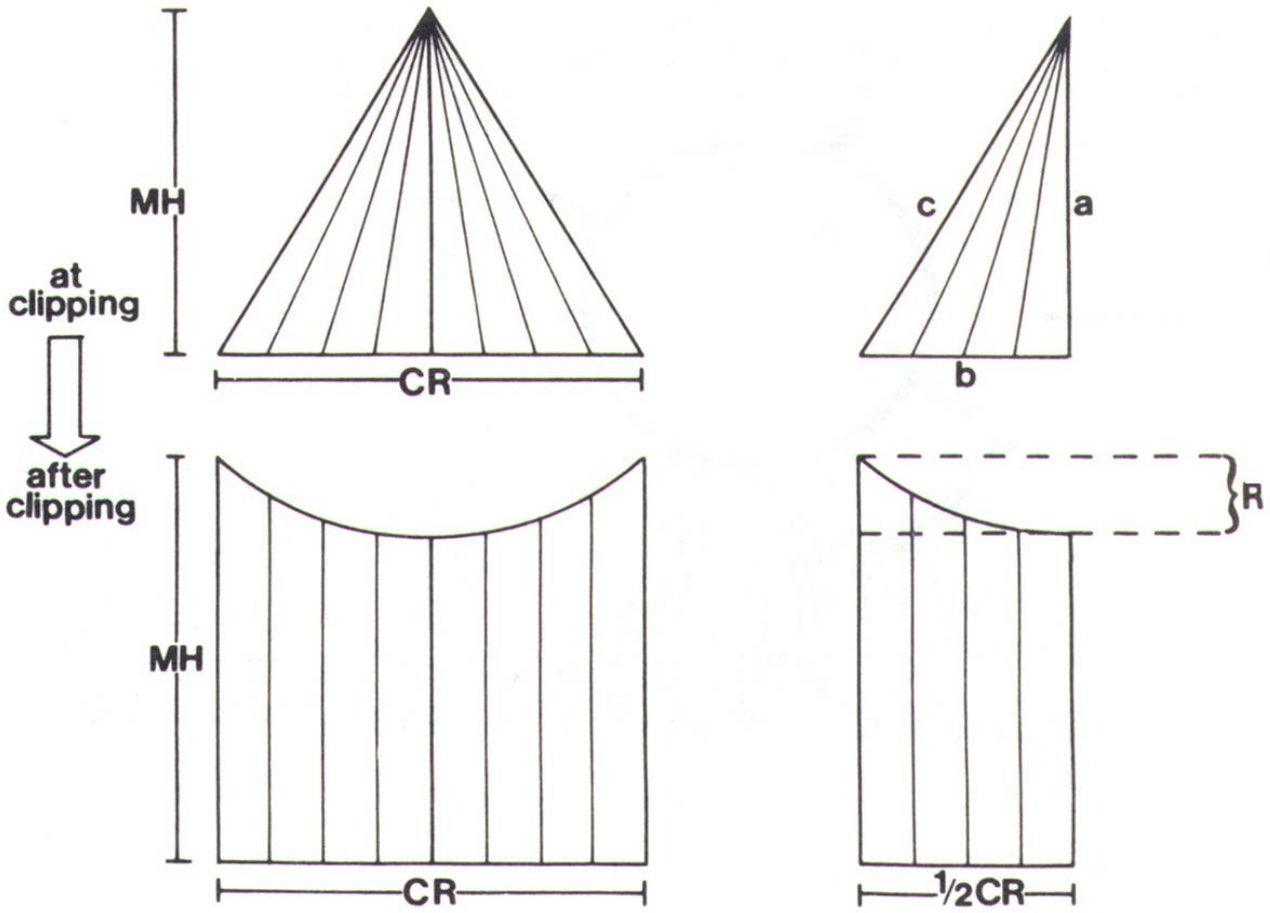
Substituting MH for *a* and 1/2 CR for *b* provides the following formulas for determining R:

$$R = \sqrt{MH^2 + (\tfrac{1}{2}\,CR)^2} - MH$$

or

$$R = MH\sqrt{1 + \left(\frac{CR}{2\,MH}\right)^2} - 1$$





$$\%\ V = \frac{R}{MH}$$

Observable marcelling may or may not result, depending on the percent of variation in shoot height from mowing. Where CR = MH, the shoot height variation equals approximately 12 percent - an acceptable level that does not result in a marcelled appearance. Where CR > MH, large restitution heights and substancial shoot height variations occur, resulting in observable marcelling.

ADJUSTMENT

Before making the adjustments, also remember the basics: Reels will adjust EASIER, FASTER, and MORE POSITIVE when the reel and bedknife are sharp and GROUND at the PROPER ANGLES .

Excerpt from a Textron Publication

LIGHT CONTACT between the bedknife and reel will help promote a self-sharpening action.

Excerpt from a Toro Publication

Over adjustment of the reel to bedknife can cause the reel to climb over the bedknife and may lead to rifling of the bedknife. Rifling can lead to striping, an uneven cut, or even a complete failure of the cutting unit.

There should be NO contact between reel and bedknife. None is needed (suggest a .002" clearance). Grass blades are .006-.007 inches thick. Several reasons why this clearance is necessary;
1. When the reel is allowed to contact the bedknife, the square (sharp) edges of the reel and bedknife will rollover, becoming dull.
2. Contact between the reel and bedknife will generate heat. Heat generated through this contact will distort the shape of the bedknife. Distortion causes the bedknife to draw closer to the reel, resulting in more rollover of the cutting surfaces and more heat generated in the bedknife.
3. Drag produced by an improperly adjusted cutting unit may result in an unacceptable clip ratio, undue strain on drive mechanism and premature wear of the cutting unit.

Excerpt from John Deere

Height of Cut (HOC)

Two Methods of Measuring HOC

Bench Setting

The height at which the bedknife is set above a firm level surface

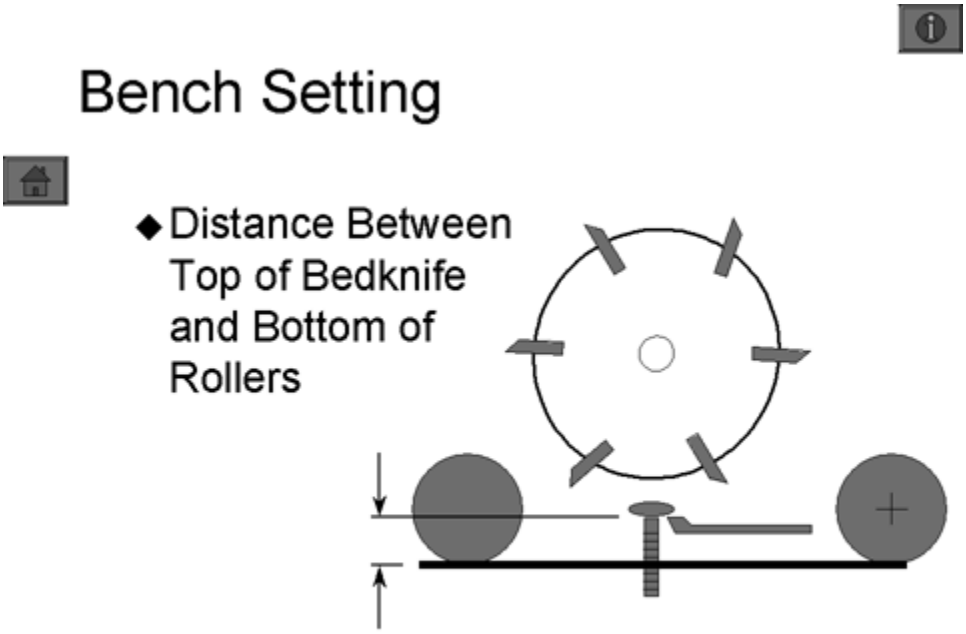
Effective Cutting Height

The actual Height at which grasses are cut

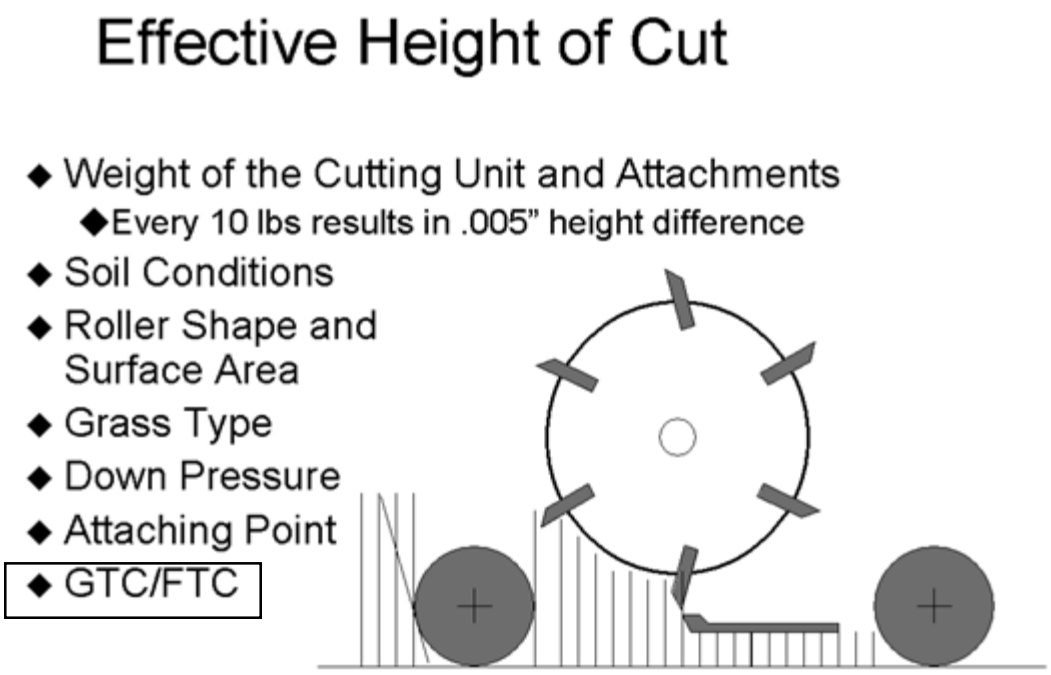
Bench setting is done with a gauge bar (typically aluminum) or a straight bar with a dial indicator in place of the screw shown above.

The "Bench Setting" simply measures the distance between the top of the bedknife (cutting surface) and the bottom of the rollers (the supposed ground level).

In reality when using this method the superintendent observes the RESULT and then makes corrections if necessary. So the superintendent starts with a bench setting that based on previous experience gives the results desired. If the ball speed is too fast or slow, or the grass becomes stressed because of a low height, changes are made up or down to the initial setting.



The most widely accepted method of establishing "height of cut" is the bench setting. This is done statically in the shop and typically does NOT take into account the conditions in which the reels will be cutting.

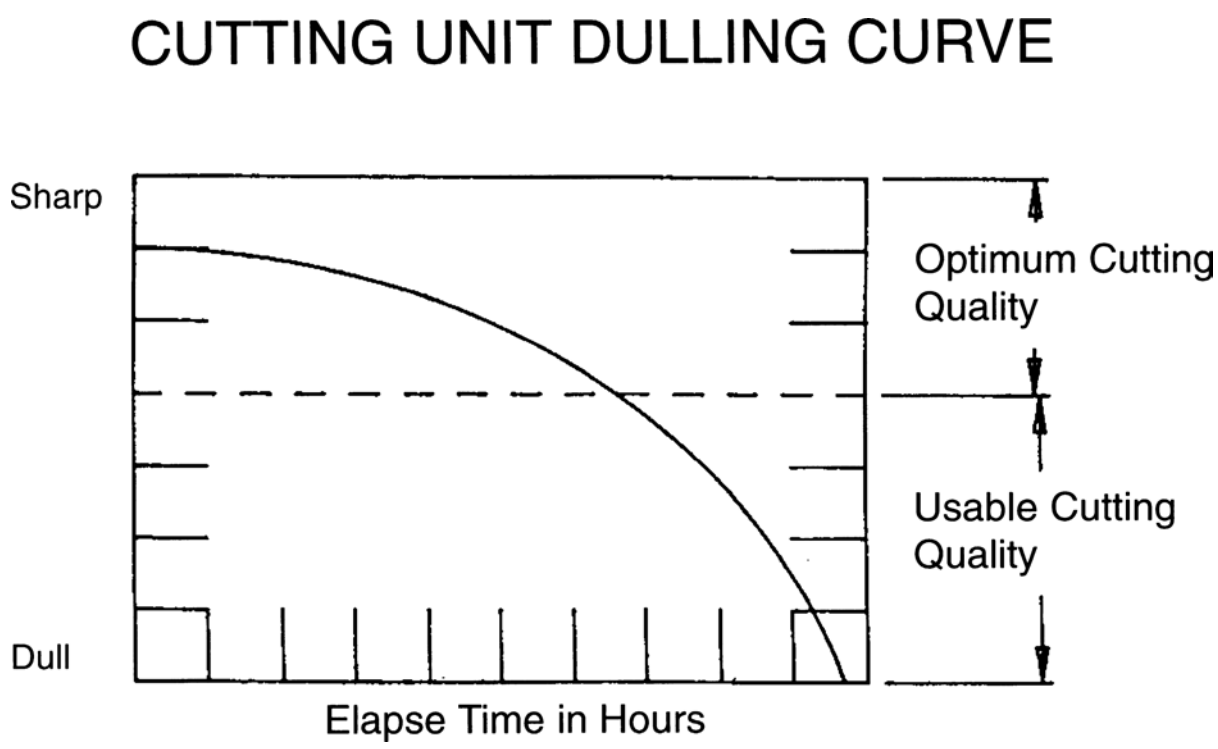


The effective height of cut or "true height of cut" is the actual height of the grass plant after it has been cut. This method takes into account the many factors that affect height of cut (HOC), such as;

1. Soil conditions
   -Wet or soft, resulting in the rollers sinking in to some degree
   -Dry or hard, rollers do NOT sink into the ground.
2. Grass and Environment Conditions
   - Thick or Lush, rollers will ride up on the grass raising the HOC.
   - Weak, limp grass in early spring or late fall (or poor sunshine).
   - Thatch causing rollers to ride up raising the HOC.
3. Surface contact of the rollers
   - Smooth rollers have more surface area and will ride higher in the grass raising the HOC.
   - Grooved rollers have less surface (support) area and will sink lower in the grass lowering the HOC.
4. Weight of the reel AND ATTACHMENTS
   - The heavier the reel, the more the rollers will sink into the grass effectively lowering the HOC. A "rule of thumb" is for every 10 additional pounds, the reel will "sink" into the ground .005".

Cutting Unit Performance

THE DULLING PROCESS



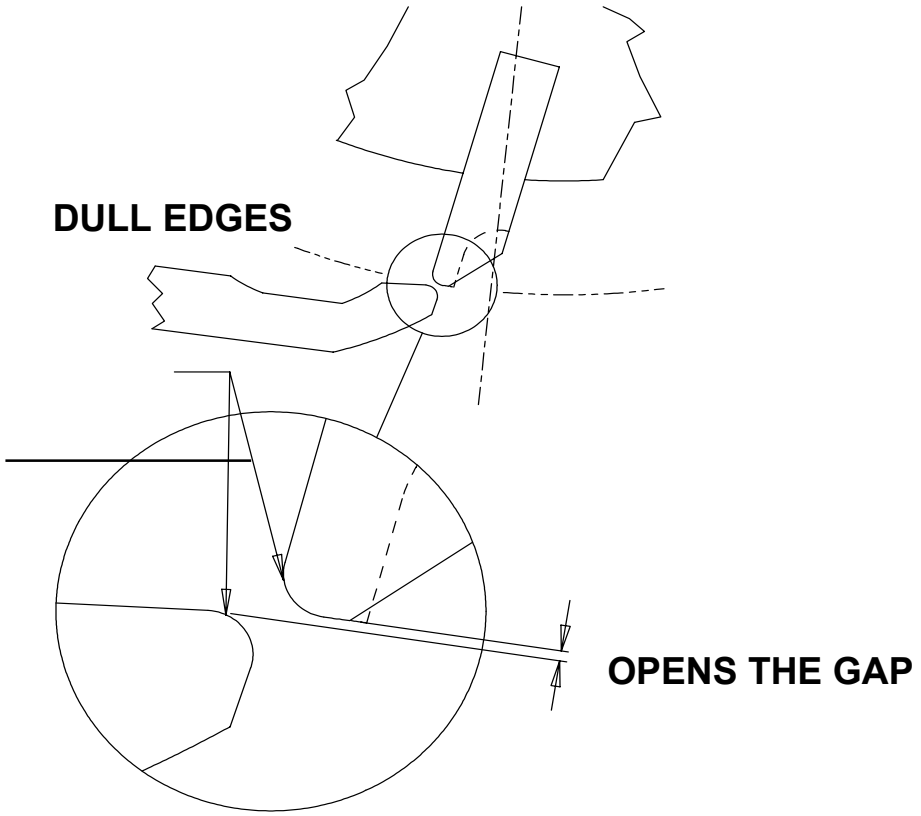
WITHOUT taking corrective action, this graph shows how the quality of the cut deteriorates over time. The cutting unit will become duller with time and this can be a primary reason for a poor quality of cut.

OTHER "QUALITY OF CUT" ISSUES:

"Cut quality" that may not be directly related to sharpness can depend on bedknife attitude, bedknife parallel to reel, cutting unit counterbalance or downpressure setting, and reel speed. Other factors that could effect cut quality could be damaged mower parts: ie. gouged or wavy bedknife, nicked reel blade, broken welds or blade ends, bent bedknife ears, worn bearings, bent cutting unit frame, and loose attaching hardware (such as bedknife screws). Non-reel related issues such as mowing speed, tire pressure, and engine governed speed could effect cut quality as well.

MANY THINGS CONTRIBUTE TO THE DULLING PROCESS:

Sand
Chemicals
Rust from Moisture
Dirt
Foreign Objects
Grass itself is abrasive



A microscopic review of the reel and bedknife reveals that it takes only SIX to TEN HOURS of operation for a crisp sharp edge to begin to dull. This will result in a widening of the gap between the cutting edges.

When reels become dull, the leading sharp edge of the reel and bedknife become rounded. This is normal wear. The approximately 90 degree edges must be restored to once again deliver a good quality of cut.

CUTTING UNIT DULLING CURVE

Note that you want to take corrective action prior to dropping out of the "OPTIMUM CUTTING QUALITY" range.

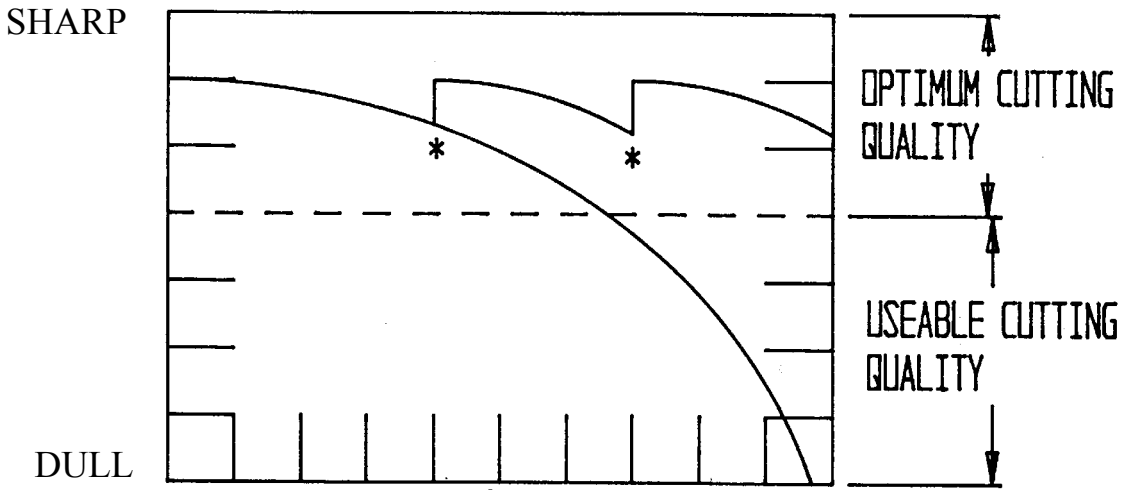


Chart from Toro Publication

THREE WAYS TO RETAIN A BETTER QUALITY OF CUT:

- **ADJUSTMENT**
- **BACKLAPPING**
- **GRINDING**

***There areappropriate times to perform each of these maintenance practices to optimize cut quality, and maximize cutting unit efficiency.**

This graph shows how the quality of cut deteriorates over time IF NO corrective action is taken. Note that the reel sharpness has fallen below the “optimum cutting quality”. The reel may still be cutting to some degree, but the quality of cut is poor.

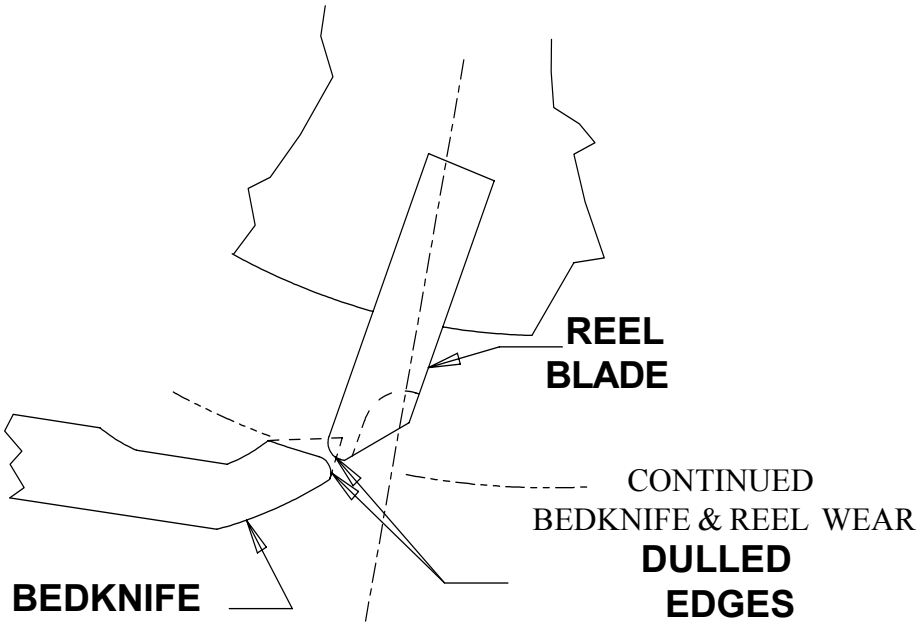
When having a “Grind only” program with no relief, more likely then not, the cutting unit is in the dull area longer before the edge is restored. This is because the only way to “maintain” this edge is to grind. Thus limiting a technicians options. Also effecting the quality of cut.

REEL
BLADE

BEDKNIFE

BEDKNIFE
WEAR

DULLING PROCESS

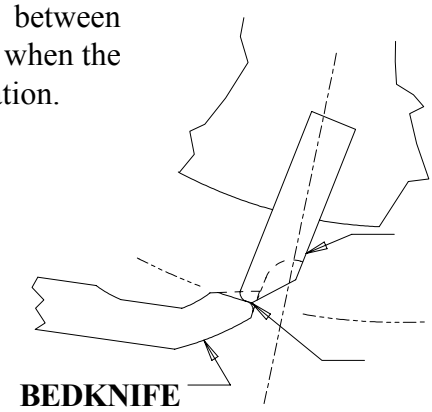


These diagrams illustrate what happens when blades and bedknives begin to dull. As the bedknife and reel blades wear, the rounded edges will not cut the grass as cleanly, causing more damage and stress to the plant structure. When the reel is adjusted, these two parts are brought closer together and a better cut will occur.

REEL DESIGN AND THE ADJUSTMENT PROCESS

REMEMBER - The bench setting clearance between the reel and bedknife may be different than when the cutting units are on the ground and in operation.

There are two causes for this:



1) When the cutting units are dropped on the turf, the ground can push the bedknife up, closing the gap between the two parts. An example of seeing how the ground pressure can play a role in your gap is demonstrated by setting the reel with a slight gap on the bench. By simply pushing on the bedknife with your hand, you can produce contact. This is more critical at lower heights of cut where ground pressure has a greater impact on the bedknife.

2) Metal expands when heated up, so as the reel rotates, the increased friction that is generated between the reel and bedknife could play a role in closing this gap as well.

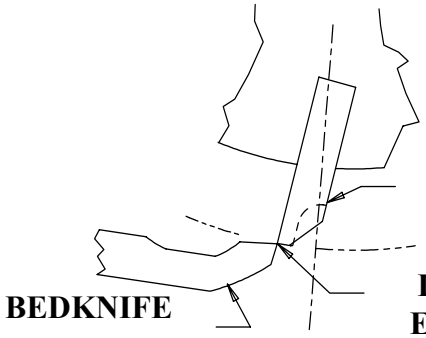
CUTTING UNIT EFFICIENCY

The OEM specification for cutting unit design includes a "relief" in the reel blade. **WHETHER MAKING CONTACT OR NOT**, this design reduces the surface area when the two cutting parts are brought closer together from adjusting, and it will:

- **Reduce friction when in operation.**
- **Reduce the stress on the hydraulic system and minimize the potential for premature hydraulic problems.**
- **Minimize the stress on the engine, and will**
- **maximize the horsepower for the traction unit. This can be important on hilly terrain.**

ADJUSTMENT METHODS

Some manufacturers prefer a clearance for setting the reels and specify between .001" and .003". This clearance is normally determined two ways; one by using a feeler gauge, and the other is by using newspaper.



When using the feeler gauge, start your adjustment on the leading edge of the reel where there is a slight drag on the gauge between the reel blade and bedknife. Alternate sides on the outer ends of the reel until the adjustment clearance is equal on both sides. The end result should be equal clearance along the entire length of the reel. Do not spin the reel while making the gauge checks and make your checks along the same reel blade.

If using the newspaper method, first check the clearance by inserting it in the reel parallel to the top surface of the bedknife. Slowly rotate the blade so it passes over the top of the paper. If the reel has been set correctly, the paper will be pinched and will show a heavy crease mark. If the paper is cut, the reel is set too tight and could result in significant wear to the reel and bedknife. If no mark is made on the paper, the clearance is too large and will result in a much quicker dulling process. Another common practice of using newspaper is to use two pieces; one will be folded while the other is cut, which will provide a desired gap.

OTHER ADJUSTMENT METHODS

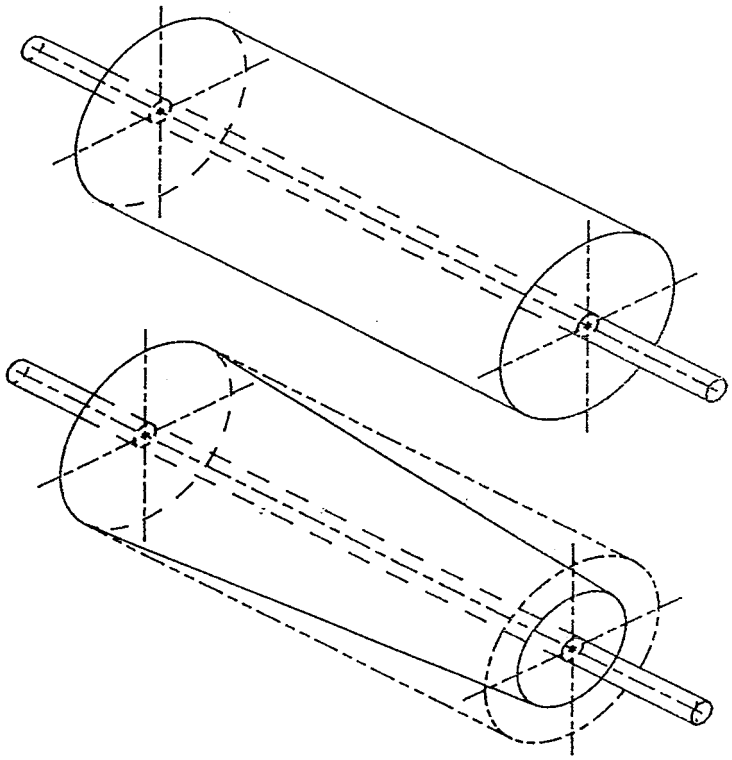
There are manufacturers that recommend "light" contact when setting up the reel and a special note should be taken as to what constitutes contact. When a new or properly sharpened reel is put together, a gap can be set to cut paper with zero "noise" and no contact. After a period of time, it is possible to place a peice of paper between the reel and bedknife as described on the previous page and have a gap, but when rotating the reel there is a contact noise, or whisper. The wear process that occurs over time illustrates that you can effectively cut grass with a +.002/-.001 tolerance along the entire cutting length of the reel. With such minute variation across a long width from the wear process, the "contact" or "noise" that is produced will result from these tolerances, even if there is an apparent gap during set-up.

If making light metal to metal contact during operation, the reliefed area of the reel blades minimize the amount of metal contact between the reel and the bedknife. As these two cutting parts rub together, the metal removal that occurs through the light contact is greatly reduced and will play a role in maintaining a sharper, more square cutting edge. This will allow the adjustment process to be more effective for a longer period of time.

Regular adjustments will continue with wear on the reel and bedknife until more effective action must be taken. When paper can't be cut cleanly with the desired set-up clearance, backlapping or grinding must occur.

*****FOR PROPER ADJUSTMENT CLEARANCE, PLEASE REFER TO YOUR OEM GUIDELINES***

ADJUSTMENT & OPERATIONAL WEAR



Even reels that are not improperly or over-adjusted, can start to lose their cylindrical shapes and become coned. Typically, the leading edge of the reel blade that enters the grass first takes more abuse and is prone to more wear than the trailing edge.

As the "relief" portion of the reel blade deminishes through the season and more surface of the reel blade passes the over the ever increasing bedknife surface, the adjustments may accentuate inaccurate wear patterns. In addition to an uneven cut, this phenomena can cause excessive wear on the bedknives, faster wear on all bearings, and it will increase the consumption of fuel.

All reels eventually become tapered with use. If the reel is not adjusted or ground to a cylinder shape again, a mismatch in the height of cut between adjacent reels can result.

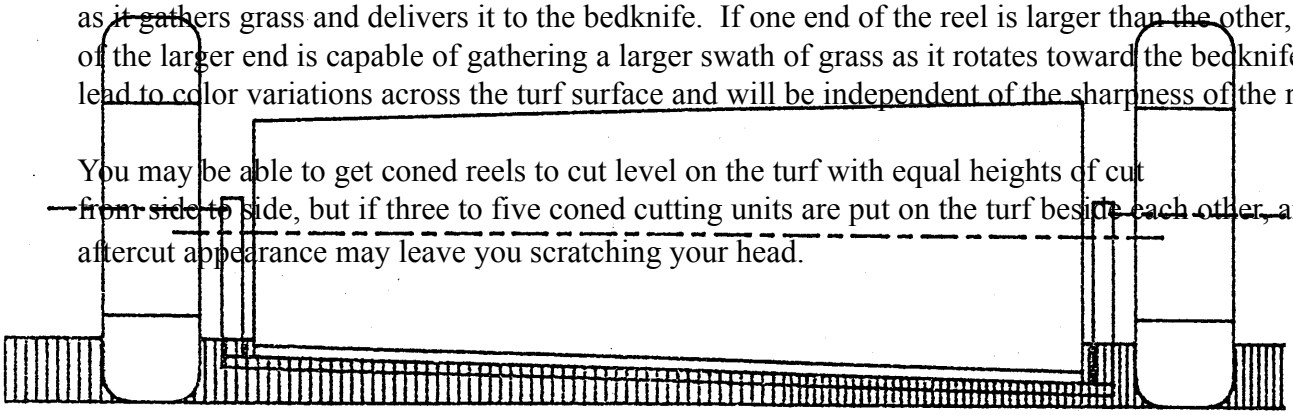
Excerpt from a Toro Publication

AFTERCUT APPEARANCE AND A TAPERED REEL

Care must be taken if twisting the bedknife or adjusting rollers to compensate for a tapered reel. This may not only generate undue stress on the bedknife, bearings, and the frame, but can alter the "Aftercut Appearance" of the turf.

This picture illustrates what happens when a reel becomes cone shaped. Notice how the left side is not even with the right side. This can be a primary cause of an uneven cut. 010 of an inch difference in set-up with your reels - either in height from end to end, or from one cutting unit to another can be a visible mismatch on putting greens. .

The aftercut appearance can potentially be effected by the "blade path", which is the path that the blade takes as it gathers grass and delivers it to the bedknife. If one end of the reel is larger than the other, the reel blade of the larger end is capable of gathering a larger swath of grass as it rotates toward the bedknife. This can lead to color variations across the turf surface and will be independent of the sharpness of the reel.



You may be able to get coned reels to cut level on the turf with equal heights of cut from side to side, but if three to five coned cutting units are put on the turf beside each other, an inconsistent aftercut appearance may leave you scratching your head.

BACKLAPPING

- It is recommended that backlapping be done on a regular schedule. It is more of a preventive maintenance procedure as you attempt to maintain high quality of cut standards.

- While backlapping will hone the edge, it should never be used to sharpen extremely dull or out of shape reels.

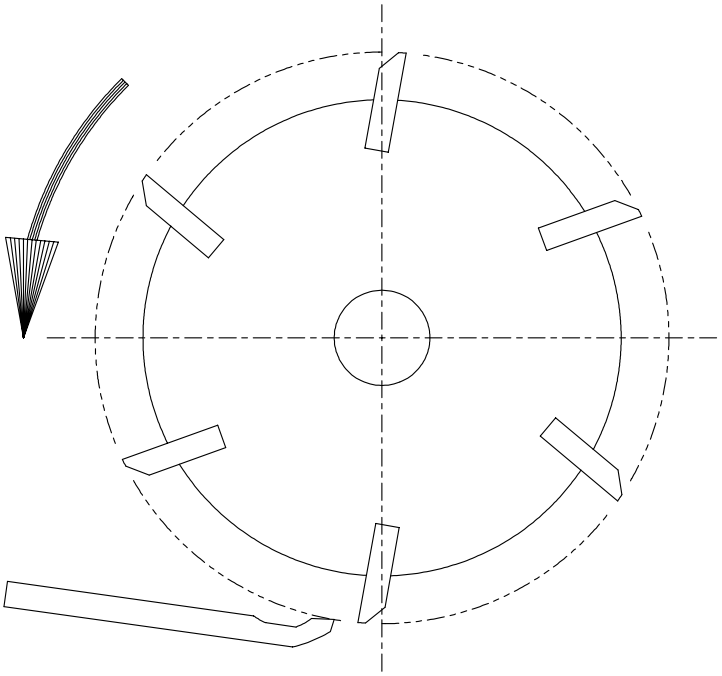
OEM Technology

Most traction units are now manufactured with a backlapping mode on the machine. This allows for the capability to backlap and maintain the cutting units while they are still attached to the tractor.

If it takes more than 5 minutes to backlap your reels, you will most likely need to grind the cutting units because:

1) **The edges have rounded off severely enough where lapping will be ineffective in generating an edge.**

2) **The OEM "relief" on the reel blades is deminished and lapping is not a viable option.**



BACKLAPPING

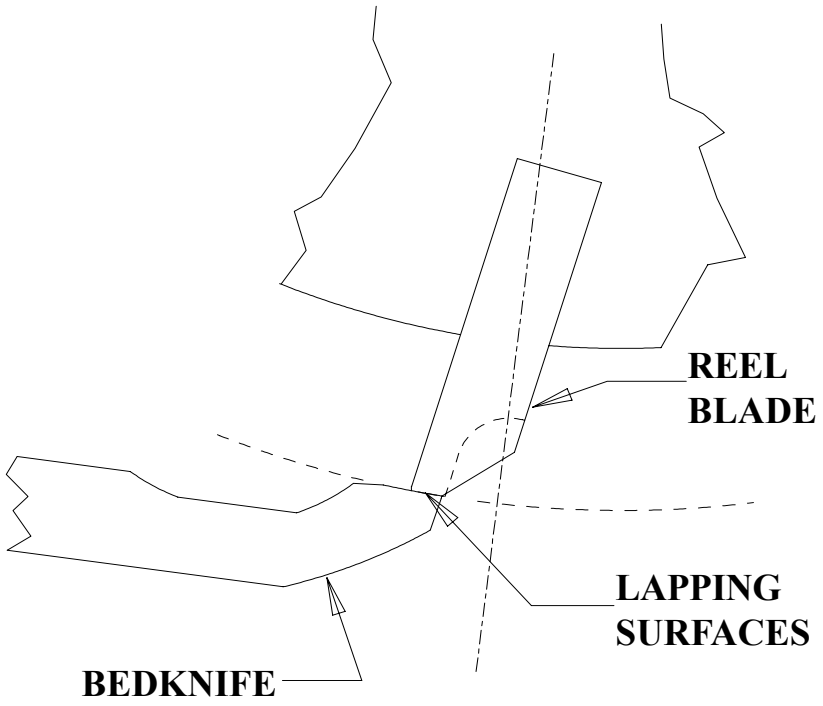
Backlapping is a method of removing metal by reversing the direction of the reel, adjusting it until light metal contact is made, and applying lapping compound. Lapping can bring back sharpness to a cutting edge and is demonstrated by the diagram on the opposite page. The entire top of the bedknife that lies in the blade path, and the width of the reel blade are lapped, as edges are brought back to square.

Reasons for Backlapping:

1. Maintain a sharp leading edge.
2. Honing the cutting surface.
3. After grinding to remove the burr.
4. Grooved or serrated edge smoothing.

ALWAYS RINSE OFF THE RESIDUAL COMPOUND AFTER BACKLAPPING, AS IT MAY HAVE A NEGATIVE IMPACT ON THE CUTTING EDGES WHEN THE REEL IS ROTATED IN THE FORWARD DIRECTION.

BACKLAPPING



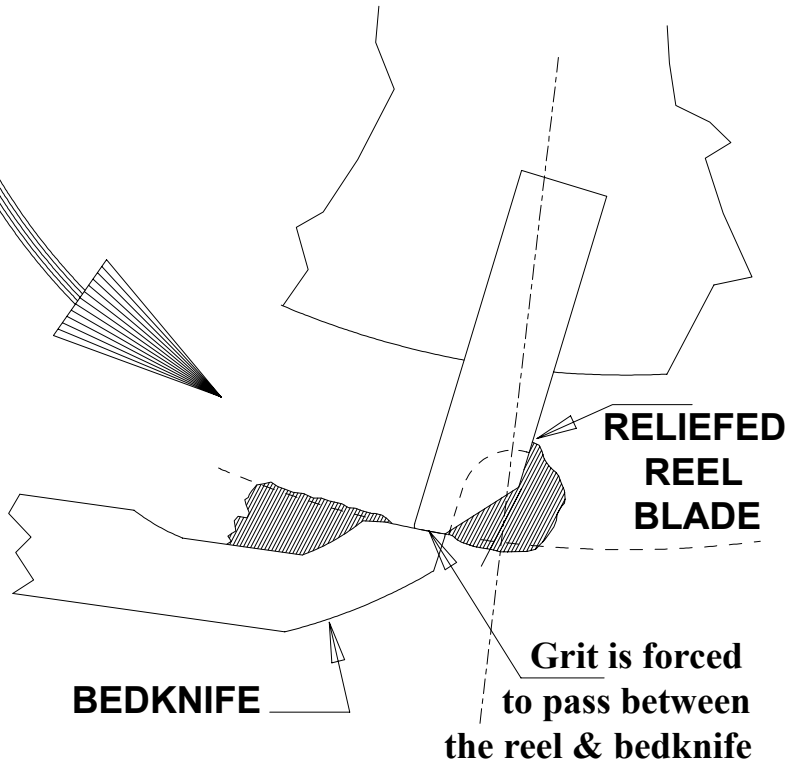
While there is speculation over the effectiveness of backlapping, an understanding of what you are attempting to accomplish must exist. There are many factors that will dictate whether this is a feasible maintenance practice at various golf courses, but ifutilized asintended, backlapping can be a great alternative to pulling reels off of a traction unit and having to go through the effort to grind much more regularly.

The objective of a backlapping schedule is to keep the edges at an optimum, while avoiding the potential for dulling to increase to a level where grinding must occur. For this reason, backlapping modes have been put on most hydraulically driven cutting units (or is an option) and if used in a timely manner, two minutes lap time per reel should be all that is required. As the reel wears, this lap time will increase due to more surface metal needing to be removed.

To effectively produce an even finish and to minimize the lap time as described above, the operator needs to stay with each reel for the two minute time span, and continuously redistribute the compound to prevent the abrasive material from building up in one particular area. If this type of practice is followed, the process is fast and effective. If this type of lapping practice is not followed, the process has potential to cause excessive wear in certain areas of the knife, and can actually have a negative impact on the performance of the cutting units.

REEL DESIGN AND THE BACKLAPPING PROCESS

WITHOUT RELIEF ON THE REEL BLADES, BACKLAPPING IS NOT A REASONABLE OPTION.



Reason: The relief area on the reel blade provides a landing area for the lapping compound to adhere to. This enables the grit to be suspended on the reliefed area and is pushed between the reel and bedknife, thus effectively removing metal. On a flat ground or worn reel, there is so much surface area and metal to remove on the reel blade that it makes the lapping process ineffective and time consuming.

The image above illustrates how the lapping process works. First, the cutting unit is adjusted to make metal contact. The applied lapping compound clings to the relief area of the reel blade. As the reel turns, the lapping compound is forced between the top of the bedknife and the bottom of the reel blade. The grit in the compound then rubs the metal off both parts similar to emery cloth or sandpaper. Remember, lapping only hones the edges and should never be used as a replacement for grinding. The most amount of metal that can be expected to be removed using 80 grit lapping compound is probably less then .005.

The thinner the lapping surface area of the reel blade, the less time it will take to backlap.

REEL GRINDING
(RESHAPING THE REEL)

THERE ARE THREE PRIMARY OBJECTIVES WHEN MAKING THE EFFORT AND TAKING THE TIME TO GRIND YOUR CUTTING UNITS:

- **Grind to PRODUCE A SHARP EDGE.**
- **Grind to REMOVE "TAPER" that has developed through use.**
- **Grind the SPECIFIED "RELIEF" as originally designed from the OEM.**

These three objectives for reel grinding can bring your reel back to "OEM - Factory New" condition.

When Is It Time To Grind

Reel grinding should be done when the adjustment and backlapping procedures are no longer effective, and the grass is not cut cleanly. By checking the cutting edges of the reel blades and bedknife, you can visibly see if the relief is gone, and you can physically inspect them to see how rounded off and dulled the edges are. There are some "general" time frames that can be estimated for grind intervals and they are as follows:

- √ **8" - 10" Diameter ROUGH MOWER reels:**

  Should be backlapped "as needed"; if estimated use totals 15-20 hours of cutting per week, this will yield a need to grind approximately every 400-500 hours, or once every six to eight months.

- √ **5" - 7" Diameter FAIRWAY & TRIM MOWER reels:**

  Should be backlapped "as needed"; if estimated use totals 20-30 hours of cutting per week, this will yield a need to grind approximately every 375-425 hours, or once every four to six months.

- √ **5" Diameter GREENS & TEE MOWER reels:**

  Should be backlapped "as needed"; if estimated use is five to seven times per week, averaging 15-25 hours of cutting time, this will yield a need to grind approximately every 200-250 hours, or once every three to four months.

The grind intervals noted above are strictly estimates. The need to grind will depend on course conditions, top-dressing practices, adjustment and backlapping practices, and ultimately, the judgement of desired cut quality.

INSPECTION OF THE REEL

Prior to grinding a reel, the mowing unit must be prepared. This preparation is very important and should be performed when using "Manual" single blade grinders or "Spin" grinders.

ALWAYS INSPECT:

- REEL BEARINGS - They must be in good condition and properly adjusted to assure that the reel assembly spins true to the reel axis. There should be zero end-play, and no movement up and down with the reel. Most OEM's have a spec for bearing re-load, which is the amount of force it takes to turn the reel.
- ROLLER BEARINGS - Front and Rear rollers must be checked, because movement of the reel while grinding will have an effect on the quality of the grind. In the field, the condition of the rollers will effect the overall performance of the cutting nit.
- GEAR CASE SEALS - Replace if applicable.

ALWAYS DO:

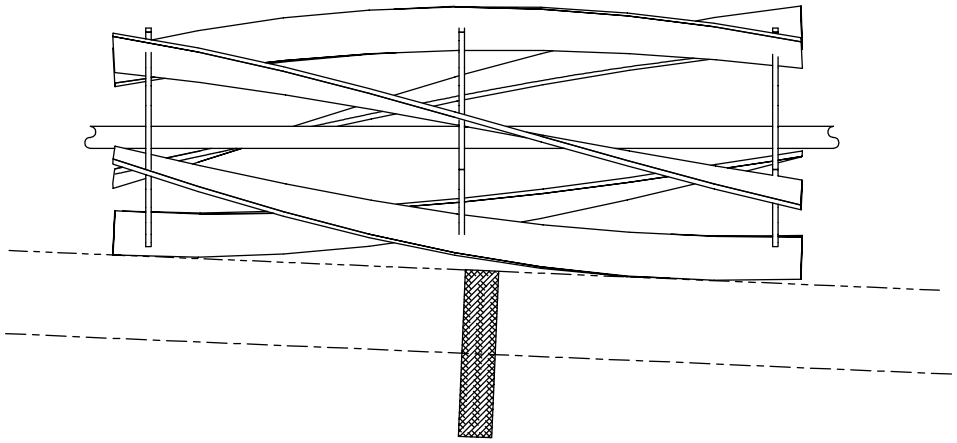
- Thoroughly clean the reel, removing grass and debris off the blade and bearing area.
- Verify that the reel spins freely in the frame with no "sticking" spots.
- Inspect the reel for bent and broken blades. When trying to straighten out severly bent blades, avoid having to heat the blades if possible. Be careful that the blades do not crack, and/or pull away from the weld in the spiders.
- Inspect for sprung or twisted frame.

Reels should be ground in-frame and go through the inspection listed above. This not only minimizes the effort needed to prep the reel for grinding, but the reel winds up being ground in the same bearing position within the frame as it will be when in operation.

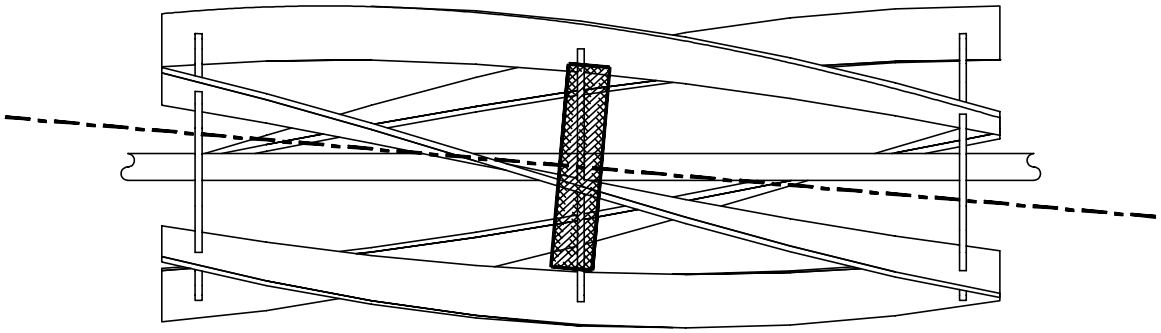
GRINDER TO REEL ALIGNMENT

Quality Control - Removing Taper in Reels

To CYLINDRICALLY grind the reel, the reel must be accurately aligned in both a horizontal and vertical plane.

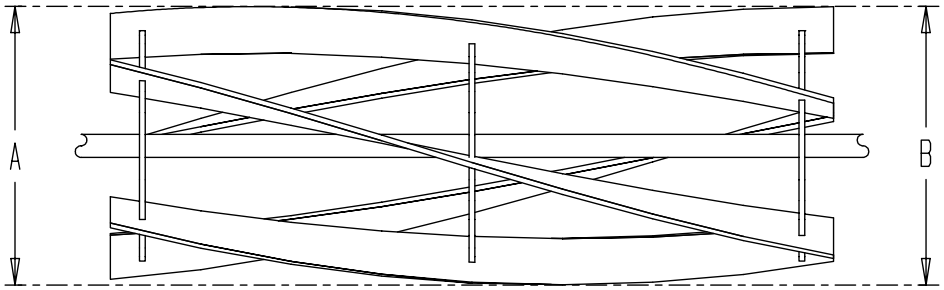


Horizontal Alignment

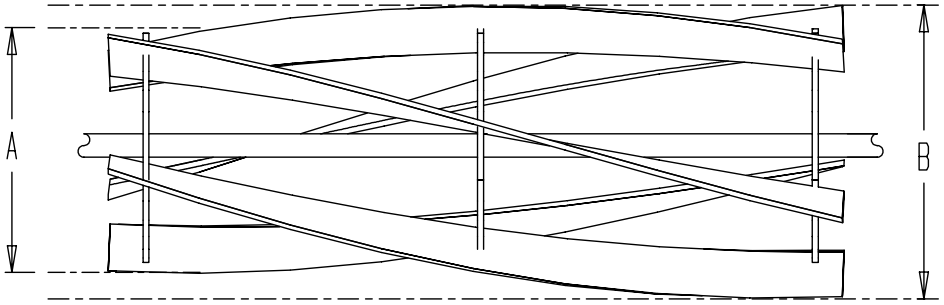


Vertical Alignment

On some reels, the window of adjustment allowing for taper is very small. Taking time to properly grind a cylinder will minmize the potential for adjustment, quality of cut, or aftercut appearance issues.



If diameters A and B are equal, the reel is **cylindrical**.



If diameters A and B are not equal, the reel is **conical.**

NOTE: Always correct a conical shaped reel by grinding

These diagrams illustrate how most reels become cone shaped after they are used for a season. Due to the helical shape of the reel blade, natural abrasion, and reel adjustment, cone shaping occurs. In order for this problem to be corrected, the center shaft of the reel must be aligned, so that it is parallel to the grinding wheel. If this is not done, the chances of taking the cone shape out of a reel are highly improbable.

TWO KEY ELEMENTS PRIOR TO GRINDING

- **Reel prep work assuring quality condition of bearings, etc. as specified under "Always Check" & "Always Do"**
- **Proper Alignment that will allow for an OEM "cylindrical" grind**

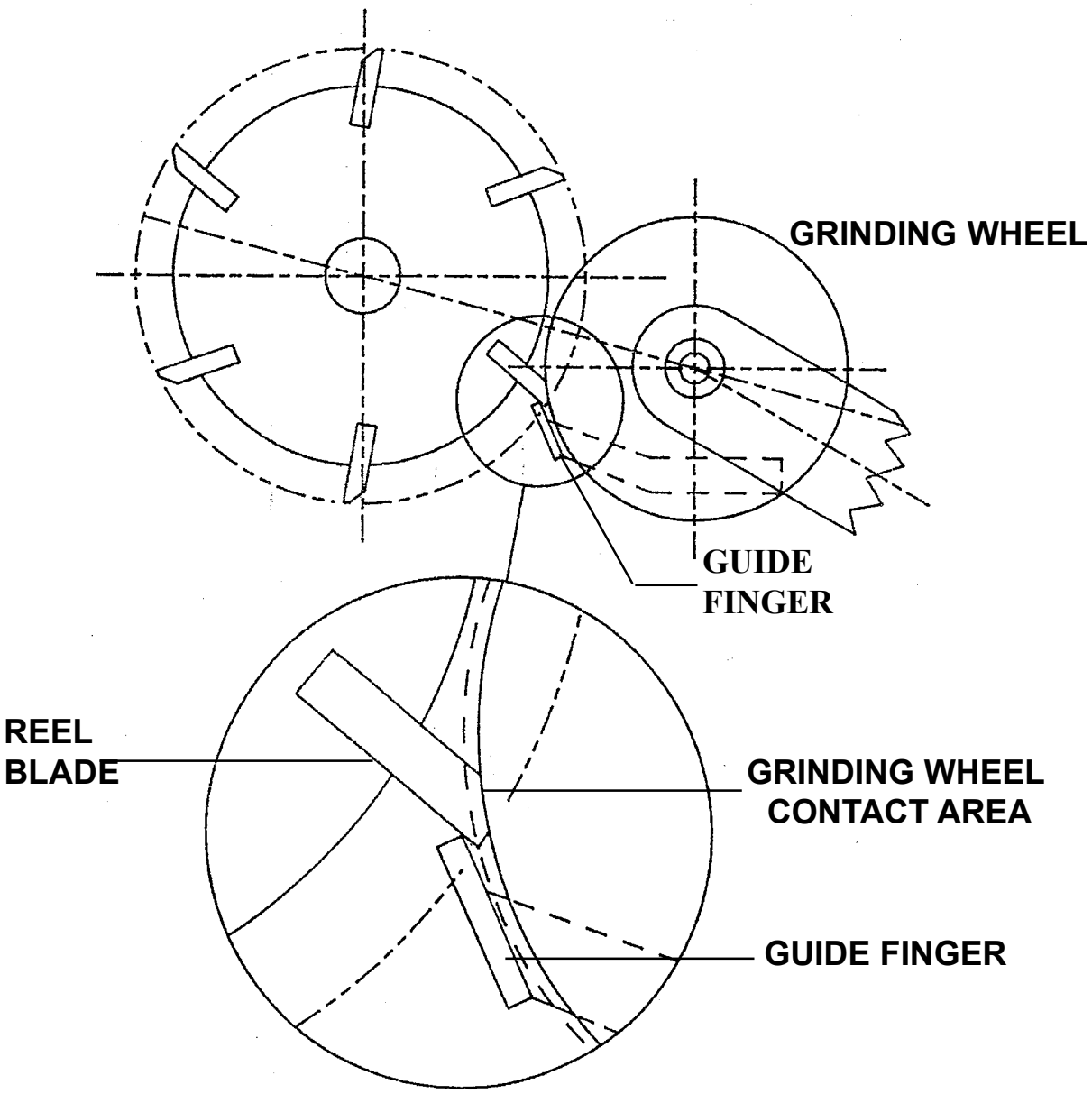
THREE FORMS OF GRINDING

SINGLE BLADE GRINDING– Grinds one blade at a time to a sharp edge, and usually requires backlapping to put all blades on the same cutting circle.

SPIN GRINDING– Rotates the reel while producing a sharp adge, and puts all blades on the same cutting circle.

RELIEF GRINDING– The secondary grind process for spin grinding, and depending on the operators single blade grinding process, it will be the secondary grind process as well.

SINGLE BLADE GRINDING



These pictures demonstrate how a reel is set up on a single blade grinder to achieve the desired angle on the edge of the blade. On single blade grinding the grinding wheel turns, the reel does not turn. Each reel blade is ground separately.

NOTE: By raising the grinding head position, you will get less of a relief angle, and by lowering the head, you will get more of a relief angle. Adjusting the grinder stone position up or down will allow the operator to match the OEM "relief" specification.

20 -30

Figure1

approx.
25 %

Figure 2

Figure 3

Figure 4

These pictures show various angles that can be put on the end of the reel blade.

Figure 1: Shows the normal angle ground on a single blade grinder - it is called a "Full Relief" angle.

Figure 2: Shows the preferred edge found on most new equipment. It also shows an average "Relief" grind.

Figure 3: Shows what a blade would normally looks like after a season of wear.

Figure 4: Shows a flat grind or what a blade looks like after is has been spun ground.

An optional method of grinding which requires a **much higher skill** level is to make the initial grind a near flat grind which has an approximately 3-5 degrees back relief angle as shown in figure 5.

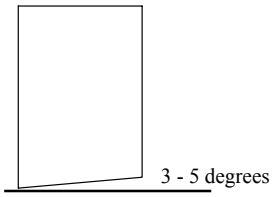


Figure 5

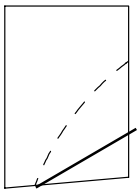


Figure 6

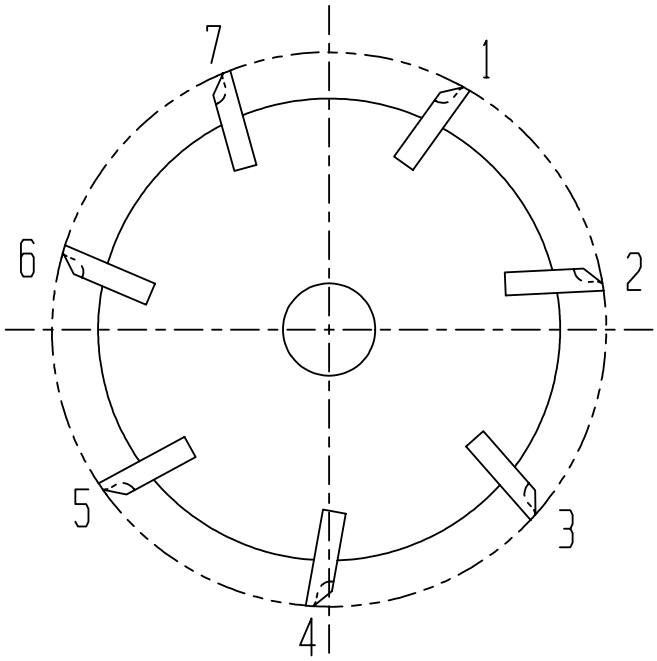
Care must be taken to ensure that the initial relief grind is toward the back edge of the blade, and not toward the front cutting edge. This would yield a reel that will not cut.

It is very important to a quality grind that a staggered grinding method is used to achieve a uniform blade height.

SINGLE BLADE GRINDING

PROCESS: Grind across blade # 1. The grinding should be done with light to moderate cuts as heavy grinding pressure will result in excessive heating of the blades. Also, the carriage should be traversed manually in **smooth** and **uniform speed** passes across the blade and without stopping. Hold the reel to the guide finger with your left hand and pull the grinding head assembly with your right hand. As soon as the grinding wheel contacts the reel, remove your left hand. The guide finger will keep the blade in place as the grinding head assembly is traversed across the reel. When it reaches the left side of the reel, the reel blade comes fully off the grinding wheel and partially off the guide finger. The reel blade will automatically pick up the same blade on the return stroke. The blade will be held to the finger in both directions by the rotation of the grinding wheel driving the blade downward against the finger. When you reach the right end of the blade, let the carriage come off the blade and gently against the travel stop.

Next, manually rotate the blade #2 and grind blade #2 and continue to grind all of the blades without changing the grinding wheel setting. If you have brought all of the blades to a sharp edge, advance the grinding wheel slightly and regrind the blades, in reverse order -- starting with the highest blade number and going down. Example: #5 then 4, 3, 2, 1. The reason for this is to get a better finish and to compensate for grinding wheel wear on the original grind. If the blade is not ground to a sharp edge, adjust the horizontal infeed wheel and grind another cycle. Grind the blades 2-3-4-5-1 as an example on the second cycle. Listed are two optional methods to stagger reel blades during grinding. The reel must be ground until you achieve a sharp edge. Again, always reverse order with a slight infeed after achieving a final sharp edge.



GRINDING SEQUENCE

1 3 5 7 2 4 6

2 4 6 1 3 5 7

3 5 7 2 4 6 1

OR

1 2 3 4 5 6 7

2 3 4 5 6 7 1

3 4 5 6 7 1 2

SPIN GRINDING

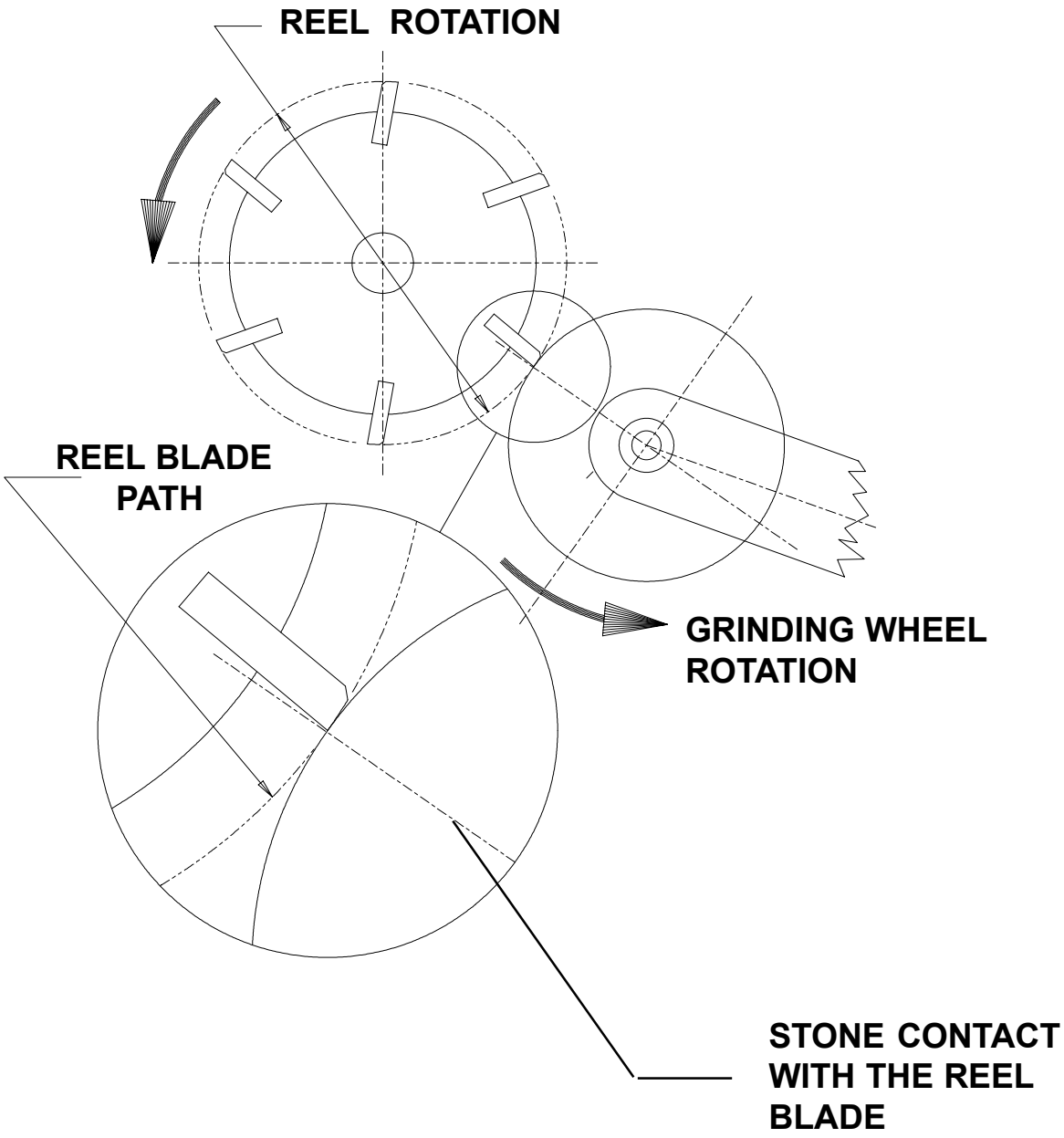
Spin Grinding Accomplishes Two Things:

- √ **Sharpens the front leading edge**
- √ **Brings all the reel blades on the same cutting circle**

While spin grinding serves the purpose of generating a sharp edge, it is only 1/3 of the formula in re-shaping the reel to the optimum OEM design. Some general statements which apply to spin grinding are:

1. Always travel off the reel and then come back onto the reel to change directions. Reversing direction while the stone is still on the reel will remove more material on the ends during the delay, making for a non-uniform grind.
2. Spin grinding puts all reel blades on the same cutting circle. Unless properly aligned, spin grinding DOES NOT ensure trueing the reel to a cylindrical shape.
3. Microscopically speaking, the outside diameter of each blade is an arc. The deviation is so small that it will never be seen by the naked eye and the backside deviation will be greater than what exist toward the front leading edge. This phenomenon results from the back edge of the reel contacting the stone first, and as the reel rotates, the stone is forced down. With the completion of rotation, the stone "up" pressure will generate deviation on the front edge as the front edge comes off the stone. A rigid stone will provide less deviation than a non-rigid stone.

A non-rigid (or spring loaded) stone will result in a maximum "relief" of .004" (or 1.2 degrees) from the front cutting edge of the reel to the back on a thick blade, and .0025" (or 1.7 degrees) on a milled blade. This "relief" deviation will diminish very quickly as the caustic and abrasive cutting action of the grass takes place.



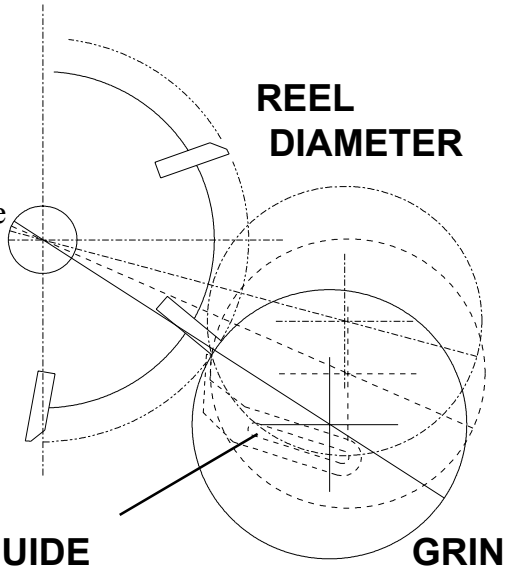
This picture shows how the edge of a reel blade is ground on spin grinders to achieve a sharp edge. Note that both the reel and the grinding wheel rotate in the same direction, causing opposite directional contact at the grind point. This will yield a better grind performance in producing a sharp edge.

SPIN SPEED **:** SPIN SPEED is determined by the diameter of the reel and the number of reel blades. There is an OPTIMUM "spin speed" for every reel where the operator can aggressively grind - yet get a smooth grind.

"RELIEF" GRINDING ON A SPIN GRINDER

RELIEF GRINDING ON AN "UPRIGHT" STYLE SPIN GRINDER

This picture illustrates that the grinding stone feeds from the front of the grinder . By doing something as simple as positioning a grinding wheel at different heights with a relief finger, you can relief grind the back edge of a reel blade. Lowering the grinding head allows the reel blade to drop deeper between the stone and the finger - providing a steeper relief angle. Fore LESS relief angle, raising the grinding head will kick the blade to a flatter position as it rests between the stone and the finger.

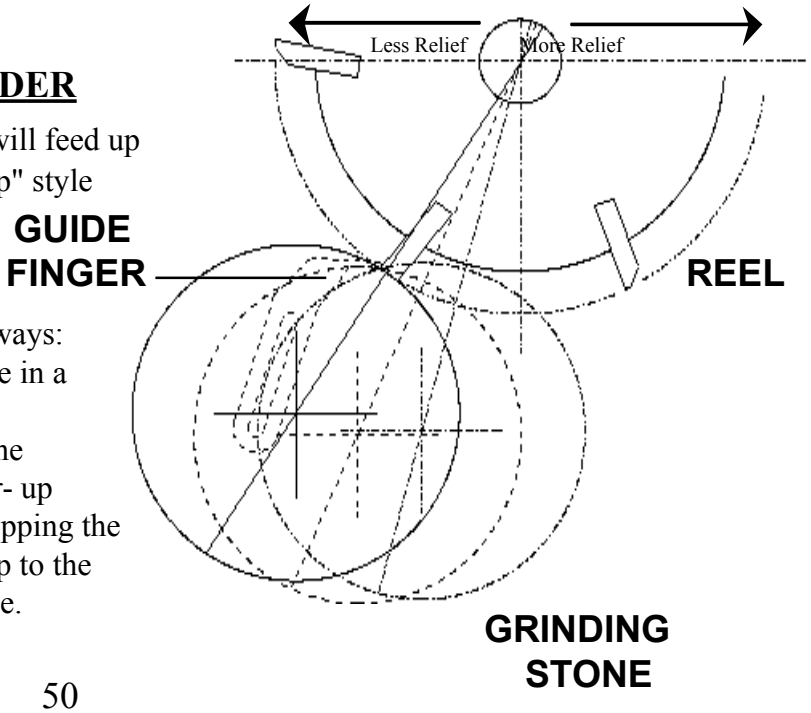


GENERAL RULES : Whether you are using an "Upright" or "Tabletop" spin grinder, always:

1) Check your relief angle
2) Check for stone clearance with front roller
3) Check stone clearance with the blade above the one you are reliefing
4) Check stone and finger clearance with the side frame of the reel
5) Spin grind first to remove taper

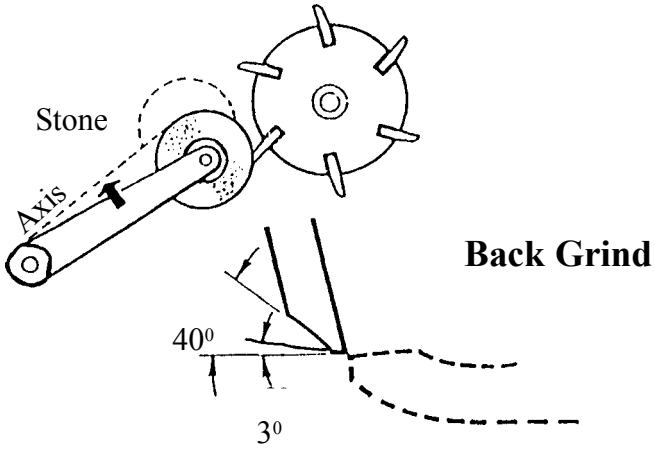
RELIEF GRINDING ON A "TABLETOP" STYLE SPIN GRINDER

This picture illustrates that the grinding head will feed up from the bottom part of the table on a "tabletop" style reel grinder.



The relief angle can be changed one of two ways:

1) Re-positioning the reel on the machine in a horizontal plane.
2) Re-positioning the guide finger near the grinding stone: Moving it to rest higher- up over the stone gives less angle; OR dropping the finger to a lower position in relationship to the stone will provide a greater relief angle.

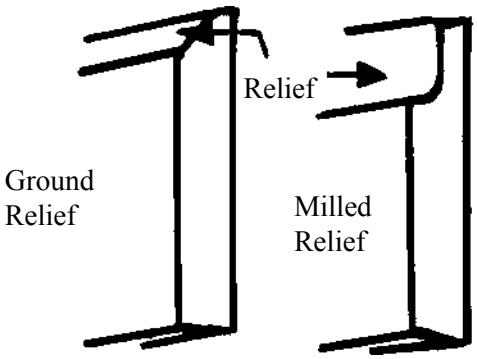


Back Grind

On thicker bladed reels, a back grind of approximately 40 degrees is necessary.

The reel will now be backlapped to match the bedknife.

Usually, when a reel has been sharpened using the individual blade or straight line grind method, it is necessary to backlap the reel. ***Excerpt from a Jacobsen Publication***



Different Types of Reel Blades

It is important to understand that Toro reel mowers are designed and manufactured to optimize available power from the engine and hydraulic systems. To help do this, we put a "relief" on every reel blade to reduce the width of reel blade that contacts the bedknife. This has been proven to reduce power requirements, as well as allow the machine to operate more efficiently. This can be very important, depending on the terrain, type of grass and amount of grass being cut.

We have two different methods of manufacturing reel blades with a "relief". The reel blades are made from straight stock steel and then are either relief ground or the relief is milled in. Either way, there is a relief on the blade when it is manufactured. ***Excerpt from a Toro Publication***

John Deere recommends Relief Grinding the reels before spin grinding for these reasons:

Reduced blade contact area, results in less friction, requiring less horsepower to drive the reel.
Ensures longer wear life.
Less time is required to backlap.
Reduces pulling and tearing of the grass as the unit gets dull by use.
Provides an area for backlapping compound to be trapped to more effectively backlap reels.
Relief grinding removes metal from the trailing edge of the blade forming an angle (Relief Angle) to reduce the contact area of the cutting edges.
Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is .001" to .002" too high. ***Excerpt from a John Deere Publication***

BEDKNIFE GRINDING

Every time you grind the reel, you SHOULD grind the bedknife. If you do not, the reel to bedknife clearance may vary from one end of the reel to the other, and thus could effect the "quality-of-cut".

TWO BEDKNIFE GRINDING OPTIONS:

1) *Regrind a used bedknife*
2) *Replace the bedknife and grind the new bedknife*

GRINDING A USED BEDKNIFE

PREPARATION FOR GRINDING A USED BEDKNIFE:

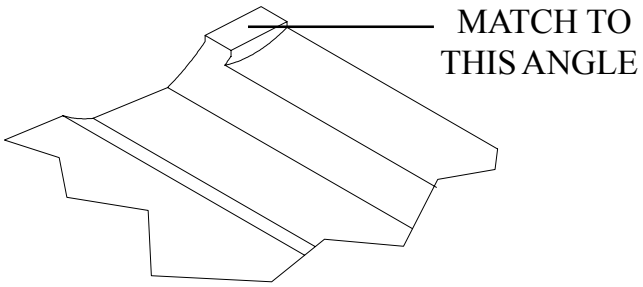
- Use a wire brush or power washer to thoroughly clean the bedknife/bedbar assembly. Do not use a hand held grinder.

- Inspect the bedknife/bedbar assembly to assure that it is straight and true by using a high quality straight edge. A warped bedbar will greatly reduce bedknife life.

- Establish the correct angles according to the OEM specification

The methods to do this are are:

Correct/Best Method - Establish the recommended angle from the bottom of the bedknife.
2nd Choice - Match old angle on end of bedknife. See illustration.
3rd Choice - Find worn surface, tip back 5 degrees and grind. This is the poorest method.



GRINDING A NEW BEDKNIFE

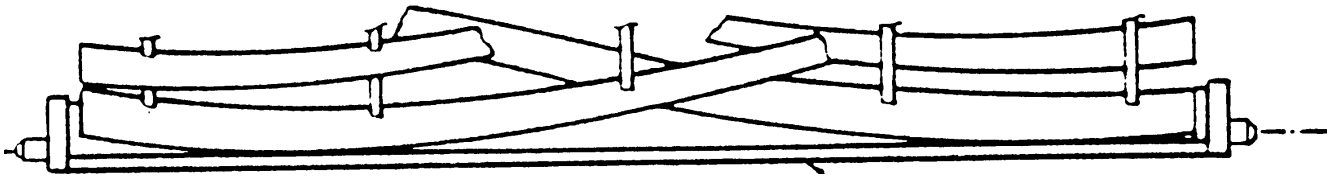
Replace the bedknife when it is worn to the point where it can no longer be reground with a correct relief on the top surface. All new bedknives should be ground because the torque of the bedknife mounting screws will distort the bedknife when put onto the bedbar.

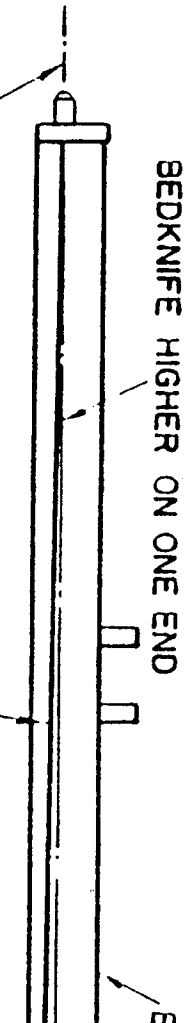
- Remove the old bedknife from the bedbar. Clean the bedbar with a wire brush and/or power washer. Do not use a hand held grinder.

- Inspect the bedbar for flatness and distortion with a high quality straight edge. If it has been damaged, replace it - OR - in some cases it is feasible to grind the bedbar surface straight and true.

- Install the new bedknife per mowing unit manufacturer's recommendation. This is normally done by inserting and tightening the bedbar screws from the center holes in the bedknife first, and working your way out toward the end. This will prevent the knife from "loading up" and possibly moving during use.

- Grind the top face only matching the angle on the new bedknife. Grind the minimum necessary to true the knife.





PARALLEL LINE
WITH MOUNTING
POINTS

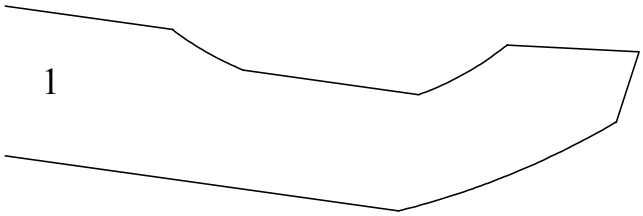
NOTE: CUTTING EDGE NOT PARALLEL
WITH MOUNTING POINTS

New bedknives that are installed on bedbars are not necessarily straight and parallel with the mounting points. They must be ground to assure the correct straightness and parallelism.

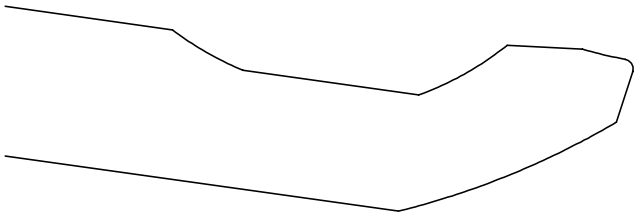
Manufacturers angles are determined by the flat bottom surface of the bedknife. If you grind according to the alignment of the bottom surface of the bedknife, you will be assured of straightness and parrallelism.

THE CONDITIONS OF BEDKNIVES ARE ILLUSTRATED BELOW

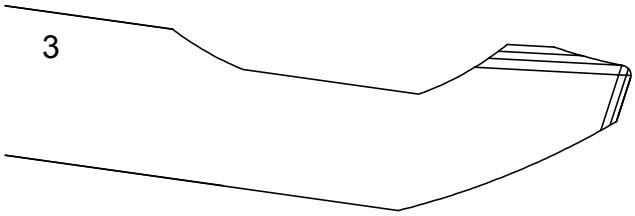
1) This top picture shows that a new knife has a sharp edge in which the "top" and "front" faces are ground at an angle.



2) This bedknife shows that the front edge begins to round and dull.



3) Note the diminished relief on the top surface. Bedknife life may be extended by grinding both the front face and top face on a used knife.



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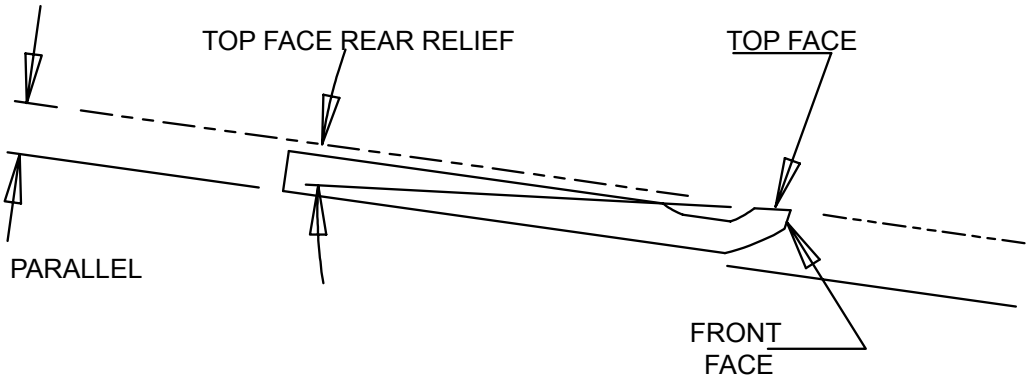


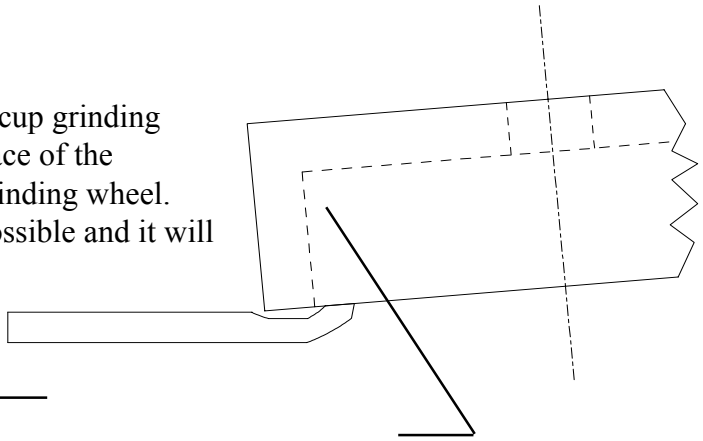
Note that the top face rear relief angle is based on the bottom of the bedknife. It is essential that when a bedknife is ground, either used or new, the OEM angles are replaced.

NEVER "OVER" RELIEF GRIND A BEDKNIFE AS IT WILL REDUCE IT'S LIFE EXPECTANCY SIGNIFICANTLY.

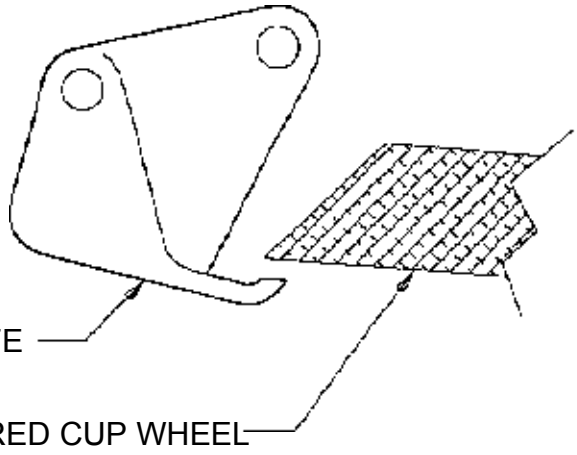
KEY ELEMENTS OF AN EFFECTIVE QUALITY BEDKNIFE GRIND:

* Control heat buildup so it never exceeds a comfortable touch. If your grinder does not have a flood coolant system, take a bucket of water and a rag (sponge,etc.), and rub the wet rag across the bedknife with each pass to keep it cool.
* Always pass off the ends of the bedknife for a uniform grind.
* Never remove an excessive amount of material with one in-feed of the grinding wheel. This could temper the metal of the bedknife.
* Sparking out will result in the most uniform grind possible.
* Remove the burr with a wood block.

This picture shows the position of a standard cup grinding wheel when in use. Note that the whole surface of the bedknife is covered by the back part of the grinding wheel. There may be some cases where this is not possible and it will be important to dress the grinding stone.



This picture shows that on some bedknives, a special flared cup wheel my be neccessary in order to avoid hitting the "ears", or casting portion of a bedbar.



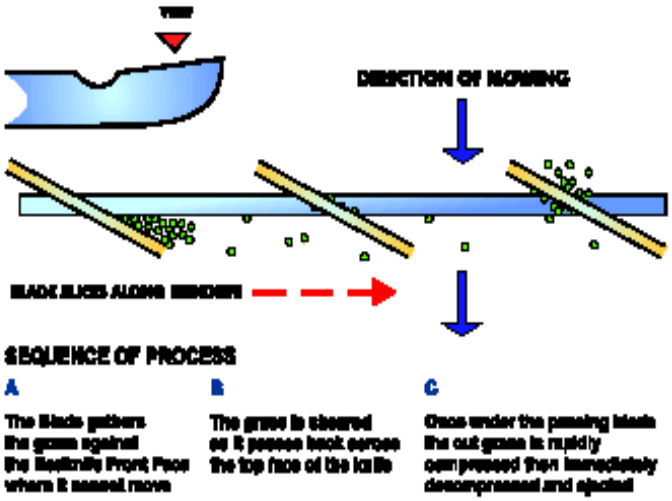
Dressing the grinding wheel is important to the quality of grind. A grinding wheel which is loaded will cause excessive heat build up and can cause an irregular grind. The best dressing method is a diamond dresser rigidly mounted in relation to the grinding wheel. Other methods which can be used are hand held diamond dressers and hand held dressing bricks. Hand held dressers are difficult to use and makes it more difficult to achieve an accurate wheel dressing.

Alternate Methods

So far we've dealt with the standard American Method of maintaining reels. There are alternatives. As technicians it is a good idea to at least be familiar with all the equipment you may be called upon to operate. Many of us don't have the option of what reel or bedknife grinder we may end up with through circumstances. If you move from a facility that spin grinds only to one that has a relief grinder, it's good to know how to use it, or at least the principles behind it. And Vice Versa.

The main alternate method of reel maintenance is to spin grind only and have no bedknife to reel contact. With relief, and contact, the reels cut like scissors. With no contact, the reels cut similar to a scapel. Have you ever cut yourself with scissors? With a sharp knife?

The difference between a scissors-cut and a scything action is important to understand. Scissors require two blades traveling in opposing directions, and will cut adequately if there is sufficient light contact along the length of the two blade edges. A scythe, as we have already determined, consists of a single cutting blade being drawn through the leaf tissue, damaging fewer cells in the process. Scissors will cut, but a scythe cuts better. This is precisely why a surgeon uses a single-blade scalpel (which is drawn through the flesh) instead of scissors.



THE REEL MOWING PROCESS–

Since horse-drawn reel mowers were replaced by the first gang mower tractor (introduced by Worthington Brothers on a tri-wheeled frame with a Ford Model T engine), modern mower manufacturers have continued to improve upon the original reel designs. Specialization according to task resulted in optimization of reel configuration (number of blades, reel size and diameter) for the specific turf conditions (density, turf height) in which it would operate. Interestingly, much of the original reel geometrypioneered by Budding and Atterton remains valid today.

The process involved in reel mowing is quite simple. As it rotates, the reel blade gathers the grass blades against the front face of the bedknife, which holds them in one straight plane and positions them for a uniform cut. This also controls the height of cut. The leaf tissue is sheared as the reel blade passes back across the top face of the bedknife. The cut material is compressed momentarily, then rapidly decompresses and ejected from the reel/ bedknife interface.

The helix of a reel cylinder is designed to cause the reel blades to act like a succession of razor blades passing along the bedknife with little or no contact, creating the horizontal scything action so critical to a clean cut of the leaf tissue. The flatter the helix angle of the reel blade, the higher the velocity with which the point of cut passes along the bedknife. Smaller diameter, many-bladed reels (such as in greensmower heads) tend to have the flatter helix, while larger diameter reels with fewer blades (such as a Blitzer unit, for example) will have the greatest helix or bend to them.

Taking a look at the geometry of the process, it becomes clear that several angles in the reel/ bedknife interface are critical to the optimal functioning of a reel mower. With the wearing away of reel blade and bedknife material over time, the actual angles will change and must be restored to near ideal by the grinding process.

The bedknife positions the grass blade at the proper angle for mowing. The front face of the bedknife is the positioning face, while the top face is the ejection face. A correct front face angle must always be acute (< 90°). It ensures the grass blades are positioned at the proper angle for presentation to the reel blade. The top face angle is the ejection angle between the top face of the bedknife and the arc created by the rotating reel blade. Since this angle changes as the relative position of the reel blade moves, it's difficult to know what real angle does exist. Therefore, an average or range of ejection angles is calculated based on the size and thickness of the bedknife and reel blade (which are determined by the ultimate conditions desired). Generally speaking, the greater the ejection angle, the better the clippings would be ejected from the reel/bedknife interface.

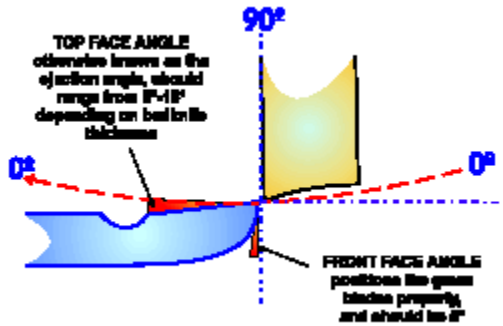
Not only is the ejection angle ground into the top surface of a bedknife directly related to its ejection capability, but it also reflects upon the durability of the bedknife. The hardness of the matched pair (reel blade and bedknife) is a carefully calculated compromise between durability and grass ejection capability. The loss of sharpness (and often the cause for rifling) is closely connected to the ejection angle of the bedknife.

Many superintendents perceive the problem of rifling after noticing streaking on the surface of the turf. Upon examination of the mower involved, it is usually evident that the bedknife has been excessively and severely tightened against the reel cylinder.

Inevitably, this causes the leaf tissue to be cut in a mechanical scissors- like fashion in the middle of the reel blade surface, rather than by scything action at the edge of the reel and bedknife. Instead of the clean cut achieved by scything, the leaf tissue becomes pinched. It is then literally pulled apart and ruptured during the scissoring process, thus opening the grass blade to a myriad of potential problems.

SCISSORS VS. SCYTHE

This difference between a scissors-cut and a scything action is important to understand. Scissors require two blades traveling in opposing directions, and will cut adequately if there is sufficient light contact along the length of the two blade edges. A scythe, as we have already determined, consists of a single cutting blade being drawn through the leaf tissue, damaging fewer cells in the process. Scissors will cut, but a scythe cuts better. This is precisely why a surgeon uses a single-blade scalpel (which is drawn through the flesh) instead of scissors.



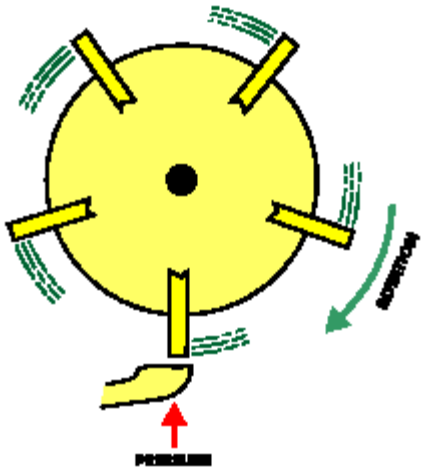
In a reel mower, one difference between a scythe and scissors action is the velocity of the cutting edge moving down the bedknife. A properly ground and adjusted mower will operate in a scything action at up to 4x the velocity of an improperly ground or misadjusted reel functioning as a scissors. Remember the analogy of razor blades shooting down the length of the bedknife edge?

As the bedknife is an equal partner with the reel blade in the cutting process, equal consideration must be given to proper grinding and in-season maintenance of the front and top faces of the bedknife. If the bedknife is not sharp and true, those razor blades being fired down the bedknife by the helix of the reel blades will encounter both high and low spots on their journey, resulting in an imperfect cut.

INTO THE GRASS

Even the most precise angles and adjustments can go awry if not maintained properly once the reel and bedknife start to wear. This is where all the contention about relief/no relief, lapping vs. no lapping, and contact vs. no contact adjustment come into play.

The single blade grinding method popularized in the United States earlier in this century applied varying levels of cut to each reel blade, resulting in an imperfect cylinder. Lapping was invented to make a single-blade-ground reel truly cylindrical again. Very simply, oil was mixed with sand and slathered on the reel while it turned backwards (so the high reel wouldn't bang into the bedknife).



THE ROTATION OF THE REEL AGAINST THE BEDKNIFE PRODUCES AN EFFECTIVE BRAKE DRUM

During the lapping process, the abrasiveness of the sand wears down the high blades to the level of the low ones, but also creates two curved, mirrored surfaces from the bedknife and reel tip. The curve assumes the arc of the reel rotation. Unfortunately, these two mirrored surfaces act as a drum brake, with the rotating blades of the reel forming the drum and the bedknife acting as the brake shoe. This causes considerable wear to the bedknife and reel, and also requires more power to rotate the reel due to the drag factors involved. By effectively wearing away the sharp leading edges of the reel blade and bedknife, lapping also turns a scythe into a scissors cut (requiring light-to-moderate contact between the two surfaces).

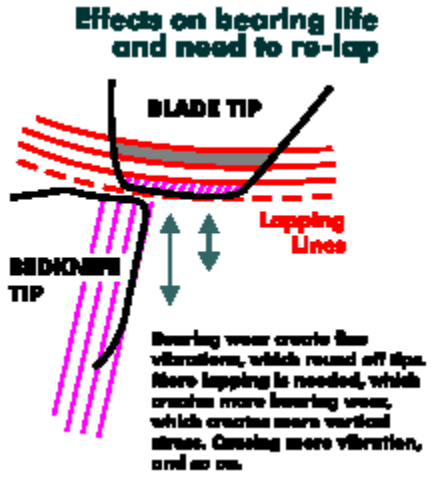
The definition of lapping can be broadened to be "any wearing process", even that incurred by the wearing of reel blade and bedknife during normal use of the mower. Normal wear and tear produces curved, mirrored surfaces just as intentional "paste" lapping does, but the surfaces are rounded and irregular thus requiring greater and greater contact via tighter adjustment to maintain functionality.

Paste lapping can restore some of the cutting ability of worn reel tips and bedknife edges. A well-lapped blade certainly produces a far better finish than a rounded and dull blade, but is a temporary fix until the reel can be properly ground and adjusted again. Grinder technology exists today that can allow a complete regrind of a greensmower reel in less than ten minutes, floor-to-floor.

RELIEF GRINDING

In order to reduce or minimize the braking effect of lapped surfaces, relief grinding (also called "backing off" or "blade thinning") was invented. A portion of the reel blade surface is mechanically removed to reduce the surface areas in contact. This technique usually involves a secondary operation, but some spin grinders impart a hollow, grind with integral relief during the grinding process. When the original relief wears off from lapping and/or excessive blade contact and the reel blade tip gets "fat" again, the reel must be either lapped to produce a temporarily sharp edge or reground to original angles and dimensions. Very few mowers still have functional relief three or four months into the season.

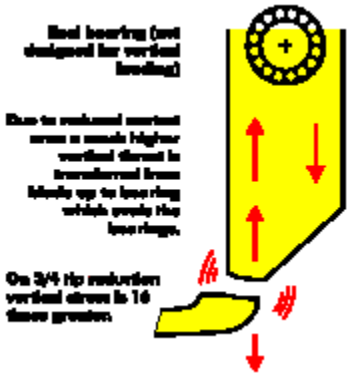
Reducing the blade thickness by 3/4 reduces the torque required to turn the reel by a factor of 16. It also, however, increases the vertical (upward) thrust on the reel bearings by a factor of 16, actually driving the reel and bedknife surfaces apart. Since reel bearings are not normally designed to absorb vertical loading, this vertical thrust causes bearings to oval over time, resulting in a fine vibration. The vertical oscillation of the reel cylinder tends to round off the reel and bedknife tips, and can create a rifling effect as the reel cylinder beats against the bedknife. To remedy the situation, more lapping is required, which in turn causes more vertical thrust, wear, and vibration. And so the circle continues.



A point of contention is the belief that relief grinding produces a better cut. In actuality, relief grinding has no effect whatsoever on the quality of cut, since on lapped reels there is no relief at the actual point where the grass is cut. Relief does, however, reduce the torque required to turn a lapped reel and the subsequent load on the engine and hydraulics of the mower. The best relief is obtained from a properly ground, non-lapped reel adjusted for “no contact at all”.

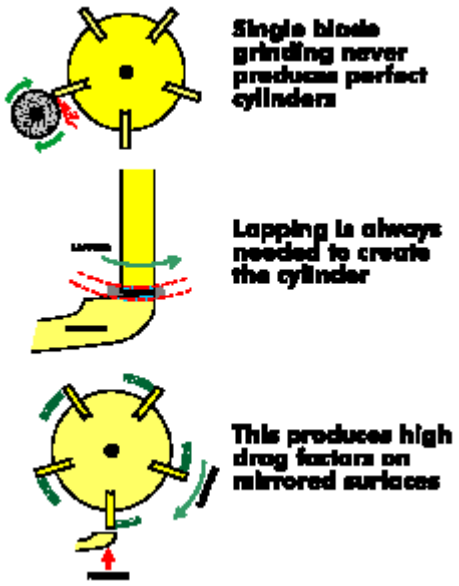
EQUIPMENT CONSIDERATIONS

It helps to take a step back and think of modern reel mowing machines as their predecessors were: horses towing the gang mowers of old around. Likewise, the fancy traction units of today merely pull the cutting units around. The reels are where it all happens. The manner in which a reel is adjusted to achieve a proper cut will significantly impact the load on the horse (or the traction unit).



It makes sense that a freely spinning reel (with little or no contact) will reduce the load, thereby extending its useful life. Tightening down on a reel-to-bedknife adjustment will create a significantly greater load for the horse to pull, leading to premature failure or demise.

One problem for the mower manufacturer is most critical: drag on the engines and hydraulics. Many traction units today have their engines and drive systems sized very precisely to the anticipated normal load, with little power to spare (for cost considerations). The braking effect of mis-adjusted or overly tightened reels often causes undue system load, resulting in engine wear, higher fuel consumption, heat gain to hydraulic systems, overload to seals and hoses, and otherwise unsatisfactory performance. For this reason, many manufacturers insist (quite rightly) upon maintaining relief on their cutting units. This way they can at least try to minimize the risk of overloading their mowers.

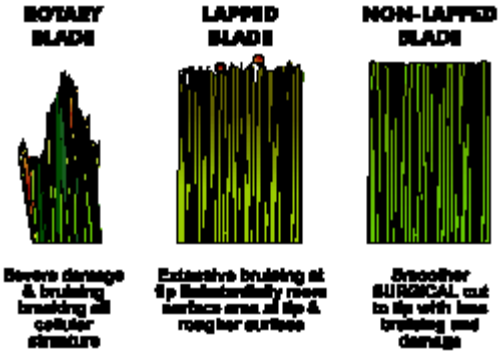


THE AGRONOMIC VIEWPOINT

The condition in which a mower leaves a leaf blade can have a significant impact on overall plant health. We tend not to think very much about what is going on at the microscopic level where the grass is cut, except perhaps to acknowledge the difference between a rotary and reel mower cut.

Plant pathology research demonstrates just how damaging the use of lapped (or otherwise improperly sharpened) reels can be. Poorly ground mowers tend to flail at the grass, leaving bleeding rough edges. A microscopic inspection of the leaf tip area reveals that a clean, scything cut made by a properly sharpened, non-lapped reel results in less leaf surface area exposed to pathogenic infection, and lower evapotranspiration rates. The plant can use more of its nutrients for root growth rather than damage repair.

Even though reel mowers have advanced dramatically over the years with hydraulic drive systems, sophisticated cutting unit suspensions, groomers and a myriad of other advancements, chances are many of us are grinding, adjusting and maintaining our reel mowers exactly as we did years ago.



A strategy to move the maintenance program up a notch to avoid "the mower doesn't cut so we need to tighten it down a bit more" syndrome can yield dramatic improvements (and savings) on many fronts. Simply touching up the front face of the bedknife every week on greensmowers, every two weeks on tees, maybe monthly on fairway units - whatever works for you - will go a long way toward extending the functional life of a quality grind and save time by forestalling the need to lap.

Investing ½ hour every two months in sharpening - however you do it, with whatever machine you use - vs. spending four hours lapping over that two months (15 minutes twice per week) will yield even greater benefits to your overall agronomic and turf equipment maintenance programs.

ROTARY BLADE GRINDING

PRIOR TO GRINDING PROCEDURES

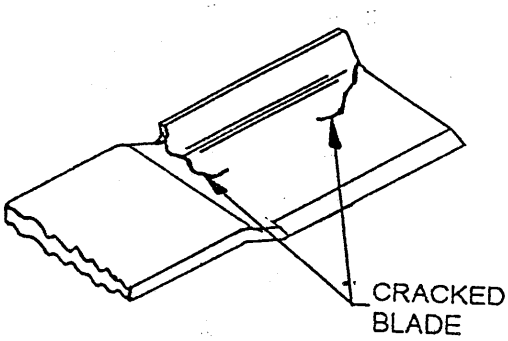
Follow these instructions, to correctly sharpen Rotary Lawn Mower Blades.

1. *CLEANING*

A rotary mower blade which has a buildup of dirt and dried grass clippings can not be properly sharpened or balanced.

To clean your blade follow these steps:

1. Put on safety glasses
2. Scrape off the heavy grass buildup with a flat scraper.
3. Use a wire wheel on a bench grinder or a wire brush by hand to finish cleaning.



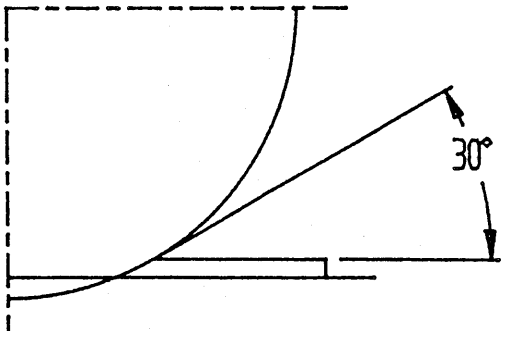
2. *INSPECT THE BLADE*

If the blade is bent, twisted, or cracked, it must be replaced. A blade can be checked for cracks by performing a ring test. If you put the blade on a small horizontal steel pin and then tap it with a hammer it should ring. If it is cracked, generally it will not ring and should be replaced.

Do not attempt to straighten or repair a bent, cracked or twisted blade. The use of such a blade could present a serious safety risk.

3. *GRINDING*

With the motor off, match the cutting edge whenever possible. On most rotary blade grinders this can be accomplished by either raising or lowering the stone in relation to the base that the blade rests on, or there is a stationary stone with an adjustable blade guide. The cutting edge angle should be approximately 30 (thirty) degrees. If it is not, adjust the blade guide and/or the depth control until the desired bevel is achieved.



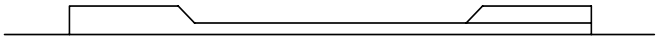
NOTE: Because of the relationship of the grinding wheel to the grinder base during grinding, the adjustable depth of the stone or the adjustable blade guide will give a slightly concave surface as illustrated above. This is normal and acceptable.

NEVER overheat the blade during grinding. You can quench the blade in water to keep it cool.

ALWAYS balance the blade. You can do this as you are grinding for less correction at the end.

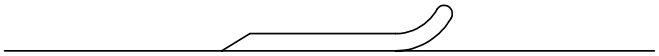
Grind the same area of the blade as the manufacturer had ground when new.

INCORRECT

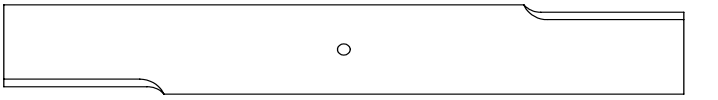


CORRECT

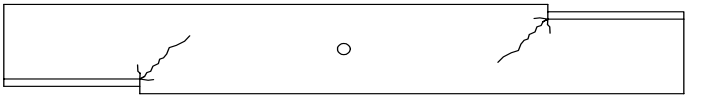
INCORRECT



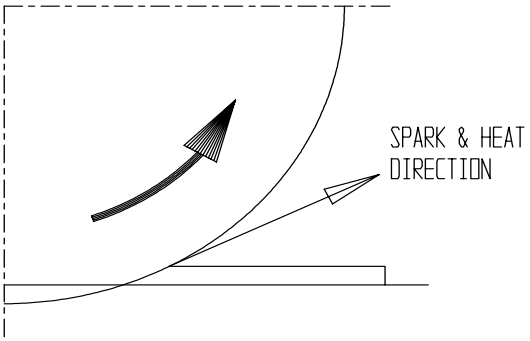
CORRECT



BLEND GRIND



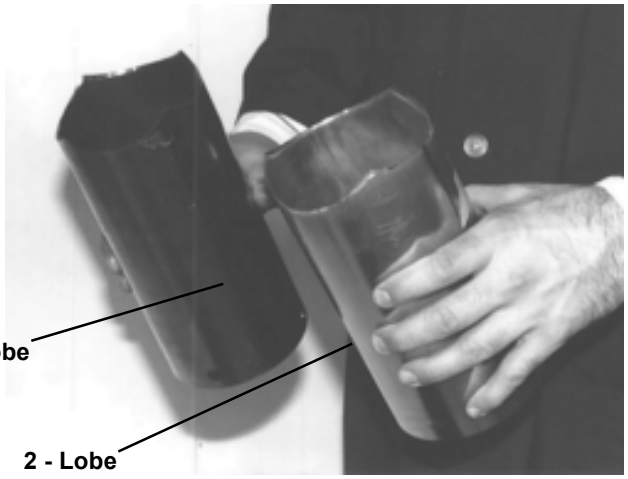
DO NOT STEP GRIND



Grinding away from the edge carries the heat away from the edge.

HOLE CUTTER SHARPENING

Cutting a hole with a dull cutter will tear the root system rather than cleanly cutting the root system. Torn roots will cause brown rings or halo effects on the greens. The way to avoid and/or correct this problem is to keep the hole cutter blade sharp so it is cutting and not tearing.



Hole cutting is done with a cutter of one of three general types:

- 3 Scallop Cup Cutter
- 4 Scallop Cup Cutter
- Straight Bottom Cup Cutter

There are four primary methods to keep the cutter blade sharp:

1. **Hand Filing:** Hand filing is time consuming and inaccurate. Additionally, because of the time required, it is not often done on a regular basis. Ultimately, the holes are cut with a dull cutter.

2. **Hand Grinding:** Using a 90 degree die grinder with a suitable sanding disk, follow the contour and angle of the cutter edge.

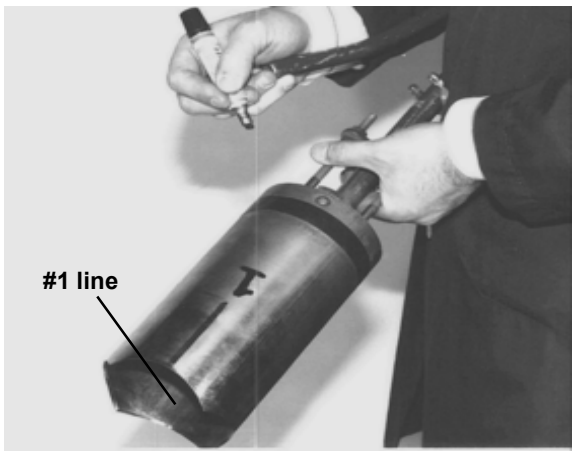
3. **Blade Replacement:** A good method, but due to the cost of replacement blades, there is a strong tendency to use blades after they have dulled for an extended time.

4. **Use of a Hole Cutter Sharpener:** There are cutter sharpeners with the proper designs that will be sharpen 3 Scallop, 4 Scallop, and Straight hole cutters.

The correct method for sharpening a hole cutter is to do so often and lightly prior to use. By using this method, your cutter is always sharp and the stock removal from the blade is minimal.

SHARPENING WITH A HOLE CUTTER SHARPENER

1. Clean inside and outside surface of the hole cutter shell.
2. Examine the tips on the hole cutter shell, if any tips are bent, they must be realigned straight with the outside diameter of the shell.
   NOTE: The tip surface is hardened so take careful not to break tip while straightening.
3. Draw a line down the center of each lobe, approximately 4" long with a black grease pencil or marker. Number each line in order.
4. With the motor OFF insert the shell into the hole in the grinder. Line up the #1 line with the pointer on the machine base. Make sure the plunger stop plate engages the cup plunger and pushes it back away from the grinding disc.



5. Push shell against the grinding disc and back off approximately 1/4".
6. Turn ON the motor and grind lobe #1 in short, light and smooth strokes.

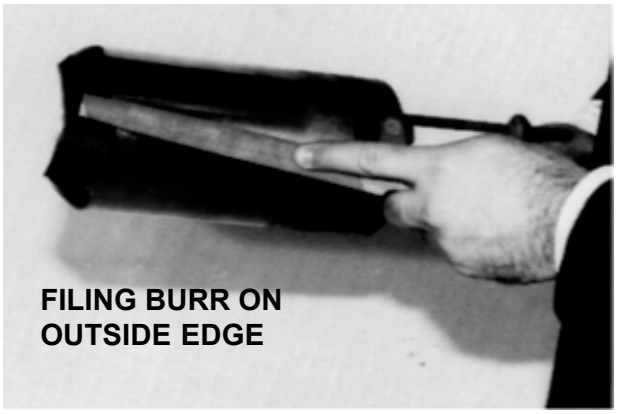
   NOTE: The entire hole cutter cutting edge is hardened. When grinding aggressively on the cutting edge, it causes heat buildup. Excess heat buildup causes a softening of the metal and permits a burr to roll over to the outside diameter of the cup. Take quick grinding strokes to minimize heat buildup. Excessive and/or rapid stock removal in one pass creates excessive heat and can also soften the hardened shell.
7. Rotate to the #2 line and remove an equal amount of material as in previous steps.
8. Rotate to the #3 line and remove an equal amount of material as in previous steps.
9. Rotate to the #4 line, if applicable, and remove an equal amount of material as in previous steps.
10. Turn motor off, check to see if all the tips have been completely re-ground and that an equal amount was ground off each lobe. Regrind if required repeating Steps 6-9.

NOTE #1: Watch the spark pattern for full grinding disc contact. This will help in grinding each lobe equally.

NOTE #2: After grinding a few shells, you'll develop a feel for how much metal is being removed and it will become easier to grind each lobe equally.

NOTE #3: If the metal edge turns color after grinding, remove less metal on each stroke to remedy this problem.

NOTE #4: Keep a sharp edge on the shell by sharpening more often. This will lessen the amount of material needed to be removed during each sharpening. This would also help the problem of burning metal and grinding too much in one pass



Aftercut Appearance
Troubleshooting

There are many interchangeable terms used to describe various conditions. Some common terms are used to describe completely different conditions. The terms used are to help clarify and standardize use of these terms and the conditions they reference.

Turf Condition
Turf conditions play a dramatic role in the aftercut appearance. Turf conditions must always be considered before attempting to remedy a problem with adjustments to your turf equipment. Equipment used strictly for mowing cannot remedy turf conditions but can often times be adjusted to adapt to a given turf condition.

The goal of a turf equipment service person is to help address concerns by matching the equipment to the current conditions. This is a partnership between you and the person or persons responsible for the turf. The ultimate solution is usually a combination of turf remedies and machine adjustments.

It is important to remember that the same "fix" will not work for every turf condition and it may not work every time in what seems to be identical conditions. Requirements are different between warm season grasses and cool season grasses and the cutting unit needs to be setup for the grass type and seasonal differences.

Cutting Units
A cutting unit set up incorrectly can cause more problems than it can resolve. The items listed below must be checked, corrected if necessary, and be the same on all cutting units:

§ Adjusters, Pivots, Bushings and Compensating Springs- lubricated if necessary, tight and in good working order
§ Bedknife- correct for the application with sharp, flat and straight cutting edge
§ Bedknife Attitude- set to manufacturer recommendations
§ Bedknife Contact - set properly according to manufacturer recommendations
§ Reel – Sharp cutting edge (relief or backgrind recommended) with less than .002 (.05mm) run out as a general rule of thumb, always refer to manufacturers recommendations.
§ Reel Bearings- in good condition, no end-play and adjusted properly
§ Reel Diameter- Meets or exceeds the manufacturer recommended minimum diameter
§ Rollers - parallel to the reel (see operators manual)
§ Roller condition- Bearings (no end-play), surface run out as a general rule should be less than .015(.38mm) (but always refer to manufacturers recommendations), and centered in the frame,
§ H.O.C. set to obtain the correct *effective* height of cut
§ The wear factors must be equal. (a new part on one unit and the same part being worn on another unit can cause differences)

Troubleshooting

- Define the issue (ask enough questions and see the issue for yourself) the issue must be clearly defined before you can begin to address it correctly.
- Evaluate turf conditions for their part in the outcome (including weather trends such as extreme wet or dry, recent turf maintenance performed such as top dressing etc.).
- Verify the traction unit is operating properly and in good condition (no switches jumped, proper RPM, maintenance up to date etc).
- Check and recheck the cutting units for accurate and proper setup.
- Understand and be able to duplicate the complaint or condition.

While attempting to resolve aftercut appearance issues it will be necessary to make physical changes to components of the cutting unit or traction unit. All adjustment, changes, and modifications from a current condition should be made singularly using a scientific process. Make only one change at a time and take careful notes of the conditions resulting from each change before additional changes or adjustments are made. A systematic approach to troubleshooting will assist in resolving issues timely and effectively.

Listed on the following pages are some causes and possible corrective actions beginning with the most likely and ending with the least likely. Although the aides listed are observed individually the ultimate solution is most likely going to be a combination of two or more corrective actions.

To begin, some basic data should be gathered for future reference.

Machine:

Model _____ Serial Number _____ Engine @ _____RPM

Cutting Units:

Model _____ Serial Number _____ _____ _____ _____

Number of Blades _____ Serial Number _____ _____ _____ _____

Use: (describe – i.e. Fairways, Outfields, Greens etc.)

_____

HOC _____ **Number of Blades** _____ **Type of Grass** _____

Over-seeded? _____ **Last Turf Maintenance Performed** _____ **Date** _____

Current Weather Pattern (i.e. Drought, Hot etc.) _____

Condition Found: _____

_____

Condition Environment (when it happens, what needs done to duplicate the condition):

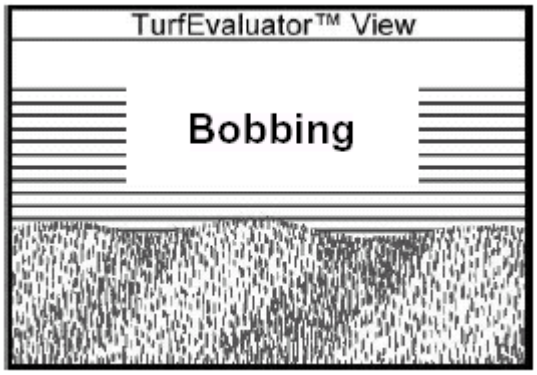
_____

_____

_____

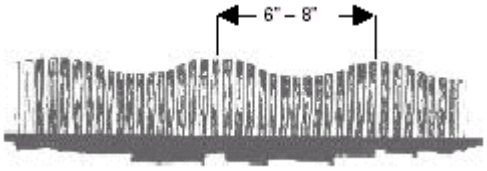
_____

_____



Description:

Rocking movement of the cutting unit that leaves an unacceptable wave like appearance. This could be all or one of the cutting units. Color variations are present. The appearance of light and dark patches could be an indication of bobbing. This pattern can usually be identified by the wave tips beingapproximately six to eight inches tip to tip.



Some Causes of Bobbing:

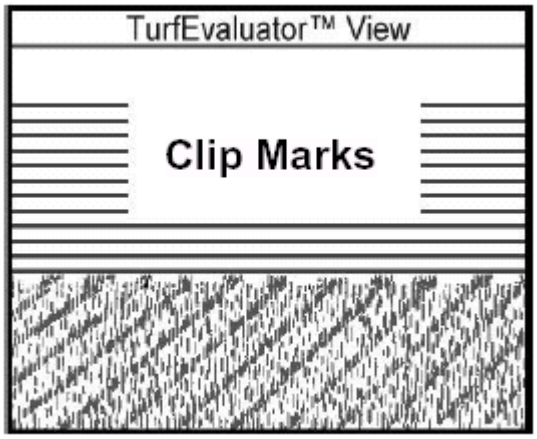
Note-Sometimes bobbing can be mislabeled due to variations in the turf.

1) Ground speed too fast
2) Inconsistent turf density
3) Ground not level (see note)
4) Grass build up on roller
5) Cutting unit weight bias (not using or mis adjusted turf compensation system)
6) Counterbalance/down pressure set wrong (too light on ground)
7) Out of round rollers
8) Suspension of roller loose so forward speed is inconsistent
9) Cutting unit is not tracking with traction unit
10) Mowing in the same direction
11) Grain
12) Using groomers on the cleanup pass

Some Corrective Aids:

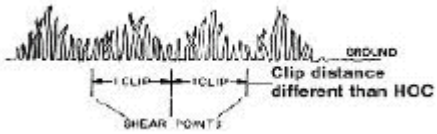
Note-Change mowing direction 90 degrees. If the pattern follows the mow direction it is bobbing, if it does not the pattern is most likely due to turf variations.

1) Slow ground speed (can sometimes compensate for density changes)
2) If pattern matches turf density changes then apply turf remedy to gain consistent density (dethatch, verti-cut and aerate)
3) Limit access to turf when wet
4) Use scrapers or brushes to clean rollers
5) Use (or adjust) turf compensation springs
6) Adjust counterbalance/down pressure for more weight on turf
7) Verify roller condition
8) Insure cutting unit suspension is in good working condition
9) Insure the cutting unit is tracking parallel to traction unit travel
10) Change mowing direction frequently
11) See grain
12) Groomers should be used in a straight line. Turning while the groomers are in use can cause the cutting unit to track wrong (see 9)
13) Change roller type to reduce rolling resistance



Description:

An unacceptable wave pattern on the surface of mowed turfgrass. The wave tips being two or less inches tip to tip can usually identify the pattern. The clip and the HOC, as a rule of thumb, should be approximately the same, but can be varied to achieve specific results.

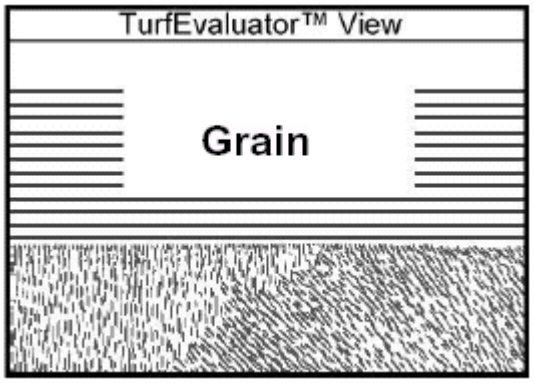


Some Causes of Clip Marks:

1) Ground speed is too fast for the reel speed
2) The reel speed is too slow for ground speed
3) HOC too low for the number of cutting unit blades
4) Reel diameter has worn beyond the range reel speed can be adjusted to compensate
5) Reel motor not performing to specification
6) Reel drive system slipping

Some Corrective Aids:

1) Decrease ground speed
2) Increase reel speed
3) Verify the proper cutting unit configuration and number of blades for the application
4) Verify the reel diameter has not worn below minimum diameter
5) Verify reel motor performance
6) Verify the reel drive performance
7) Verify engine RPM
8) Verify hydraulic performance (pump output, relief settings etc.)



Description:

The tendency for grass or its runners to grow horizontally. Horizontal growth can also be the result of recurring weather, water flow, wind, and sunlight direction. Some cultivars (i.e. Bent and Bermuda grasses) tend to naturally grow horizontally.

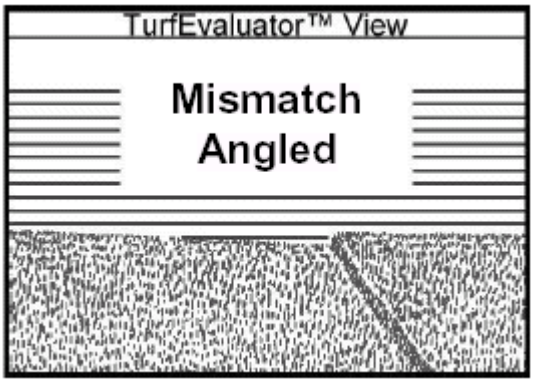
Some Causes of Grain:

1) Not alternating mowing direction
2) Turf conditioning or maintenance incomplete
3) Inconsistent turf density or texture
4) Improper front roller (full)

Some Corrective Aids:

NOTE: When addressing issues of excessive grain: the aftercut appearance may worsen then gradually improve with continued maintenance.

1) Establish a pattern of mowing that changes direction regularly. The more random the directions change the better.
1) Circle cutting
2) Dethatch, verti-cut and aerate
3) The use of groomers, brushes and combs may be helpful
4) Use Wiehle front rollers
5) Protect area from the affects of weather



Description:

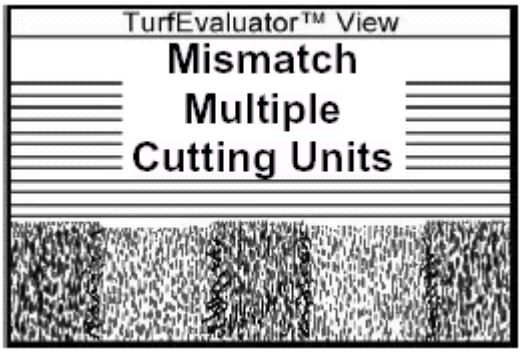
Cutting units running side by side cut at different heights. One cutting unit appears to be cutting lower on one side while all other points appear equal in height. Usually this is the result of one cutting unit

Some Causes Angled Mismatch:

1) HOC set different from one end of the cutting unit to the other
2) Rollers not parallel to the reel and to each other (vertical and horizontal)
3) Different attitude/BCD from one end of the cutting unit to the other
4) Mowing too fast
5) Weight distribution of cutting unit is uneven
6) Worn roller bearings
7) Hose or cutting unit movement is restricted
8) Variations in terrain
9) Variations in turf density (thatch or grain)
10) Cutting unit is not tracking straight

Some Corrective Aids:

Determine unit at fault
1) Verify HOC settings on each side are equal
2) Verify rollers are paralleled prior to setting HOC
3) Verify attitude/BCD is the same on both ends of the cutting unit
4) Mow Slower
5) Insure weight is distributed evenly (use the proper counterbalance weight for the unit)
6) Verify roller condition
7) Correct hose routing or any other obstruction to full cutting unit movement
8) If problem seems to come and go check the turf density between the areas where the condition is most noticeable and where least noticeable
8) Verify terrain is not such that the cutting unit can not follow it
9) Dethatch, verti-cut, aerate
10) Verify the cutting unit is tracking parallel to the traction unit direction



Description:

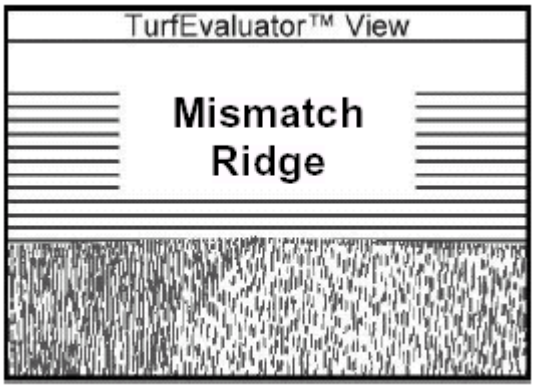
The cutting units on one line cut at a different effective HOC than cutting units on another line. This is an effective HOC difference not a setting diff

Some Causes of Multiple Mismatch:

1) Turf density (excessive thatch)
2) Cutting off too much grass at one time
3) Mowing too fast
4) Counterbalance/down pressure settings
5) Differences in ride height
6) Reel speed differences

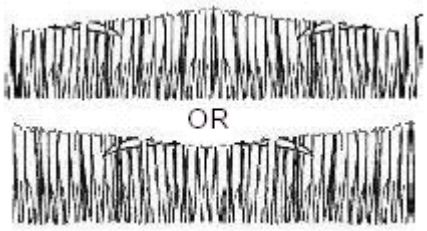
Some Corrective Aids:

1) Dethatch, verti-cut and aerate
1) Change mowing direction frequently
2) Mow more frequently
3) Slow mowing speed
4) Adjust counterbalance or down pressure system to even effective HOC
5) Adjust ride height to allow for even lift arm placement
5) Adjust air pressure
6) Verify reel speed is consistent across all cutting units
7) Roller profile can help stabilize effective HOC
8) Adjust rear HOC to match the effective HOC of the front cutting units



Description:

Two cutting units side by side each are cutting higher on one end. This can be viewed as a ridge or a trough depending on how the units are set up compared to the other.

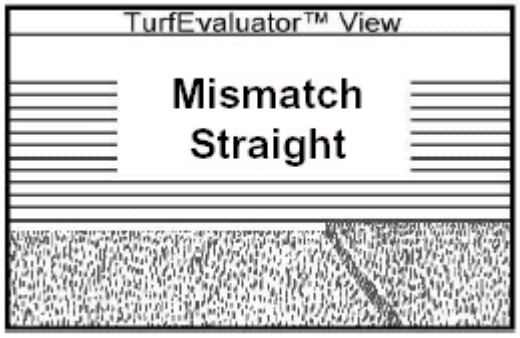


Some Causes of Ridged Mismatch:

1) Inaccurate HOC settings from one end of each cutting unit to the other end
2) Rollers not parallel to the reel or each other (vertical and horizontal)
3) Variations in terrain
4) Variations in turf density
5) Hose or cutting unit movement restricted
6) Mowing too fast
7) Counterbalance or down pressure springs worn or set improperly
8) Worn roller bearings

Some Corrective Aids:

1) Verify HOC settings on each side of all reels is equal
2) Verify the rollers are parallel prior to setting the HOC
3) If the condition appears to come and go check turf conditions in areas where the condition is noticeable as compared to those areas it is not
3) Verify the cutting unit can follow the turf
4) Dethatch, verti-cut, aerate
5) Correct hose routing or any other obstruction to full cutting unit movement
6) Slow mowing speed
7) Verify counterbalance/down pressure system condition and adjustment is correct for conditions
8) Verify roller condition



Description:

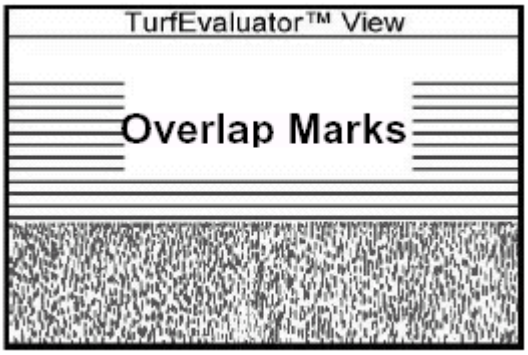
Cutting units running side by side cut at different heights. Each unit appears to be cutting well. This can show up when two different mowers are used on the same turf due to different effective HOC settings.

Some Causes of Straight Mismatch:

1) Different HOC settings
2) Different effective HOC
3) Cutting edges dull
4) Cutting off too much grass at one time
5) Bedknife settings different for each of the affected units
6) Different bedknife height (worn reel diameter)
7) Counterbalance or down pressure systems set improperly
8) Worn roller bearings
9) Inconsistent turf density (excessive thatch/grain)
10) Different parts used for each affected unit
11) Rollers not parallel

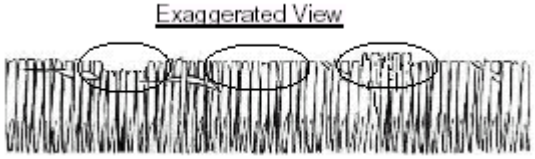
Some Corrective Aids:

1) Verify all HOC settings within .005(.12mm) of each other
2) Verify the weight, roller options and anything else that will change the effective HOC
3) Sharpen reel and bedknife
4) Increase mowing frequency
5) Set bedknife attitude/BCD the same on all units
6) Verify reel diameter (must be equal on all units)
7) Set counterbalance adjustment to obtain consistent effective HOC over all cutting units (can be different for each cutting unit)
7) Set down pressure system to obtain consistent effective HOC over all cutting units (can be different for each cutting unit)
8) Check for worn or damaged roller bearings
9) If pattern comes and goes check for different turf conditions that would change the effective HOC
9) Dethatch, verti-cut, aerate
10) Verify parts used as identical (type and brand)
11) Parallel rollers (vertical and horizontal)



Description:

The area of overlap is that area where cutting units mow over the path of other cutting units. This is either individual cutting units within the path of a machine or where those paths meet (up and back). The grass is rolled and/or cut at least twice within this area. Various color variations can appear.

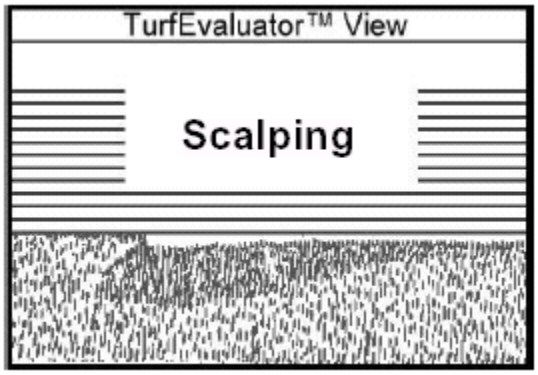


Some Causes of Overlap Marks:

1) The effects of being cut twice usually create indented or marks of lighter color
2) The effects of being rolled twice usually create raised or darker marks. These marks should dissipate within a few hours after mowing.
3) Excessive thatch or grain
4) Color variations in canopy (Small green leaves on longer stem can increase overlap mark occurrence)
5) Cutting off too much grass at one time
6) Dull cutting units
7) Cutting out of clip range

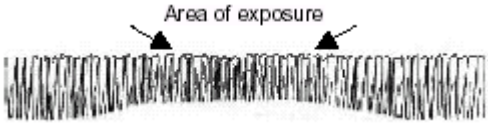
Some Corrective Aids:

1) Decrease the bedknife attitude/BCD
2) Rollers with different end designs(shouldered roller)
3) Dethatch, verti-cut, aerate
4) Increase fertilizer
5) Mow more frequently
6) Sharpen reel and bedknife
7) See Clip Marks
9) Adjust turf compensation system
10) Change mowing direction frequently



Description:

Mowing the grass at such a low HOC as to expose the stem or crown. This produces a very light green color. In some grasses with thatch buildup this will uncover the thatch and show light brown in color. Usually a result of the cutting unit's inability to follow the turf.

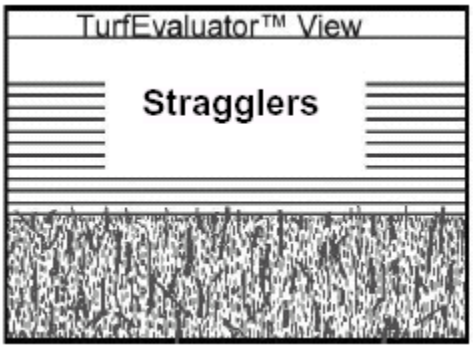


Some Causes of Scalping:

1) Cutting below the normal HOC
2) Uneven turf beyond the capability for the mower to follow
3) Rollers set too far apart or rear roller too short
4) Improper attitude for HOC(attitude/BCD too aggressive)
5) Incorrect bedknife for the HOC
6) Cutting off too much grass at one time
7) Inconsistent turf density (excessive thatch or grain)
8) Ruts created by cart or vehicle traffic when wet

Some Corrective Aids:

1) If lowering the effective HOC make the change gradually to allow the turf grass to adapt
2) Verify the location of the scalp in relation to turf undulation or heavy thatch a change in the mowing direction could be helpful
3) Roller fixtures or attachments to the cutting unit can allow the rollers to set wide apart. The closer the rollers are to each other the better the unit will follow uneven terrain
3) Proper roller for application
4) Reduce bedknife attitude/BCD
5) Verify the correct bedknife is being used for the application and HOC
6) Mow more frequently
7) Dethatch, verti-cut, aerate
8) Restrict access to turf while saturated
9) Set roller and/or skids to catch terrain variances



Description:

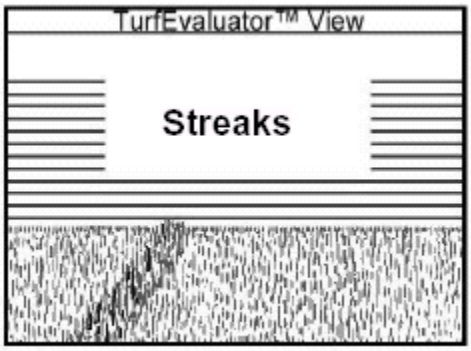
Scattered uncut grass blades throughout the cutting unit path. The uncut blades stand above the general line of the effective height of cut. Cutting unit sharpness, adjustment, clip versus grass length, resiliency of grass, and bedknife attitude are the key factors effecting this condition. Frayed leaves from poor cutting efficiency can have the same effect.

Some Causes of Stragglers:

1) Dull cutting edges (reel and bedknife)
2) Bedknife Adjustment incorrect
3) Bedknife attitude/behind center distance (BCD)
4) Cutting unit out of clip range (driving too fast for the reel speed or reel speed too fast for HOC)
5) Incorrect roller used
6) Cutting off too much grass at a time
7) Cutting in the same direction (rolling grass down)
8) Grain in turf
9) Inconsistent turf density or texture
10) Grass wilted from weather stress

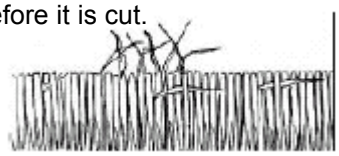
Some Corrective Aids:

1) Sharpen cutting unit (bedknife and reel)
2) Adjust Bedknife (light contact is preferred)
3) Increase bedknife attitude/BCD
4) Increase forward speed (higher HOC)
4) Decrease reel speed (higher HOC)
4) Decrease forward speed (lower HOC)
4) Increase reel speed (lower HOC)
5) Verify Roller for application (wiehle roller, Anti-scalp for higher HOC [usually do not touch the turf] etc.)
6) Mow more frequently
7) Change mowing direction regularly
8) See Grain
9) Dethatch, verti-cut, aerate



Description:

A line of taller grass that has not been cut. Single streaks are the result of a bent or nicked bedknife. Multiple streaks are more often the result of rifling due to heavy contact between the reels and bedknife. Streaks may also occur where a tire rolls down an area before it is cut.

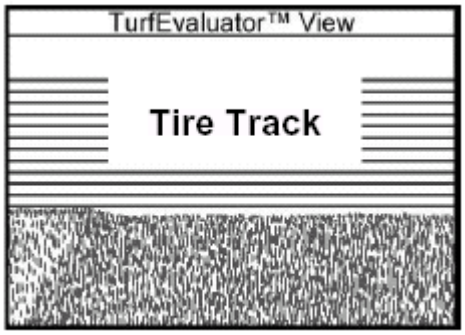


Some Causes of Streaks:

1) Damaged bedknife (picking up objects such as spikes)
2) Rifled bedknife or reel (uneven wear)
3) Loose or over torqued bedknife screws
4) Bent reel blade
5) Turning too aggressively (Streaks can show where
the cutting units don't overlap each other around corners or on side hills)
6) Bedknife ends tufting grass (from dragging or inconsistent bedknife contact)
7) Wrong roller for application
8) Tire marks

Some Corrective Aids:

1) Beware of objects that could get caught in the reel. Check area to be mowed for foreign objects prior to mowing
1&2) Repair or replace damaged reel and bedknife (regrind if necessary)
3) Always use a torque wrench to tighten screws evenly and to proper torque
5) Change mowing pattern
5) Find where streak orients from the cutting unit and correct the damage in that area
5) Lock or unlock steerable cutting units as necessary
6) Verify proper bedknife for application
6) Verify proper adjustment of bedknife (attitude/BCD and light contact across entire knife)
7) Correct roller for application
8) See Tire Track



Description:

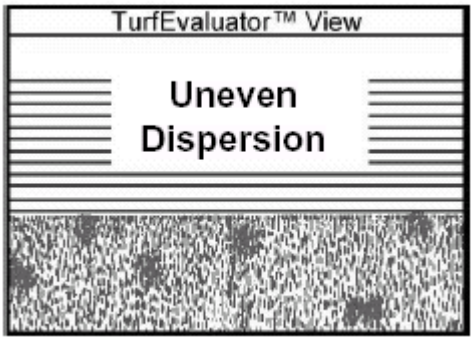
Caused by the tire rolling the turf. If the tire rolls the turf after the cutting unit has cut the turf the effects should dissipate over time.

Some Causes of Tire Tracks:

1) Air pressure too high or too low
2) Traction unit weight
3) Moisture content in or on turf
4) Tire configuration (edge profile)
5) Tire rolling turf prior to cut
6) Inconsistent turf density and texture
7) Cleanup pass marks

Some Corrective Aids:

1) Adjust air pressure to maintain even contact on turf
2) Remove unnecessary weight such as cabs and accessories used in winter etc. (Four wheel drive if not necessary)
3) Restrict vehicle access to turf after heavy rains
3) Mow later in the day when moisture has stabilized
4) Change tire to a different profile (a wider, larger diameter tends to be more effective)
5) Use of brushes or combs may prove helpful if tire rolls turf first
6) Dethatch. Verti-cut, aerate
7) Alter clean up path by moving a foot over on alternating days or changing directions if cutting units are offset.
7) Reduce clean-up pass frequency



Description:

The discharge from the cutting unit should be spread evenly over the turf. The discharge collecting and dropping in clumps on the turf is referred to as clumping. The discharge gathering in a row at one side of the cutting unit is referred to as windrowing. When the grass collects at the edge of the basket and falls out this is referred to as dribbling.

Some Causes of Uneven Dispersion:

1) Cutting off too much grass at one time
2) Mowing while grass is damp
3) Grass collecting on rollers
4) Scrapers improperly adjusted
5) Grass collecting on frame members
6) Grass collecting on bedknife heel
7) Grass collecting on bedknife edge
8) Not using baskets
9) Grass missing baskets
10) Cut off bar is misadjusted
11) Clippings not being reprocessed
12) Too much grass clipping volume for front discharge

Some Corrective Aids:

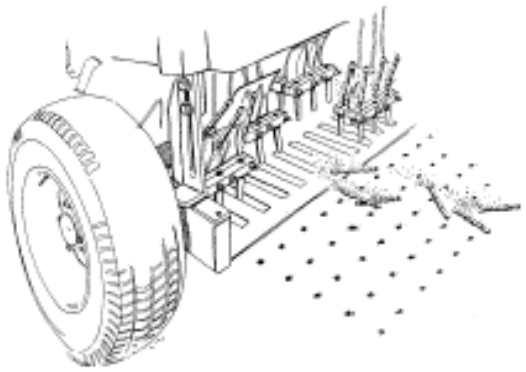
1) Mow more frequently
2) Allow turf to dry out prior to mowing
3) Use brushes or scrapers
4) Adjust scrapers (should lightly brush grass and have slight clearance to roller)
5) Adjust cutting unit discharge (shields or deflectors)
6) Reduce bedknife attitude
7) Adjust bedknife contact (light contact is preferred)
8) Use baskets or other collection devices
9 & 10) Adjust cutoff bar and shields (see operators manual)
11) Change to front throw
12) Change to rear throw

Ideas found successful by some

-Dragging a net
-Dragging a hose
-Growth inhibitors

Reel Mower
TERMINOLOGY

Aerate
Process of coring, spiking, slicing, or other methods to introduce air from the atmosphere into the soil and thatch without destruction of the turf; synonymous with aerify.



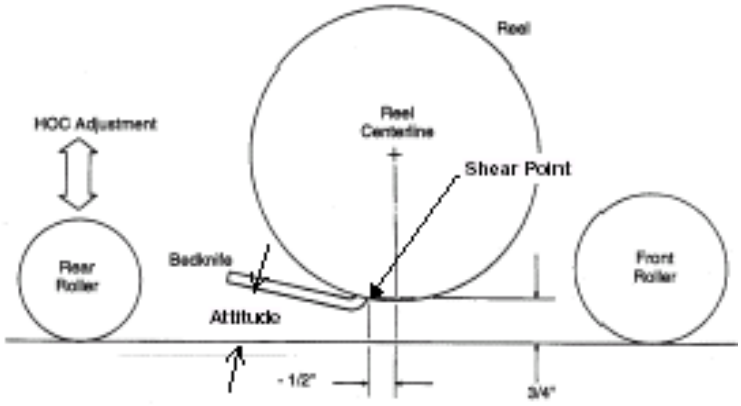
Aftercut Appearance
The general appearance of the cut path after mowing. Quality of cut as well as marks left by rollers, wheels, and dispersion of clippings affect appearance. When all is said and done, a good after cut appearance is what the superintendent and players want.

Annual Bluegrass
Annual bluegrass **(POA ANNU**A) is widely dispersed as a winter annual in both cool-season and warm-season turfs. It is also used as a perennial turfgrass on intensively cultivated sites in the cool temperate and subarctic climates. Within a few years after establishment, closely mowed and intensively irrigated bentgrass fairways will have some encroachment of annual bluegrass. Annual bluegrass may also become a dominant component of a fairway polystand within five years. Many older golf courses are basically composed of annual bluegrass, primarily the perennial types.

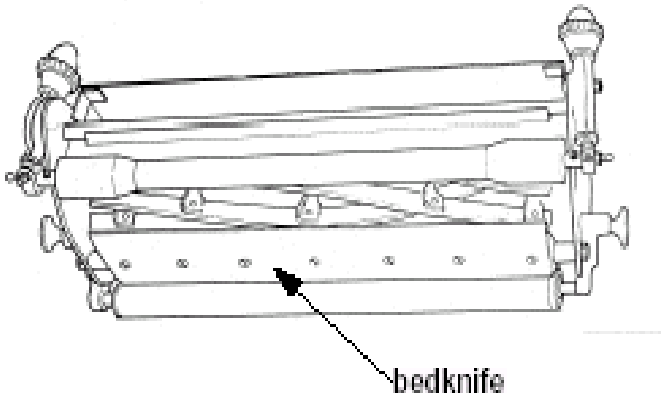
Backlapping or Lapping
A method to simultaneously sharpen the cutting edges of the reel blades and bedknife. Backlapping is done by reversing the rotation of the reel from the normal mowing direction. A abrasive paste (slurry) is applied the to the rotating reel blades with a long handled brush to aid in the sharpening process. There are different grit pastes and grades depending on need.

Bedbar
The supporting structure to which the bedknife is attached.

Bedknife Attitude
The angle between the bottom of the bedknife and the ground plane under the cutting unit. As the bedknife attitude is changed, it is important that the reel to bedknife shear point changes relative to the center line of the reel. This can change the after cut appearance of the grass. The result may be better or worse depending on several factors. Bedknife attitude is adjusted by changing the height of the front, rear, or both rollers. A height of cut change is NOT necessarily part of a change to the bedknife attitude. A large angle is also referred to as an aggressive bedknife attitude. A small angle (flat attitude) can have most or all of the bedknife riding ON the turf. This can influence after cut appearance.



Bedknife
The lower cutting member on a reel type mower. The bedknife is attached to the bedbar, and the assembly is mounted to the main frame in one of two ways. One allows for paralleling and adjusting the bedbar (bedknife) up to the reel, while in others the bedbar is fixed and the paralleling and adjustment are made by moving the reel.



Bentgrass (cool-season turfgrass)
Creeping bentgrass is the main turfgrass used on intensively maintained fairways in cool climates. Creeping bentgrass succeeds at cutting heights of less than 0.8 inches, mowing at one- to two-day intervals, heavy irrigation, moderate fertilization and the use of fungicides. Colonial bentgrass is sometimes used with creeping bentgrass as a polystand.

Bermudagrass (warm-season turfgrass)

Bermudagrass is adapted to a wide range of soil conditions. Although not very cold tolerant, several new cultivars have been developed which respond better in cooler temperatures. The improved Bermudagrass cultivars have excellent wear, heat, and drought tolerance plus a rapid recuperative rate. Their most common problems are a potential for thatching, shade intolerance, and susceptibility to insect pests.

Bobbing

An undesirable cutting unit movement that leaves an unacceptable wave-like appearance. As a general rule mowing slower should lessen the problem.

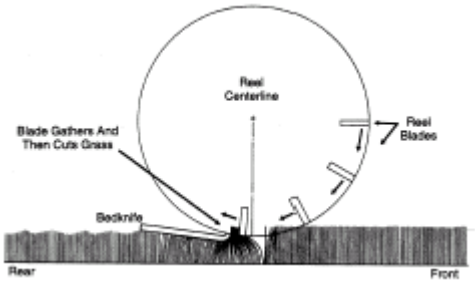
Brushes or Combs

Attachments generally installed on the cutting unit to lift the grass blades resulting in a cleaner cut. They also promote a more vertical growth and prevent or correct grain in the grass.

Clip (Clip Distance)

The distance between sheer points. Factors which affect clip include:

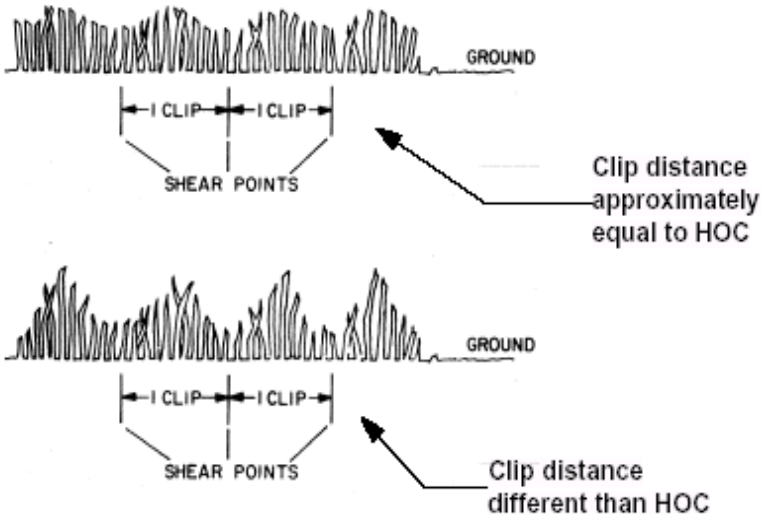
- The number of reel blades
- The ground speed
- The rotational speed of blades



Under close examination grass that has been properly cut with a reel mower will have a uniform wavy appearance. This is because of the gathering action of grass caused by the combined forward motion of the bedknife and the pulling action of the reel blade. When the three factors above and height of cut are in a proper relationship, then the normal wavy cut will be difficult to see and the cut will usually be judged as good. If the factors are out of proper relationship the wavy cut may be very noticeable and will be unacceptable. This unacceptable wavy cut goes by several names that are used interchangeably, including marcelling, wash boarding, wave cut and corrugation.

Clip vs. Height of Cut —

The general rule of thumb concerning height of cut versus clip is that the best visual appearance occurs when the clip distance is close to the height of cut.



Clumping

The discharge of clippings into unsightly lumps or rows. Excessive clippings besides being unsightly may smother the grass or act as incubators for disease.

Combs or Brushes

Attachments generally installed on the cutting unit to lift the grass blades resulting in a cleaner cut. They also promote a more vertical growth and prevent or correct grain in the grass.

Compaction

Soil particles pressed closely together. Soil compaction prevents adequate water and air penetration and reduces turfgrass root growth.

Cool-season Turfgrasses

Cool-season grasses grow best within a temperature range of 60° to 75° F. Their environmental adaptation is limited primarily by the intensity and duration of seasonal heat and drought stresses. Cool-season grasses are generally adapted to temperate and subarctic climates. Examples: Annual bluegrass **(POA ANNU**A), bentgrass, Kentucky bluegrass, fine-leafed fescues.

Corrugation

An **UNACCEPTABLE** wavy or washboard pattern on the surface of mowed turfgrass.

Counterbalance

Refers to the transfer of weight between the cutting units and tractor to achieve desired traction and/or contour following. Counterbalance is usually achieved with springs or hydraulic cylinders. Transferring weight between traction unit and cutting units can increase traction and stability, reduce c/u ground drag and steering effort, and minimize scalping. There may be a compromise between good traction and good contour following.

Crown

The thickened part of the grass plant closest to the soil from which roots extend down and blades shoot up.

Cultivar

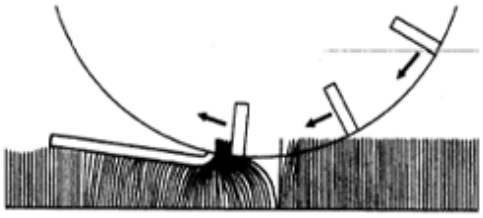
A plant of a single species that differs from another in specific characters such as disease resistance, leaf width, insect resistance.

Cultivation

A mechanical procedure such as spiking, grooving, water injection, or core-removing on established turf to improve its characteristics.

Cutting Action

A reel type mower cuts grass with a scissor-like shearing action as the moving helix-shaped reel blade passes over a stationary bedknife. This cutting action requires that the bedknife and reel blades be sharp, matched, and in close relationship with each other.



Cutting Height or Height of Cut

BENCH SET: The height at which the top edge of the bedknife is set above a flat level surface that contacts the bottom of both the front and rear roller

EFFECTIVE HEIGHT OF CUT: The height of cut on the turf. This will usually be higher than the bench setting because the rollers/wheels will not sink into the turf to the ground level.

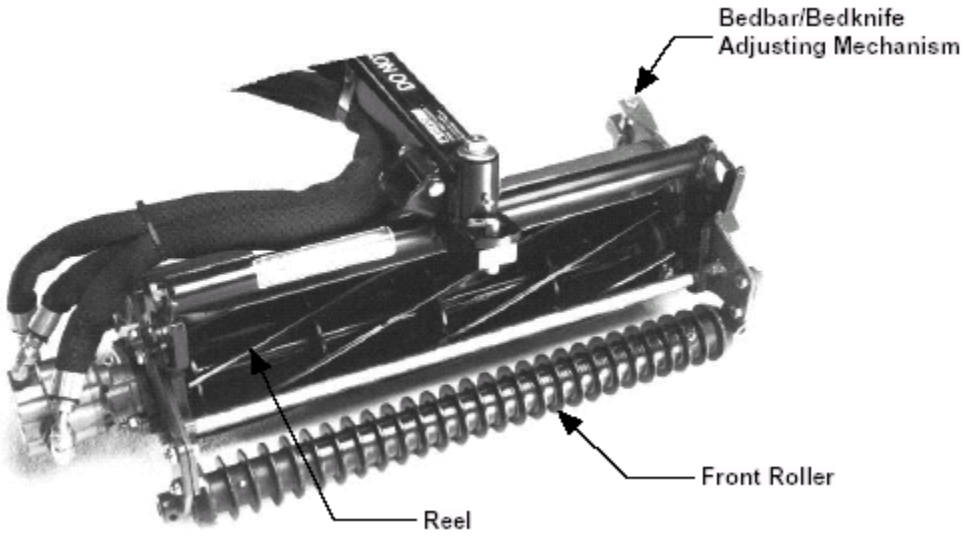
Generally, within the H.O.C. range for a given species or cultivar, mowing too closely weakens the plant, causes shallow rooting, lowers resistance to drought, increases susceptibility to fungus diseases, and encourages thinning of turf. In addition, close mowing brings more light to the ground surface and encourages the germination and growth of weedy grasses and broadleaf plants.

For example: A bench setting of 1 inch may result in an effective or actual cutting height of 1 1/16 inches because of the plant material that elevates the rollers.

NOTE: Two different cutting units set at the same BENCH HEIGHT OF CUT may have a different EFFECTIVE HEIGHT OF CUT because they have different total weights, rollers, skids and bedknife attitudes.

Cutting Unit

The cutting unit consists of a reel, front and rear rollers, a bedbar/bedknife assembly, and related adjusting mechanisms.

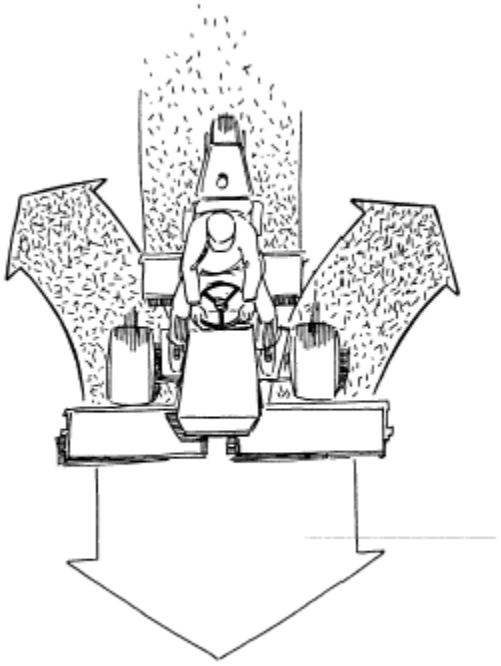


Dethatching, Thatching or Verticutting

The thinning of turf grasses by blades or wire tines which cut perpendicular to the soil surface.

Dispersion of clippings

The pattern of how clippings are thrown (dispersed) from the cutting area by the moving reel blade. Unsightly clipping dispersal is an issue with golf course managers. The grass will be deflected to the right or left depending on the helix of the reel. All reel blades are generally curved either to the right or left. Some machines have reels that curve to the right, some have reels that curve to the left and some have a mixture of both right and left curving reels. There is also an after-market chevron (herringbone) reel that deflects to both right and left. Selection of forward or rear throw is achieved on most Toro fairway mowers by simple deflector shields.



Fairway

Fairways are typically mowed at heights between 0.25 and 0.75inches, depending on several factors. A typical eighteen-hole golf course has a total fairway area of 30 to 60 acres, the average being approximately 50 acres.
Fairways are cut lengthwise with contour or straight line. They can also be cut at various angles called cross-cutting or a combination of cutting styles.

Fine-leafed Fescues

Fine-leafed fescues perform best on well-drained, moderately shaded sites and droughty, infertile, acid soils. They are intolerant of wet conditions and high fertility. Fescues are used in seed mixtures (polystands) with Kentucky bluegrass or colonial bentgrass in cooler temperate and subarctic climates and with perennial ryegrass for overseeding warm-season turfs in subtropical climates for winter play and color.

Grain

The tendency for grass and runners to grow horizontally. Most turf grasses grow horizontally in one direction. The horizontal growth occurs because of influences such as sun, wind, water, mowing or rolling the grass in the same direction. Horizontal growth can be discouraged by verticutting and varying mowing patterns.

Grass as a Lubricant

Lubrication is required to help prevent heat build-up due to friction between the bedknife and reel blades. This lubrication is normally provided by the grass that is being cut. Without lubrication, excessive heat build-up will cause uneven bedknife wear and poor quality of cut. Therefore, the reels must be disengaged whenever the mowers are not cutting for lengths of time longer than normal turnarounds.

Grinding

Back grinding (single blade) - the grinding wheel engages one blade at a time and passes down the length. The blade can be ground with a relief angle so that the amount of land is reduced.

Cylindrical - the reel is rotated as the grinding wheel passes down the reel, creating a true cylinder. It is not possible to create a relief angle while using a cylindrical grinder.

Height of Cut or Cutting Height

BENCH SET: The height at which the top edge of the bedknife is set above a flat level surface that contacts the bottom of both the front and rear roller.

EFFECTIVE HEIGHT OF CUT: The height of cut on the turf. This will usually be higher than the bench setting because the rollers/wheels will not sink into the turf to the ground level.

Generally, within the H.O.C. range for a given species or cultivar, mowing too closely weakens the plant, causes shallow rooting, lowers resistance to drought, increases susceptibility to fungus diseases, and encourages thinning of turf. In addition, close mowing brings more light to the ground surface and encourages the germination and growth of weedy grasses and broadleaf plants.

For example: A bench setting of 1 inch may result in an effective or actual cutting height of 1 1/16 inches because of the plant material that elevates the rollers.

NOTE: Two different cutting units set at the same BENCH HEIGHT OF CUT may have a different EFFECTIVE HEIGHT OF CUT because they have different total weights, rollers, skids and bedknife attitudes.

Hydroseeding

A high pressure spray technique for applying seed, mulch and fertilizer in a water slurry over a seedbed.

Intermediate Rough

A border between the fairway and the rough that is cut higher than the fairway and lower than the rough. It is also called the junior rough or step cut. It is generally 60 - 84 inches wide or one pass of a trim mower.

Kentucky Bluegrass (cool-season turfgrass)
A highly variable group of cultivars. The cultural intensity varies from medium high to low depending on the cultivar. Kentucky bluegrass in general must be mowed at higher cutting heights than other fairway grasses. The nitrogen requirement, thatching tendency, and irrigation needs are generally less than for bentgrass. The Kentucky bluegrass used on fairways generally has fewer disease problems than bentgrass and annual bluegrass.

Kentucky Bluegrass Polystands
Kentucky bluegrass is typically combined with the fine-leafed fescues in the northern part of the cool humid region. It is combined with perennial ryegrasses in the southern part of the cool humid region. These polystands require a higher cutting height than either annual bluegrass or bentgrass. Both the fine-leafed fescues and perennial ryegrasses establish quicker than Kentucky bluegrass. The fine-leafed fescues lack heat and disease tolerance needed to survive in the more southerly portions of the cool humid region. Most perennial ryegrass cultivars are prone to low-temperature injury and snow mold diseases in the more northerly portions of the cool humid region.

Lapping or Backlapping
A method to simultaneously sharpen the cutting edges of the reel blades and bedknife. Backlapping is done by reversing the rotation of the reel from the normal mowing direction. A abrasive paste (slurry) is applied the to the rotating reel blades with a long handled brush to aid in the sharpening process. There are different grit pastes and grades depending on need.

Marcelling
An unacceptable wavy or washboard pattern on the surface of mowed turfgrass.

Mismatch
The difference in height of cut of two adjoining cutting units. This may occur between units in a multiple cutting unit machine, or between passes by a single machine. Mismatch is caused by dissimilar HOC settings or rollers that are not parallel to the reels.

Monostand
A turf composed of one cultivar.

Mower Capacity
The area cut in a given time period. It is commonly expressed in acres per hour. Manufacturers often publish this information as part of the product specifications. However, because specific applications ultimately determine the maximum mowing speed, these calculations usually reflect straight-ahead mowing at an assumed speed with no allowance for overlap, stops, turns, etc.

The following formulas can be used to
provide a reasonable base to approximate the acres per hour if the average ground speed is known, or the average speed if the acres per hour are specified.

$$\text{Acres per hour} = \frac{\text{inches of cut x speed in mph}}{100}$$

$$\text{Speed in mph} = \frac{\text{acres per hour x 100}}{\text{inches of cut}}$$

Mowing Direction

Mowing directions are generally alternated each time a given area is cut. This will help keep the grass from laying in one direction and reduce the development of grain.

Mowing Speed

Mowing speed is related to the finish level, the type of terrain, flotation and suspension of the cutting unit. Features which improve the suspension and stability of the cutting unit usually allow increased ground speed while maintaining a high level of finish. (Also see clip.)

Overseed

To sow seed over an area which is sparsely covered with some kind of vegetation. Southern Bermuda grasses go dormant in cool months and golf course areas may be seeded with cool-season grasses for winter play.

Polystand

A turf composed of two or more cultivars and/or species.

Quality of Cut

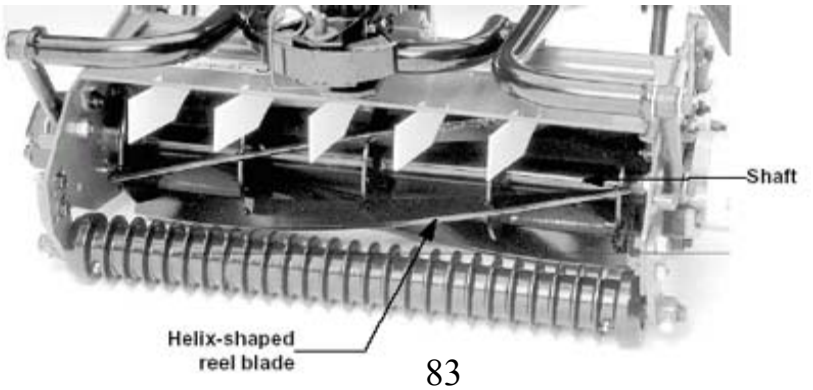
A measure of how well the cutting unit cuts the grass. Quality of cut typically includes the number of stragglers and the quality of the shear – the clean cut of the grass blade. All other measures such as clumping, mismatch, etc., are examples of aftercut appearance.

Recuperative Rate

The rate at which turf grasses recover from injury.

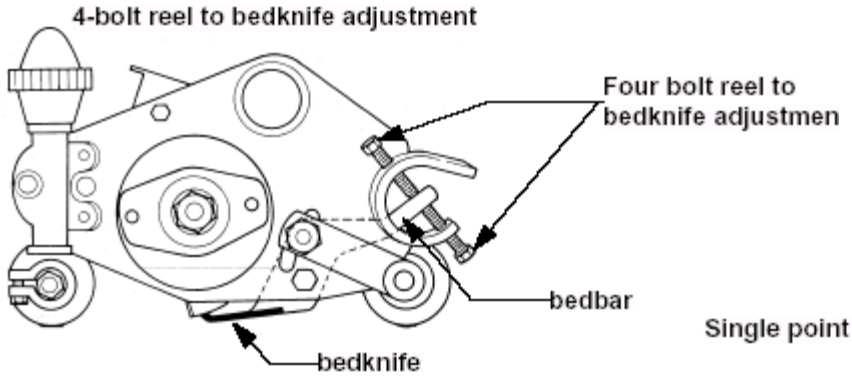
Reel

The reel consists of varying numbers of helix-shaped blades. The blades are attached to support spiders which are mounted on a rotating shaft. The reel contacts the bedknife to perform a scissors-like cutting action.

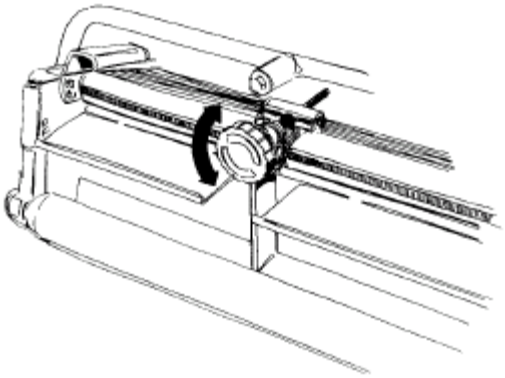


Reel to Bedknife Adjustment

Adjusts the distance between the reel blades and the bedknife. A gap causes the grass to be pinched rather than cut cleanly, and promotes dulling of the blades and bedknife. Excessive contact causes the cutting edges to wear quickly or rifle and may require more power. In order for the bedknife and reel materials to be worn away at an even, constant rate, the reel to bedknife adjustment should be frequently checked and adjusted for light contact. Continuous light contact helps maintain sharp cutting edges on the reel and bedknife.

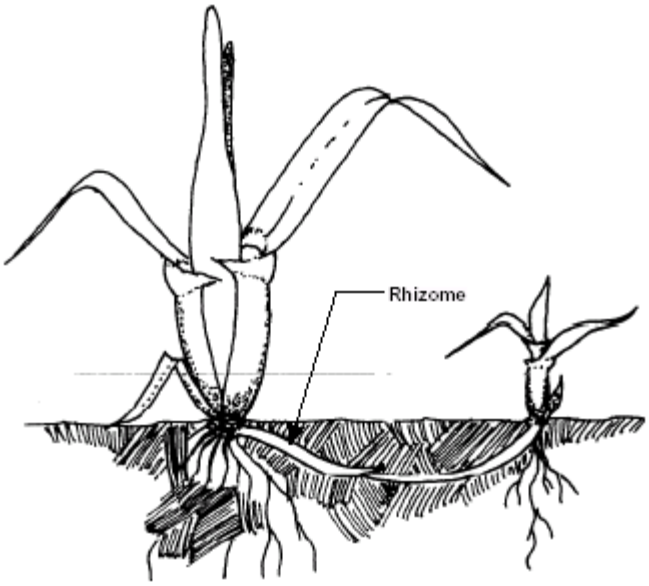


Single point reel to bedknife adjustment



Rhizome

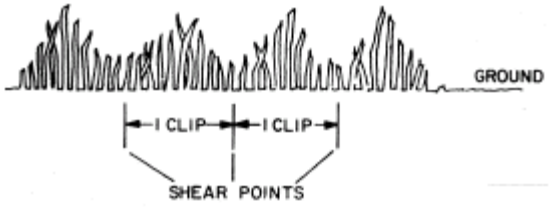
An underground, horizontally growing stem of a plant. Rhizomatous turfgrasses include Kentucky bluegrass, creeping red fescue, and Bermudagrass.



Rifling
Uneven or wavy wear of a reel and bedknife. A cutting unit which is rifled will not cut acceptably due to the variance of contact as the reel turns (a rifle cut or streak.) The most common cause for uneven bedknife and reel blade wear is due to heavy or hard contact between the reel and bedknife due to over tight adjustment. Several heavy contact points generally develop across the knife and/or reel and create greater amounts of wear in these areas. A rifled mower can only be corrected by regrinding of the knife and reel.

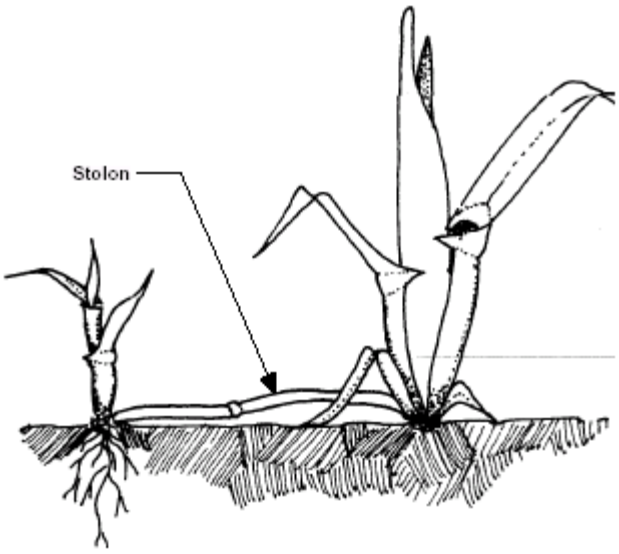
Scalping
Mowing the grass at a low height thereby removing too much blade surface and exposing brown stems and crowns. Reel mowers are prone to scalp only where the center of the turf area is higher than the supporting cutting unit ends. Scalping is caused by inability to follow contours as a result of excessive speed, improper skid or roller adjustment, too low a HOC, bumpy terrain, rough soil. Scalping also refers to the turf preparation done for overseeding.

Shear Point
The point where the reel blade and the bedknife make contact and the grass blade is actually cut.



Stems
The upward growing axis of a plant which bears leaves.

Stolon
Creeping runners which are located above ground. They may produce new roots and stems for propagation. Creeping bentgrass and zoysiagrass are stoloniferous turfgrasses.



Stragglers
Scattered uncut grass blades throughout the cutting unit path. The uncut blades stand above the general line of the effective height of cut. Cutting unit sharpness, adjustment, clip versus grass length, and resiliency are the key factors affecting this condition.

Streak
A line of taller grass that has not been cut. Single streaks are the result of a bent or nicked bedknife. Multiple streaks are more often the result of rifling due to heavy contact between the reels and bedknife. Streaks may also occur in the areas of overlap between cutting units or where a tire rolls down an area before it is cut.

Striping
Alternating color pattern caused by cutting adjacent rows of turf in different directions.

Thatch
A tightly intermingled layer of both living and dead material that develops between the green vegetation and the soil surface. A slight amount of thatch is desirable, but too large an amount will cause increased disease and insect problems. In general, the thatch thickness should not exceed the height of cut of the grass, but also should not be less than about an eighth of an inch.

Thatching, Dethatching or Verticutting
The thinning of turf grasses by blades or wire tines which cut perpendicular to the soil surface.

Topdressing
A prepared mixture of soil (preferably sterilized) usually containing a desired specification of silt, clay, sand and organic matter. It also may contain physical conditioning materials, nutrients, and pesticides which are spread over turfgrass areas for improving the surface, adding to the nutrient supply of the soil, or applying pesticides. It is used for leveling, smoothing, covering, and as an aid in controlling thatch.

Trimability
Related to the maneuverability of the tractor, but also a function of the mower attachment design. The size of the uncut circle and cutting unit offset are measurements of this factor or indicators of the mower's ability to trim.

Verticutting, Thatching or Dethatching
The thinning of turf grasses by blades or wire tines which cut perpendicular to the soil surface.

Warm-season Turfgrasses
Warm-season grasses grow best at temperatures between 80° and 95° F. They are limited in their range by the intensity and duration of cold temperatures. Warm-season grasses are primarily used in tropical and subtropical areas. Examples: Bermudagrass and zoysiagrass.

Washboarding
An **UNACCEPTABLE** wavy pattern on the surface of mowed turfgrass.

Wave
An **UNACCEPTABLE** wavy pattern on the surface of mowed turfgrass.

Windrowing
The discharge of clippings creating a visibly unacceptable trail of cut grass.

Zoysiagrass (warm-season turfgrass)
Zoysiagrass is adapted to a wide range of soil conditions but grows best on well-drained, slightly acid, medium textured soils of moderate fertility. Zoysiagrass is very tolerant of drought, heat, and cold. It is slow to green up in spring, and late-season straw coloring begins with the advent of 50° to 55° F temperatures. Another feature that limits its use is its slow establishment rate. Zoysiagrass is however, successfully used as a fairway grass in transitional climates where some cool-season and other warm-season grasses encounter the limits of their adaptation.

Fairway Turfgrass Species				
Cultural intensity	Extent of use	Cool Climate	Warm climate	Transition climate
Medium to low maintenance	Wide	Kentucky bluegrass	Common bermudagrass	Common bermudagrass
		Annual blue grass (Poa annua)		
	Limited	Colonial bentgrass	Zoysiagrass	
		Red fescue		Zoysiagrass
		Chewings fescue		
		Perennial ryegrass		
High maintenance	Moderate	Annual bluegrass (when used as a perennial)	Improved bermudagrass	Improved bermudagrass
		Creeping bentgrass		

Machine Terms That Are Often Used Incorrectly

None of the following words are interchangeable; each designates a very specific meaning.

Mower —The mower consists of two functional sections: the traction unit and the mowing components. The mowing components consist of the carrier frames, lift arms, cutting units and cutting unit drives.

Lift Arm — The lift arm is a structural unit which lifts and lowers the cutting unit.

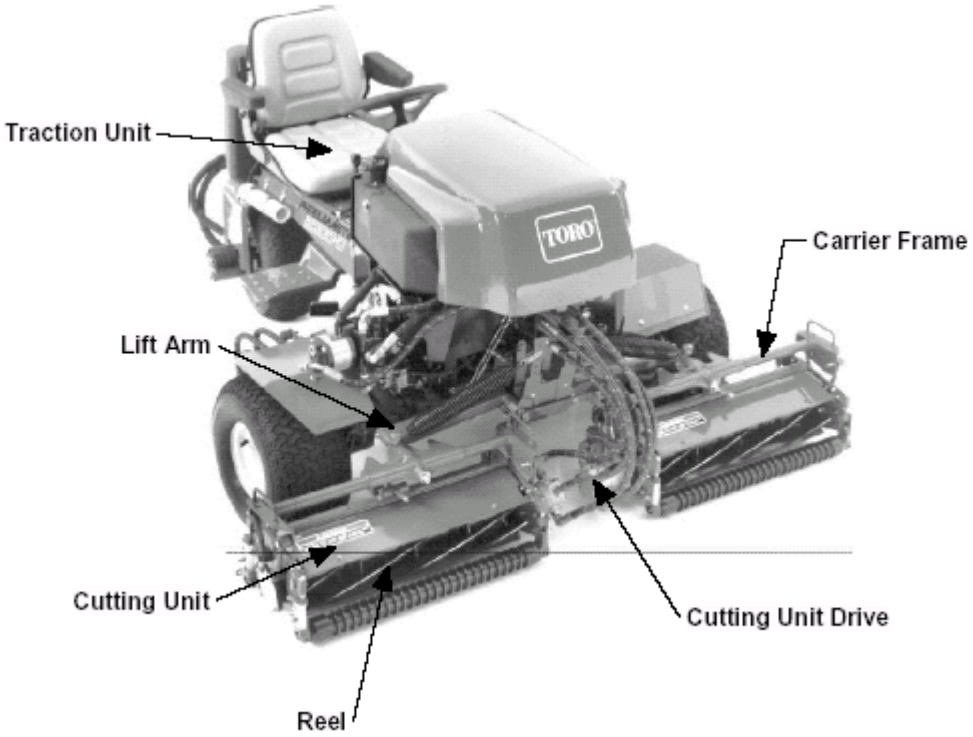
Carrier Frame —The carrier frame connects the lift arm to the cutting unit and allows the cutting unit to pivot and follow ground contours.

Cutting Unit — The cutting unit consists of a reel, front and rear rollers, a bedbar/bedknife assembly, and related adjusting mechanisms.

Cutting Unit Drive —Power for the cutting unit is provided by a belt and pulley system, hydraulic motor, electric motor, or ground driven wheels.

Reel — The reel consists of varying numbers of helix-shaped blades. The blades are attached to support spiders which are mounted on a rotating shaft. The reel contacts the

bedknife to perform a scissors-like cutting action.



Misleading Terms That Deal With Unacceptable After Cut Appearance

Bobbing — An undesirable *cutting unit movement* that leaves an unacceptable wave-like appearance. Bobbing refers to the machine movement not the aftercut appearance. As a general rule, mowing slower should lessen the problem.

Overlap stripes — An unacceptable after cut appearance of stripes that occurs in the area of the cutting unit overlap.

Clumping — The discharge of clippings into unsightly lumps or rows. Excessive clippings besides being unsightly may smother the grass or act as incubators for disease.

Streak— A line of taller grass that has not been cut. Single streaks are the result of a bent or nicked bedknife. Multiple streaks are more often the result of rifling due to heavy contact between the reels and bedknife. Streaks may also occur in the areas of overlap between cutting units or where a tire rolls down an area before it is cut.

Mismatch — The difference in height of cut of two adjoining cutting units. This may occur between units in a multiple cutting unit machine, or between passes by a single machine. Mismatch is caused by dissimilar HOC settings or rollers that are not parallel to the cutting units.

Stragglers — Scattered uncut grass blades throughout the cutting unit path. The uncut blades stand above the general line of the effective height of cut. Cutting unit sharpness

adjustment, clip versus grass length, and resiliency are the key factors affecting this condition.

Interchangeable Terms

The following four terms are used interchangeably in the golf industry. The terms do not describe different aftercut characteristics. There are many different causes for this wavy appearance.

Marcelling — An unacceptable wavy pattern on the surface of mowed turfgrass.

Corrugation — An unacceptable wavy pattern on the surface of mowed turfgrass.

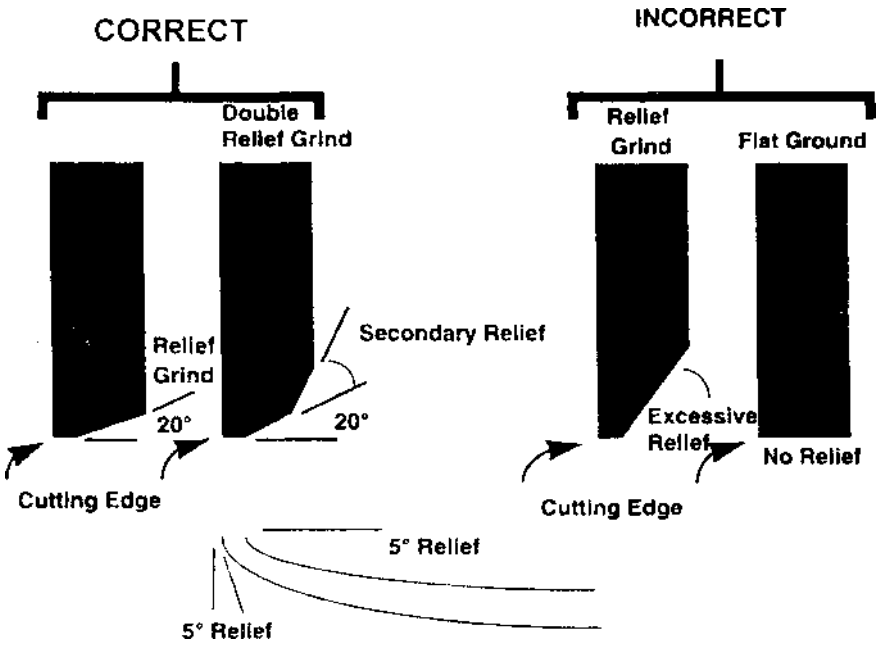
Washboarding — An unacceptable wavy pattern on the surface of mowed turfgrass.

Wave Cut — An unacceptable wavy pattern on the surface of mowed turfgrass.

MANUFACTURERS RECOMMENDATIONS

- **John Deere**
- **Toro**
- **Jacobsen**

RELIEF GRINDING



John Deere recommends Relief Grinding the reels before spin grinding for these reasons:

- ➔ Reduced blade contact area, results in less friction, requiring less horse power to drive the reel.
- ➔ Ensures longer wear life.
- ➔ **Less time is required to backlap.**
- ➔ Reduces pulling and tearing of the grass as the unit gets dull by use.
- ➔ **Provides an area for backlapping compound to be trapped to more effectively backlap reels.**
- ➔ Relief grinding removes metal fro the trailing edge of the blade forming an angle (Relief Angle) to reduce the contact area of the cutting edges.
- ➔ Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is .001" to .002" too high.

BACKLAPPING

This procedure is used to sharpen the cutting edges when grinding is not necessary. See Reel/Bed Knife Grinding in this section, to determine if grinding is necessary.

Backlapping, when compared to grinding, removes a very small amount of metal, requires less time and will effect a smooth, clean cut.

The backlapping procedure is accomplished by spinning the reel backwards while applying special abrasive compounds to the reel. Usually course compounds are used initially followed by a finer abrasive for final honing. Recommended grits for fairways and roughs are 60, 80, and 120. Reel sharpening compounds should not be toxic, oily or greasy.

The cutting unit should be inspected, backlapped, adjusted and checked daily for a uniform cut along the complete length of the bed knife. It is important that the adjustment allows the reel to turn freely without dragging against the bed knife. Metal-to-metal contact will generate heat, causing the reel to expand and intensifying the dragging that produces more heat. This viscous cycle will quickly "shut-down" the mower.

SMOOTH ROLLER

The roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward. A smooth roller is always used on the rear of a cutting unit to establish the cutting height range.

JOHN DEERE STUDY ON REEL LOADS OF RELIEF GROUND VS NO RELIEF ON REELS*

	Reel-Bedknife Clearance		
	.002" Gap	.005" Gap	Touch
Relief Ground Reel/Sharp Bedknife (HP per unit	0.75 HP	.74 HP	.88HP
No Relief Reel/Sharp Bedknife (HP per unit)	.87HP	.87HP	2.59HP
% Increase in HP Consumed per unit	16%	17.50%	294%
Increase in HP Consumed per 3235 (5 UNITS)	0.6HP	0.65HP	8.55HP

93

*TESTS CONDUCTED WHILE MOWING 1.5" BERMUDA TO 1.0"HOC

TORO REEL AND BEDKNIFE GRINDING GUIDELINES

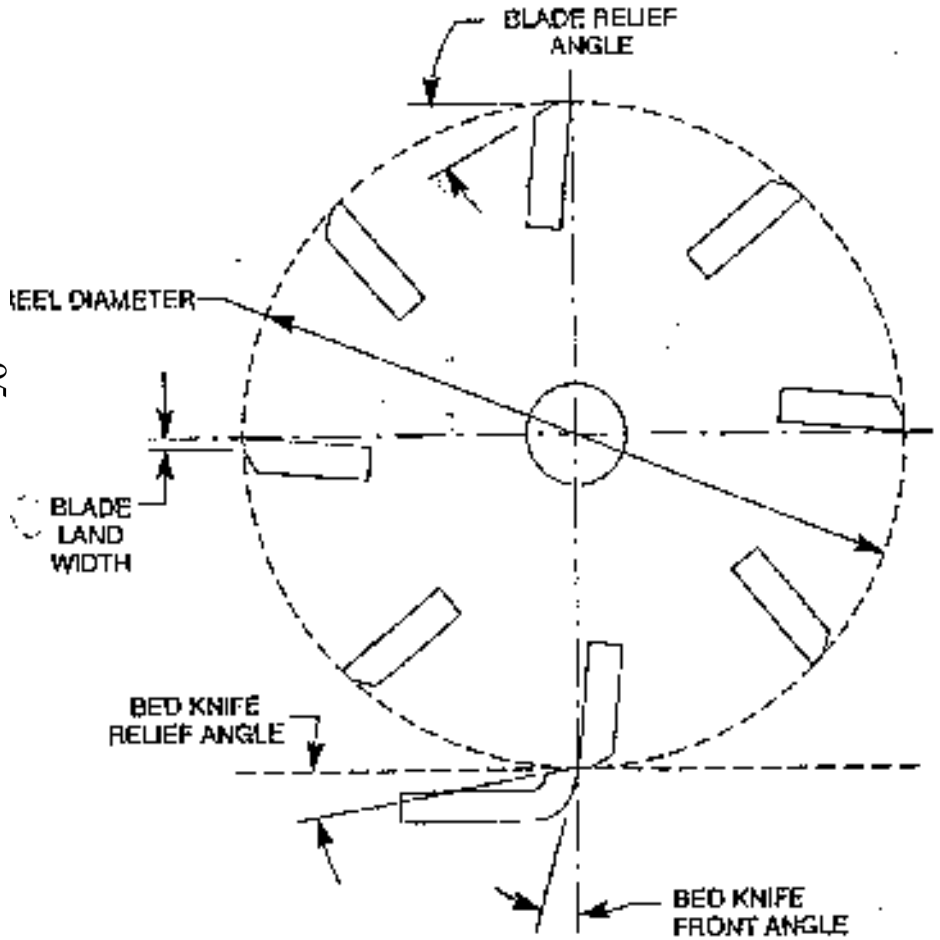
Characteristic	GR 500	GR1000 GR 3000'S	RM 223 RM 5000'S	RM108	RM 216 RM 2000'S
Normal Reel Diameter	3.5" (88mm)	5" (126mm)	5" (126mm)	7" (178mm)	7" (178mm)
Number of blades	9	5, 8,11	5, 8	5, 6	5, 8
Service Limit Reel Dia.	3.2" (82mm)	4.5" (114mm)	4.5" (114mm)	6.2" (158mm)	6.2" (158mm)
Blade Relief Angle	30	30	30	30	30
Relief Angle Range	20-40	20-40	20-40	20-40	20-40
Blade Land Width	.040" (1.0mm)	.040" (1.0mm)	.040" (1.0mm)	.060" (1.5mm)	.060" (1.5mm)
Land Width Range	.030 -.060" (.7-1.5mm)	.030-.060" (.7-1.5mm)	.030-.060" (.7-1.5mm)	.050-.090" (1.3-2.3mm)	.050-.090" (1.3-2.3mm)
Maximum Allowable Reel Diameter Taper	.040" (1.0 mm)	.040" (1.0mm)	.040" (1.0 mm)	.060" (1.5 mm)	.060" (1.5 mm)
Bedknife Relief Angle	5	5	5	5	5
Relief Angle Range	3 - 6	3 - 6	3 - 6	3 - 6	3 - 6
Bedknife Front Angle	15	15	15*	15*	15*
Front Angle Range	13 - 17	13 - 17	13 - 17	13 - 17	13 - 17

TORO REEL AND BEDKNIFE GRINDING GUIDELINES

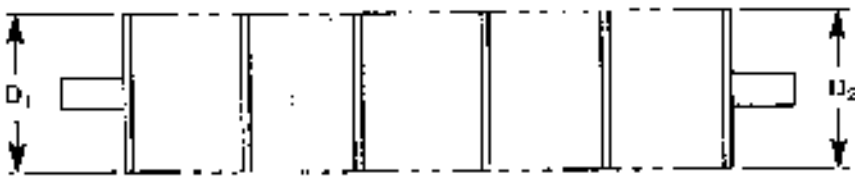
Characteristic	RM 6000'S	TURF PRO HTM 175	SPARTAN RM 11	SPARTAN RM 5 & 7	RM 335 RM 3500 RM 450 RM 4000'S
Norminal Reel Diameter	7"	7"	7"	8"	8"
Number of Blades	5, 11	5, 7	11	5, 7	5,7,11
Service Limit Reel Diameter	6.2" (158 mm)	6.2" (158 mm)	6.2" (158 mm)	7.2" (182 mm)	7.2" (182 mm)
Blade Relief Angle	30	30	30	30	30
Relief Angle Range	20-40	20-40	20-40	20-40	20-40
Blade Land Width	.060" (1.5mm)	.060" (1.5 mm)	.060" (1.5 mm)	.060" (1.5 mm)	.060" (1.5 mm)
Land Width Range	.050" - .090" (1.3 - 2.3mm)	.050 - .090" (1.3 - 2.3mm)	.050 - .090" (1.3 - 2.3mm)	.050 - .090" (1.3 - 2.3mm)	.050 - .090" (1.3 - 2.3mm)
Maximum Allowable Reel Diameter Taper	.060" (1.5mm)	.060" (1.5mm)	.060" (1.5mm)	.060" (1.5mm)	.060" (1.5mm)
Bed Knife Relief Angle	5	5	5	5	5
Relief Angle Range	3 - 6	3 - 6	3 - 6	3 - 6	3 - 6
Bedknife Front Angle	15*	15*15	15*	15*	15*
Front Angle Range	13 - 17	13 - 17	13 - 17	13 - 17	13 - 17

*** If height of cut is 1/2" or lower on these cutting uits, the front angle can be increased to 30 for improved performance**

Toro Reel and Bed Kife Regrinding Guidelines

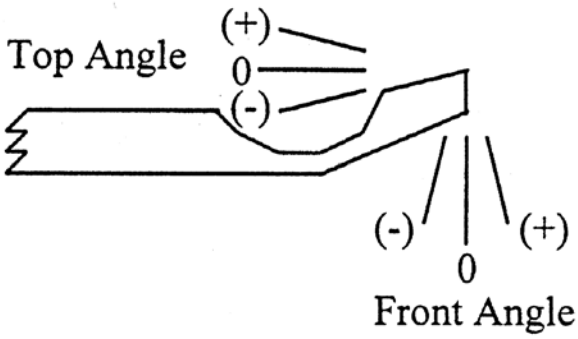


REEL TAPER ILLUSTRATION



REEL DIA TAPER = $D_1 - D_2$

Jacobsen
BEDKNIFE GRIND ANGLES



NOTE: The sketch is for reference and does not depict the actual shape of the bedknife (shape varies).

The following are the bedknife grinding specifications for all Jacobsen cutting units:

Turf King 11 (76 & 84)	ST -5111
F-133	Fairway
HF-5	Blitzer
HM-11	Ranger
Trim King	Tri - KIng 1671, 1672, 1684, 1900 series

Top face angle ..... 4 - 6 degrees (+) Positive
Front face angle ..... 0 -5 degrees (-) Negative

19" GM, 22" GM	TF/60
GK 418, GK 422, GK 426	LF - 3810
GK 518, GK 522, GK 526	LF 100
GK, GKII, GKIV Plus	LF 123/128
GKV, GK Electric	LF 135

Top face angle ..... 8 - 10 degrees (-) Negative
Front face angle ..... 0 - 5 degrees (-) Negative
Front face width ..... 3/64 Tournament
Special tournament
1/16 Low Profile
3/32 Hight Profile
1/8 Heavy section

PRACTICE EXAM
Please note:

The purpose of these questions is to familiarize you with the type of questions you will see on the certification test and to see how easily the questions and answers flow through your thought processes.

Do not refer to the list of answers until you have finished the entire study guide and the practice exam. As you study through this guide, come back and read all the questions and answers repeatedly. Remember, it is just as important to understand why an answer is incorrect as to know the correct answer.

As you finish this course of study the answers should flow easily. If they don't, go back and study the whole section or topic in question, not just the particular answer you're having difficulty with.

Good Luck!

1. Reel mowers were originally designed in the early 1800's to cut?
   a. Cotton
   b. Hay
   c. Carpet
   d. Grass

2. In the USA lack of availability of spin grinders led to single blade grinding and "backlapping" a combination which resulted in
   a. Increased friction between the reel and bedknife.
   b. More horsepower to pull or push the mower through the grass.
   c. A technique of grinding the back edge of the blade called "Relief Grinding".
   d. All of the above.

3. Technician A believes Reel cutting units give the best quality of cut, and a more exact height of cut. Technician B believes Rotary Cutting units are less expensive to purchase and easier to maintain, who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and B
   d. Neither Technician A or B

4. A Reel Cutting unit consists of which working parts?
   a. The Bedknife Leading Edge
   b. The Reel Blade Leading Edge
   c. The Reel Shaft
   d. Both a and b

5. The Bedknife performs which of the following functions?
   a. It is the sole or shoe running along the ground to support the cutting unit.
   b. It stands the grass up in a vertical position.
   c. The bedknife edge act as half of a scissors
   d. Both b. and c.

6. The Reel Blade performs which of the following functions?
   a. Rotates across the bedknife.
   b. Act as half of a scissors.
   c. Gathers the grass and discharges the clippings.
   d. All of the above.

11. The reel Rake Angle is?
    a. Fixed by the manufacturer and cannot be revised.
    b. Created by the slot in the spider which locates the blade on an angle.
    c. The angle that ensures front cutting edge is always forward of the blade body.
    d. All of the above.

12. Technician A. states that “Relief Angle” and “Rake Angle” are the same. Technician B states that “Relief Angle” can only be achieved with a separate and secondary grinding process. Which Technicians are correct?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A or B

13. Technician A states that a reel is cylindrical if all reel blades are on the same cutting circle. Technician B states that a reel is cylindrical if the reel diameter is equal from end to end. Which Technicians are correct?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A or B

14. Technician A states that “Optimum” quality of cut is achieved when the circularity of reel surface is straight and parallel with the bedknife surface. Technician B states that the tolerance between reel and bedknife can be +/- .001-.002.Which Technicians are correct?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A or B

15. Technician A states that the attitude of the bedknife will not directly affect how aggressively the mowing unit cuts. Technician B states that today, most cutting units are constructed with the cutting edge of the bedknife at the center or behind the center of the reel for a more aggressive lower height-of-cut with greens type mowing units. Which technicians are correct?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A or B

16. Bedknife top angle.
    a. Ranges from 3-10 degrees.
    b. Reduces metal contact.
    c. Allows cut grass to be ejected from the cutting unit.
    d. All of the above.

17. Bedknife front angle.
    a. Stands the blades of grass up in position.
    b. Ranges from 10-27 degrees.
    c. Has no effect on height of cut.
    d. All the above

18. Technician A states the closer the bedknife is to the center of the reel the more aggressive the cut. Technician B states the more aggressive the cut the less the grass will be stressed on a triplex greens mower. Which Technicians are correct?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A or B

19. What adjustments and maintenance practices affect the aggressiveness of the reel/bedknife relationship?
a. New bedknife.
b. Refacing the bedknife
c. Roller set up.
d. All of the above

20. Clip rate is determined by :
a. The RPM of the reel.
b. The travel speed of the cutting unit over the terrain.
c. The number of blades of the reel.
d. All the above.

21. Technician A states that to mow roughs the top surface of the grass can be wavy so a 5 bladed reel at a high RPM is desirable. Technician B states that for greens an 11 blade reel at low RPM is best. Which Technicians are correct?
a. Technician A.
b. Technician B
c. Both A and B
d. Neither A or B

22. The number of reel blades selected for an application should consider:
a. Cutting efficiency, and throw pattern.
b. Length of grass blades.
c. Clip spacing, speed , and mowing frequency.
d. All the above.
c. Incorrect blade count.
d. All the above.

23. Fanning and marcelling are two examples of what can occur when using:
a. Incorrect RPM
b. Incorrect mow speed.
c. Incorrect blade count.
d. All the above.

24. Technician A states that a perfectly sharpened and adjusted mower will cut 100% of grass mass at the "shear point." Technician B argues that a perfectly sharpened mower will leave 20-30% of the grass at peak points uncut at the desired height of cut. Which Technicians are correct?
a. Technician A
b. Technician B
c. Both A and B
d. Neither A or B

25. Technician A states that a frequency of cut too slow a (lower number) results in Marcelling. Technician B states that a frequency too fast a (higher number), over stresses grass and accelerates component wear. Which Technicians are correct?
a. Technician A.
b. Technician B.
c. Both A and B.
d. Neither A or B

26. Marcelling :
a. Usually occurs when the forward operating speed of a mower is excessive.
b. Expressed geometrically is the hypotenuse of an isosceles triangle formed by the turf grass shoots drawn together where the clipping occurs.
c. Both a and b are correct.
d. Both a. and b are incorrect.

27. Marcelling:
    a. Is the height difference between peaks and valleys of cut.
    b. Is observable where large restitution heights and substantial shoot height variations occur.
    c. Both a and b are correct.
    d. Both a. and b. are incorrect.

28. Technician A states that "Bench Setting" Height of Cut measures the distance between the top of the bedknife (cutting surface) and the bottom of the rollers (the supposed ground level). Technician B states the effective height of cut is the "true height of cut" or the actual height of grass after mowing. Which technicians are correct?
    a. Technician A.
    b. Technician B
    c. Both A and B
    d. Neither A or B

29. Effective Height of cut is affected by which of the following factors?
    a. Soil conditions.
    b. Down Pressure.
    c. Weak, limp grass in early spring or fall.
    d. All the above.

30. Technician A states that thick lush grass will raise the Height Of Cut (HOC). Technician B states that thatch will lower the HOC. Which Technicians are correct?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A or B

31. Technician A states that smooth rollers will lower HOC. Technician B states Grooved rollers will raise the HOC. Technician C states that heavier reels lower HOC approximately .005 for every additional 10 pounds. Which Technicians are correct?
    a. Technician A.
    b. Technician B.
    c. Technician C.
    d. All are correct.

32. Which of the following conditions contribute to the reel and bedknife dulling process.
    a. Dirt and sand.
    b. Rust and grass.
    c. Foreign objects and chemicals.
    d. All of the above.

33. Technician A states "cut quality" can depend on bedknife attitude, bedknife parallel to reel, cutting unit counterbalance and reel speed. Technician B states "cut quality" can be effected by worn bearings, bent cutting unit frame, broken welds and loose attaching hardware. Technician C. states "cut quality" can be effected by mowing speed, tire pressure, and engine governed speed. Which Technicians are correct?
    a. Technician A.
    b. Technician B.
    c. Technician C.
    d. All the above.

34. Technician A states that the 45 degree edges must be restored for a quality cut. Technician B states that it only takes six to ten hour of mowing operation to dull the reel and bedknife. Technician C states the dulling process closes the gap between the cutting edges. Which Technicians are correct?
    a. Technician A.
    b. Technician B.
    c. Technician C.
    d. All the above.

35. Which maintenance practices optimize cut Quality?
a. Adjustment.
b. Backlapping.
c. Grinding.
d. All the above.

36. Technician A states the OEM specification for cutting unit design includes a “relief” in the blade whether making contact or not reduces friction. Technician B states bedknife & reel wear creates additional friction. Which Technicians are correct?
a. Technician A.
b. Technician B.
c. Both A and B.
d. Neither A or B

37. The OEM specification for cutting unit design includes a “relief” in the reel blade causing which of the following effects?
a. A reduction of stress on the hydraulic system.
b. Minimizing the stress on the engine.
c. Maximizing the horsepower for the traction unit.
d. All the above.

38. Technician A states that some manufacturers prefer a clearance between .001” and .003” reel to bedknife setting. Technician B states that some manufactures recommend “light” contact when setting the reel. Which Technicians are correct?
a. Technician A.
b. Technician B
c. Both A and B
d. Neither A or B

39 When adjusting reels that specify between .001” and .003” Technician A uses a feeler gauge starting on the trailing edge of the reel where there is a slight drag on the gauge between the reel blade and bedknife. Technician B using the newspaper method inserts it in the reel perpendicular to the top surface of the bedknife. Which technicians are correct?
a. Technician A
b. Technician B
c. Both A and B
d. Neither A or B

40 When adjusting reels that specify between .001” and .003” Technician A states using the paper method, the paper will be pinched and if the paper is cut the reel is too tight. Technician B uses two pieces of newspaper, one will be folded while the other is cut, providing a desired gap. Which technicians are correct?
a. Technician A
b. Technician B
c. Both A and B
d. Neither A or B

41 When using the feeler gauge to adjust a reel you should _____ .
a. Start your adjustment on the trailing edge of the reel
b. Spin the reel while making gauge checks
c. Alternate sides on the outer ends of the reel until the clearance is equal on both sides
d. Make your checks along different reel blade

42 The reel and bedknife wear process that occurs over time illustrates that _____
a. The “contact noise” will go away
b. You can effectively cut grass with a .001- .002 tolerance
c. All feel to bedknife adjustments should be “light” contact.
d. There will always be a gap during adjustment

43 When reels are properly adjusted they will _____

a. Never need backlapping
b. Make “light” metal to metal contact
c. Have a .001”-.003” gap
d. Be more effective for a longer period of time

44 Which is the appropriate adjustment clearance for reel to bedknife?

a. Slight metal to metal contact
b. .001”- .003” gap
c. Enough metal to metal contact to hear a contact noise or whisper
d. Refer to OEM guidelines

45 What must occur when paper can’t be cut cleanly with the desired set-up clearance?

a. The amount of metal to metal contact must be increased.
b. The height of cut must be changed
c. Corrective action must be taken
d. Backlapping or grinding must occur

46 Which factor would cause reels to cone?

a. Metal to metal reel to bedknife adjustment
b. Backlapping
c. Relief grinding
d Spin Grinding

47 Coned reels will cause which result?

a. Less wear on the bedknives.
b. A more even cut
c. Faster wear on all bearings
d. A decrease in the consumption of fuel

48. Which reel phenomena would cause a mismatch in the height of cut between adjacent reels?
a. Excessive relief on reel.
b. The leading edge of the reel wears more than the trailing edge
c. Coned Reel
d. Excessive metal to metal reel adjustment

49 An uneven cut of ___ of an inch in set-up with your reels can be visible to the human eye.

a. .001”-.003”
b. .010”
c. .100”
d. .050”

50. Which coned reel condition effects the aftercut appearance of turf?

a. “Blade path”
b. “Height of cut”
c. “Spin Grinding”
d. “Relief Grinding”

ANSWERS FOR SAMPLE TEST QUESTIONS

1.-C
2.-D
3.-C
4.-D
5.-D
6.-D
7.-B
8.-D
9.-D
10.-D
11.-D
12.-B
13.-C
14.-C
15.-B
16.-D
16.-D
17.-A
18.-D
19.-D
20.-D
21.-D
22.-D
23.-D
24.-B
25.-D
26.-C
27.-C
28.-C
29.-D
30.-A
31.-C
32.-D
33.-D
34.-B
35.-D
36.-C
37.-D
38.-C
39.-D
40.-C
41.-C
42.-B
43.-D
44.-D
45.-D
46.-B
47.-C
48.-C
49.-B
50.-A