KPS™

Manual

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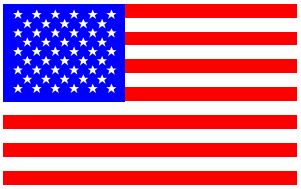

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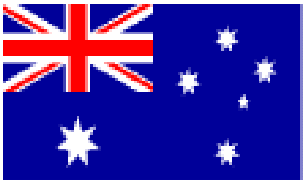

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Key Knife History

1986 - *Bob Bayly and Tom Carpenter joined forces in Portland, OR to design and build a disposal knife for OSB plants. After a year of work, they chose to proceed with the development of a second concept upon the recommendation of Dudley Smith, who along with Bob's mother, Jane Bayly, were two of Key Knife's first financial supporters. The second concept marked the beginning of today's version of the Key Knife.*

1987 - *Bob and Tom hired Cecil Ostrander to build the first prototype of a chipper system utilizing steel knife stock "borrowed" from a friendly competitor. The first installation occurred at Mountain Fir Lumber of Dallas, OR in a Mobark chipper and ran for all of 30 seconds. Once they resolved the matters of hardness and radiuses, they hired their first employee, Norma Sherratt in June of 1988 and production got underway in Cecil's barn. The achievement of producing one box of knives/day was considered a great day. Only two machines could be operated at a time due to the lack of power to the shop and the grinder was in a lean-to heated by a wood stove where the coolant had to be defrosted every morning before start up.*

1989 - *The production shop was moved to a 3500 sq. ft. facility in Wilsonville, OR. During this time, the official name of the privately held organization was changed from Commercial Knife to Key Knife. $30,000 in sales for a month was considered record setting at the time. A former saw shop owner and supporter; Herb Frelich became the first production manager and the Chip-n-Saw concept was introduced in 1990. Neil Doherty was hired as the first field rep in January of 1991 and the first CNC machine purchased in 1992.*

1993 - *The manufacturing and office relocated from Wilsonville to a 20,000 sq. ft. building in Tigard, OR and the first High Recovery system was developed. In 1994, the first Blohm (a computerized grinding machine) was purchased, revolutionizing the knife production process. Two additional CNC machines and another Blohm were purchased in 1995.*

1998 - *The company relocated again, moving from Tigard to a newly built 50,000 + sq. ft. facility in Tualatin, OR with room for additional expansion. A fourth Blohm and a fourth CNC have since been added along with the establishment of a machine shop center for further expansion into in-house product development. Likewise, in-house production of additional Key Knife system components is taking place on a calculated basis as part of the organization's overall strategic plan.*

2004-*Key Knife had a record sale year, with sales increasing 26% over 2003. To meet the growing demand for Key Knife products 3 more CNC machines were added. A new R & D test center nick named the Big Beaver, was added to help with the theory and design of the next generation Key Knife chipping systems. To continue the growth Key Knife has developed innovative products for the Pulp mill, Particleboard, and OSB industries. The demand for Key Knife products and services has taken the company to new parts of the world, such as South America and Asia.*

About this Manual

This manual has been designed to be a user-friendly reference guide for the use and operation of your KPS. Included in the manual is information on the installation and operation of the KPS, in addition information and management tools. It is our hope that this manual becomes a useable tool for you and your mill. And, as always, your local Key Knife representative is always available to answer any questions that you may have.

Key Knife Patents

The Key Knife Key Pivot System (KPS) is protected under the following patents: 5,979,522 & 5,819,826,

Safety

The Key Knife conversion is designed to provide safe and dependable service, if operated according to the instructions and intended use, in the chipping of wood material. Any other use could be dangerous and is not recommended.

Be sure to read the entire System Manual before installing the Key Knife system. Failure to do so could result in personal injury or equipment damage.

Key Knives are extremely sharp! When handling the knives, use extreme caution and wear safety gloves.

Observe all equipment shutdown, lockout, and safety procedures as recommended by the equipment manufacturers, as well as, your company policies and guidelines.

Key Knife Warranty Policy

Key Knife warrants that on the date of shipment to Buyer and for one year thereafter the Products will be free of defects in workmanship and material. If within one year from date of date of shipment of the Products, Buyer discovers that the Products are not as warranted above and promptly notifies Key Knife in writing thereof, Key Knife will, at Key Knife's option, repair or replace the item and any affected part of the Products, or refund the purchase price therefore. Buyer shall assume all responsibility and expense for removal and reinstallation in connection with the foregoing remedy. The same obligations and conditions shall extend to replacement items furnished by Key Knife hereunder. Buyer agrees to grant Key Knife access to the Products at all reasonable times in order for Key Knife to determine the existence of a claimed defect in the Products. Key Knife Product systems and accessories require installation by an Authorized Key Knife Representative. Installation by anyone other than an Authorized Key Knife Representative will void the terms of this warranty. This warranty does not cover defects due to misuse, abuse, improper or inadequate installation, storage, service, modification or repair of the Products.

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Chapter One

KPS Introduction

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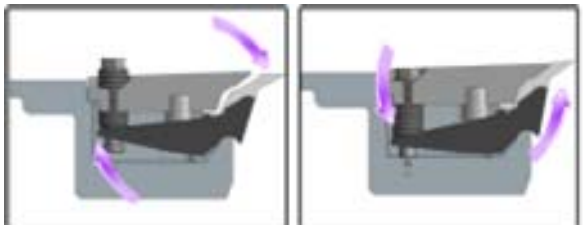
Introduction

Congratulations on purchasing a Key Knife KPS System! You have chosen the finest wood chipping technology and equipment in the industry.

Key Knife has revolutionized the whole log chipping by developing a chipper system that delivers unmatched durability, ease of use, performance and flexibility. The KPS Chipper System is designed for the progressive mill that is looking for new cutting edge technology to greatly improve chip quality and operating efficiencies. Whether you chip softwood, hardwood, frozen wood, or dry wood, the KPS flexibility gives you increased control over your operation and chip distribution.

The KPS Chipper System was value engineered to ensure it is inexpensive to run, and safe to maintain and was designed for customization and optimization for nearly all chipping requirements. This is accomplished through the UniRidge Knife, Key Pivot System, and segmented pocket design.

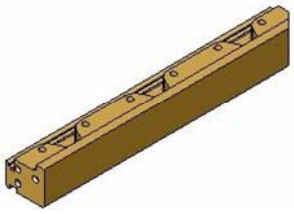


The smaller indexible KPS UniRidge Knife is safer to handle, and eliminates the costly task of grinding and babbitting.

The innovative Key Pivot System allows for quick one-man knife changes to be made in less than 30 minutes for most chippers.

Unlike all other whole log chipper systems, the KPS utilizes a segmented pocket design. This allows for the rotations of wear parts in and out of the cutting zone for a longer part life. The following pages highlight the KPS components.

KPS Holder

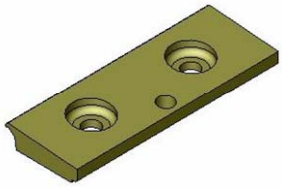


The holder is the base for the knife system and is bolted to the disc using the disc manufacturer's bolt patterns. The clamp is secured to the holder and the counterknife pivots on the radius portion of the holder.

A KPS holder is part of the KPS disc chipper retrofit. KPS holders are fastened to a chipper disc positioning knives. Holders have provisions for mounting counterknives, clamps and other KPS parts. Holders are generally application specific.

Feature	Benefit
A514 Steel	All KPS chipper holders are manufactured from A514 steel (mill proven durability).
DC 60 Wear Surface Coating	Mill proven to provide twice the component life than traditional spray-on coatings.

KPS Clamp

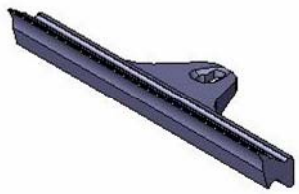


A KPS clamp is used to secure the KPS knife to the KPS counterknife. The clamp is secured by two mounting bolts to the KPS Holder.

The stationary knife clamp secures the Key Knife in the proper orientation and allows the counterknife to provide the control while the wood material is being chipped. The clamps are precision machined to fit between the back of the holder and the Ridge Knife. Clamps are designed with different levels of relief, enabling a mill to customize the amount of log control needed for its operating environment.

Feature	Advantage
Controlled Relief	Adds customization to the chipping system to optimize feed characteristics.
	Controls feeding for optimal wood control (waste wood or whole log) and best chip length formation.
	Helps to reduce wear on the faceplate and reduces power consumption.
4340 High Strength Steel	Durable performance even in the harshest chipping environments.

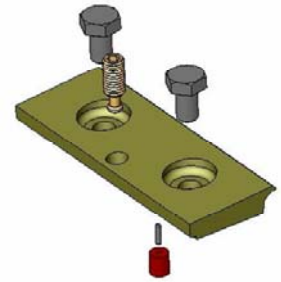
KPS Counterknife



KPS Counterknives support the KPS knife in a chipper system. The KPS Counterknife fits between the holder and knife. The counterknife pivots on the holder for knife changes. When in the closed position, it provides the clamping force to hold the knife in place during operation. The face of the counterknife is designed to maintain chip formation and efficiently transfer the chips through the chip slot.

Feature	Advantage
Forged 4340 High Strength Steel	Forged for strength, durability and stability.
DC 60 Wear Surface Coating	Mill proven to provide twice the component life than traditional spray-on coatings.
Pivot Action	Counterknife pivots to provide quick & easy knife changes.
Heat Treat to 40-44 RC	For optimal impact toughness and durability.

KPS Load Screw*

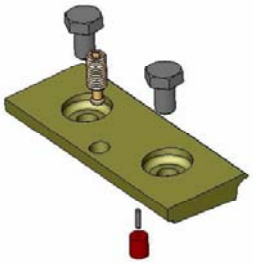


The KPS load screw passes through the KPS clamp and connects with the KPS counterknife. Tightening the load screw clamps the knife in place, while loosening releases the knife for easy changes.

The load screw applies the force required to clamp the knife. While changing knives, it is not necessary to loosen the clamp bolt, only the load screws.

Feature	Advantage
Material: 4130	Durable Performance
Induction Hardened	Prevents galling on base.

KPS Clamp Bolt*

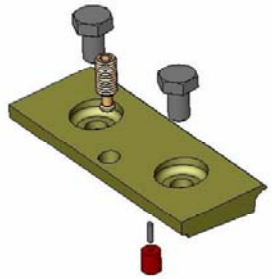


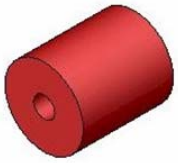
The KPS clamp screw is a custom screw made to Grade 8 specifications.

Materials & Processes:

Key Knife Custom Screw
Hex Head, Grade 8
Threads: 3/4-10 UNC-2A, 1.25 Long

KPS Spring *





The KPS Spring is attached to the KPS clamp. The spring is a solid "plastic like" part that assists opening the counterknife when the load screw is turned.

Feature	Advantage
Urethane Material	Provides long service life.

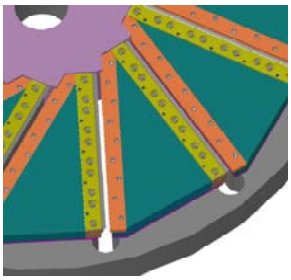
*** The KPS Load Screw, Clamp Bolt and Spring are sold as a kit.

KPS End Plate

The end plates perform two basic functions. In all cases end plates are used to seal the ends of the KPS chipper assembly to prevent packing around the moving parts of the assembly (clamp, counterknife, load screw). The end plates can also be used to adapt the KPS assembly to an internal or external radius of the disc, or adjust the overall assembly length to fit the disc's pocket.

Feature	Advantage
A514	Manufactured from durable, high strength and mill proven A514 steel.
Interchangeable end-to-end	Where possible end plates are interchangeable end-to-end reducing part count.

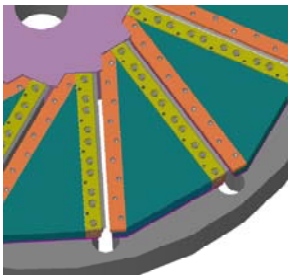
Chipper Wearplate



Key Knife designs the chipper wearplate that attach directly to a chipper disc between chipper knife assemblies.
Key Knife will occasionally design a wearplate to assist in controlling the gap opening.

Feature	Advantage
Custom Design	Designed to control gap & extension for optimal chip formation.
Material: Mild Steel	

Chipper Gap Plate



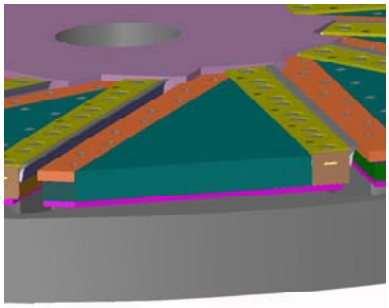
A chipper gap plate is a component typically attached directly to the wearplate, as a replaceable portion. It allows for easy and economical replacement of the high wear area at the chip chute.

It also allows for gap adjustment without full wearplate replacement.

Feature	Advantage
Material: Mild Steel	
Industrial Chrome Plating	Plating increases wearplate operational life.
Custom Design	Designed to control gap for optimal chip formation.

NOTE: Gap Plates are not designed in all chippers.

Chipper Base Plate

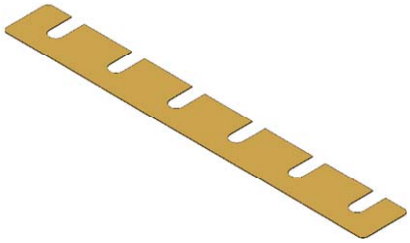


The base plate is laid across the entire disc segment. Its edges align with the edges of the chip chutes and holes are constrained concentrically with the holes in the disc.

Feature	Advantage
Material: Mild Steel	

The base plate is used to raise the holder height and provide a flat surface for mounting of the components. The base plate is typically made of mild steel, with thickness ranging anywhere from 0.250 in to 0.375 in.

Chipper Control Plate(s)



The control plates are used with the KPS chipper system to adjust knife extension and further refine chip quality.

In Pie Assemblies, control plates are inserted between the adapter plate and wear/gap plates. Inserting a control plate(s) will raise the top surface of the wear/gap plate with regards to tip of the knife, thereby reducing extension. Removing control plate(s), provides the opposite effect.

In Pocket Assemblies, control plates are inserted beneath the KPS Holder. Inserting a control plate(s) will raise the knife tip, thereby increasing extension. Removing a control plate(s), provides the opposite effect.

Control plates are made of mild steel and are available in a variety of thicknesses.

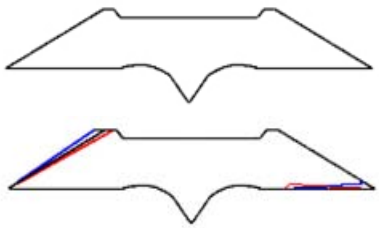
Chipper Mounting Fasteners

Bolts and studs are used to mount the holder on the disc. Typically, studs are designed with threads 1/8" smaller than the nominal diameter of the stud, and a thread stop on one end, and threads of nominal diameter on another end. Bolt and stud size are application dependent.

Feature	Advantage
Grade 8 Bolts & Studs	All mounting hardware is grade 8 for superior strength and durability.
SAE Nuts	Only SAE through hardened washers are used to assure strength and durability.
SAE Washers	Only SAE through hardened washers are used to assure strength and durability.

KPS UniRidge Knife

The knife's five-point clamping on the KPS UniRidge Knife eliminates knife flutter, greatly improving knife stability and knife life. The top keyway locates on the KPS Clamp while the bottom keyway indexes on the KPS Counterknife for superior strength. A ridge design is utilized to eliminate packing and protect the counterknife from wear.



The KPS UniRidge Knife's precision ground edges have proven to last twice as long as other indexible and conventional knife systems.

Knife variations provide an array of available customizations to improve chipping characteristics as chipping conditions change.

Feature	Advantage
Chipper Steel Material (A8)	
Heat Treated to 56-60 RC	For maximum toughness and durability.
Available in nine different knife variations	Customize the knives to meet the needs of different operating environments.

KPS™

Chapter Two

KPS Installation

Introduction

The KPS is designed as a retrofit for your existing chipper. It is designed for a precise fit and thus no modifications are needed to your chipper. This chapter will introduce you to proper installation of your new Key Knife KPS. Detailed instructions for installation can be found in Appendix **G**.

Key Knife manufactures two different styles of chippers to retrofit current chippers in the market. Our Pocket Style systems are designed for chipper discs with a drop-in pocket. Our Pie Style systems are designed to retrofit flat disc chippers that have a modular segment design. Installation instructions for both style chippers are outlined below. For a complete list of tools required for installation, see Appendix **C**.

For appropriate torque values, reference the table in Appendix **D**.

Some systems might have slightly different designs that require slight adjustments to the steps highlighted below and in Appendix **G**. Your Key Knife Representative is always available to assist in the installation and maintenance of your KPS System.

Lubricants and Shim Stock:

Key Knife recommends the use of Nickel-Based Anti-Seize compounds, such as Locktite 771, to help prevent corrosion of components.

Key Knife recommends the use of thread locking compounds, such as Locktite 242, in certain applications.

Key Knife recommends the use of either Brass or Stainless Steel Shim Stock, where a shim is required.

Installing Key Knife System

1. Remove existing system	Follow manufacturer's procedures for safe removal. Take care to properly secure the disc, as removing segments will off balance the disc. Thoroughly clean the disc pocket.
2. Install the Wearplate (Pie Installations Only)	Use a Pry Bar to ensure the wear plate does not sag in the segment area. Use Anti-Seize on the nuts and torque per the System Specification (See Appendix **D**)
3. Install Holder and Control Plates	Place the proper number of control plates in the pocket per the assembly drawings. Place the holder in the pocket and secure with provided holder bolts. Ensure the holder sits all the way back on the Wearplate (Pie Installations Only). Use Anti-Seize on the holder bolts and torque per the System Specification (see appendix **D**)
4. Install Gap Plate (Pie Installations Only, As Required)	Use Anti-Seize on the fasteners. Torque the Gap Plate Fasteners, per the System Specification. See Appendix **D**.
5. Install Clamps and Counterknives	If removed to install holder.
6. Install KPS Uniridge Knives	See Chapter 3

7. Measure Gap and Extension	Measure the gap with a straight edge and the extension with a dial indicator. Reference Extension and Gap table Chapter 4.
8. Measure and adjust run-out	Check to ensure a consistent knife height throughout the chipper. Use high-quality shim stock to adjust the low knives up to the high knife. Reference operating parameters Chapter 4.
9. Set Anvils	Set the anvil clearance to the high knife in the chipper. Reference recommended anvil clearances Chapter 4.
10. Run the chipper for several hours	This is the break-in period to allow components to settle in the pocket.
11. Check fastener torque and check all settings.	Check all fasteners to ensure proper torque after the break-in period. Recheck the run-out to ensure consistent results.

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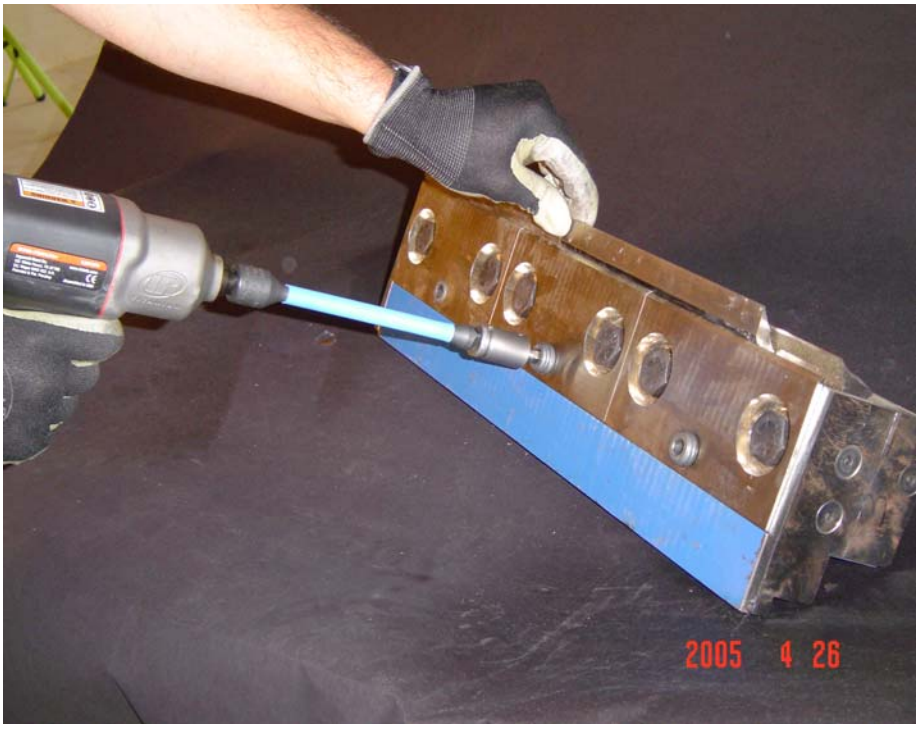
Chapter Three

KPS Knife Change



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Knife Change Procedures Pg. 2-4

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Introduction

The KPS Uniridge Knives are double-sided knives providing two cutting edges per knife. The procedure to remove and replace the knives is the same for rotating a knife. It is highly recommended that a schedule of knife changes be established and followed. Dull and damaged knives may cause excessive stress on the chipper and produce poor quality chips. By instituting a regular schedule for knife changes, you ensure your knives always maintain optimal performance. Additionally, you will not lose production time for an unscheduled mid-shift knife change.

During the knife change, remember to look for maintenance issues, such as worn or damaged components. See Chapter 5 for more details.

It is also important to emphasize the need to properly clean the pocket during a knife change. To provide superior results, the KPS is designed with precise and exact tolerances. When debris is left in the pocket, the potential for the knife not locating on the keyway exists. This problem can be compounded by additional packing developing in the pocket, creating a hydraulic effect. With proper cleaning of the pocket, the KPS will run safely and efficiently.

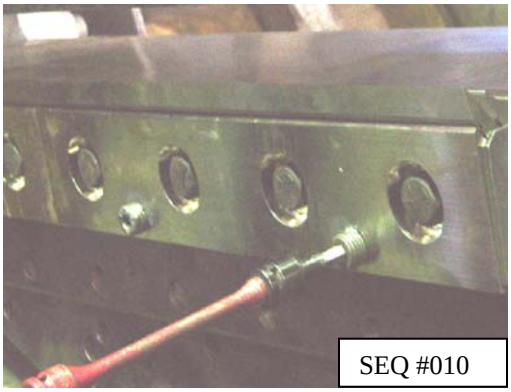
It is also common for chippers to have chip packing in the chip slot during operation. This packing can make knife changes difficult. A small prybar is an excellent tool to clean this packing out before conducting a knife change.

Warning: Key Knives are extremely sharp. When handling the knives, use extreme caution and always wear safety gloves.
Eye and ear protection should be worn when operating tools and using compressed air during the knife change.

Caution: The Load Screw must be properly torqued during the knife change to ensure proper clamping force. Failure to follow the knife change procedures can result in inadequate torque and thus inadequate clamping forces.

Knife Change Procedures

The following Sequence of Events highlights the steps for a knife change.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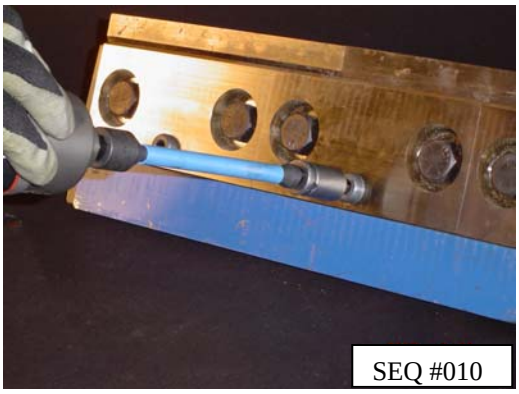
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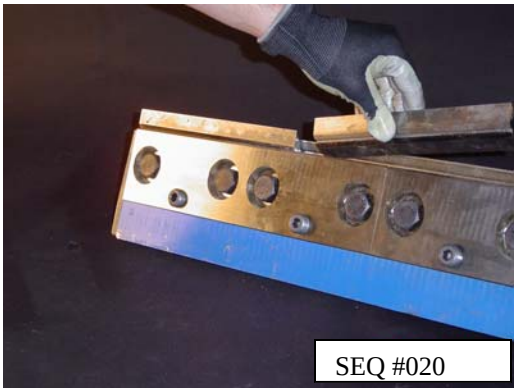
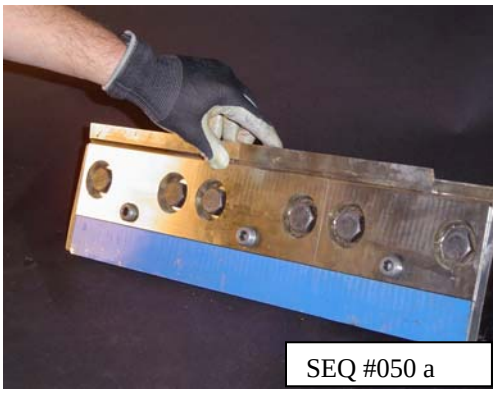
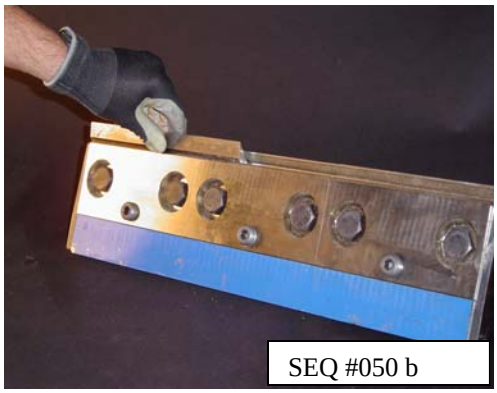
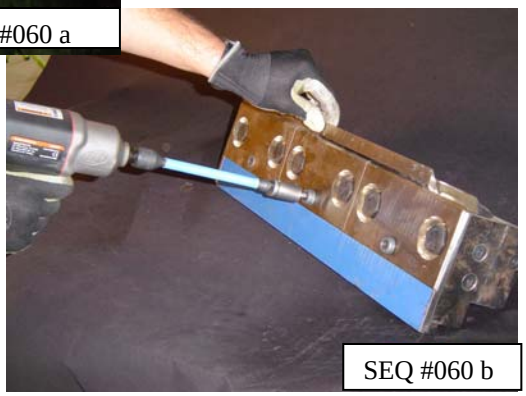

SEQ #020

SEQ #	Task Description	Additional Information
010	Open the Load Screws in the first pocket utilizing the impact wrench and 1/2" taper socket.	Open the Load Screw just until it stops. The use of the Torque Stick prevents damage to the Load Screw. Use compressed air, small pick or corkscrew to clean out the load screw, as required.
020	Remove knives from the pocket.	For knife change. If the knives are tight, simply tap the knives with a rubber mallet to loosen them.
030	Thoroughly clean the pocket.	Use a wire brush and compressed air. Pay close attention to debris at the ends of the pocket.
040	Clean knives.	For knife change. Use a wire brush and compressed air.

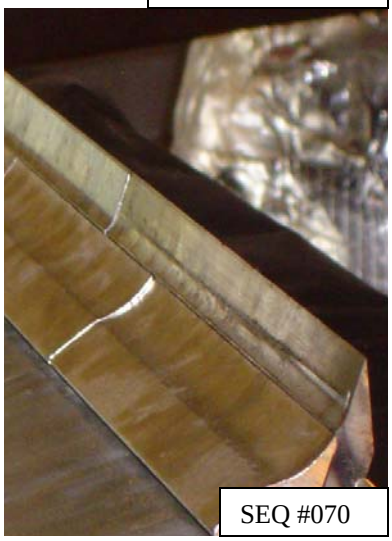

SEQ #050 a


SEQ #050 b

SEQ #060 a


SEQ #060 b

Knives Not aligned.


SEQ #070

SEQ #	Task Description	Additional Information
050	Place knives in the pocket.	Ensure the top keyway on the knives are properly located on the clamp.
060	Close the Load Screws utilizing the impact wrench, torque stick, and 1/2" taper socket.	Ensure the knives stay located on the ridge. You may have to hold the knife in place while closing the Load Screw. Apply Anti-Seize to the Load Screw, as required.
070	Ensure the knives are properly aligned in the pocket.	If the knives are not properly located on the keyway, or the pockets have not been sufficiently cleaned, the knives will not properly align in the pocket. When this occurs, take corrective action.
080	Spot check the proper torque of the Load Screws with a torque wrench.	Reference Appendix **D**. Torque Values

Tools:
Small pick
Scraping tool
Air Hose
Impact Wrench, 1/2" drive
Torque Stick, 80 ft/lb
1/2” Taper Socket, 1/2” drive
Torque Wrench, 50 - 250 ft/lb

CAUTION

Load Screw must be fully torqued to provide the proper clamping force on the knife.

Failure to apply the necessary torque can result in knife movement, reduced knife life and reduced chip quality.

SEQ #	Task Description	Additional Information
090	Repeat sequence 010 - 080 for remaining pockets.	NOTE: Ensure the Load Screws are closed before rotating the disc. Failing to do so could result in the Load Screw catching on the anvil.

KPS™

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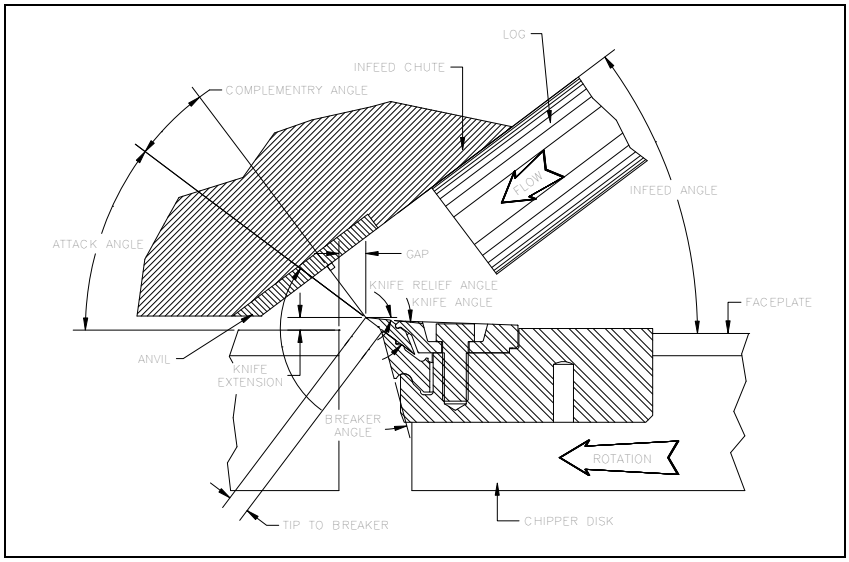
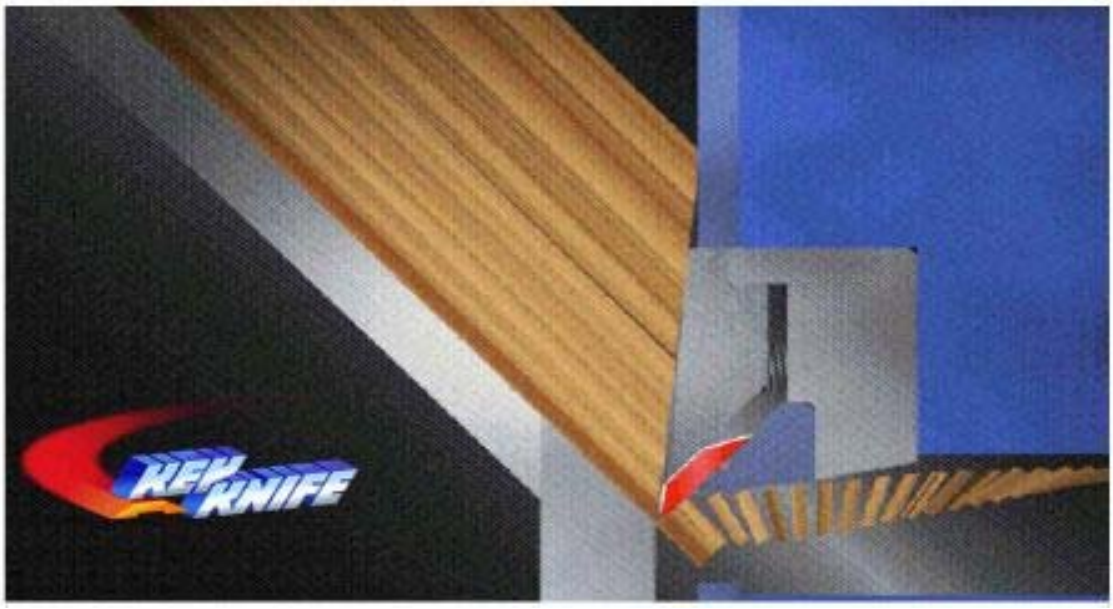
Chapter Four

KPS System Set-Up



- Theory – Wood Chipping Pg. 1-2
- Theory – KPS Chipper Pg. 3
- Attack Angle Pg. 3
- Extension Pg. 4
- Gap Pg. 4-5
- Knife Relief Pg. 5
- KPS Knife Options Pg. 5-6
- KPS Clamp Options Pg. 6
- KPS Counterknife Options Pg. 6-7
- Operating Parameters Pg. 7

Theory – Wood Chipping



Wood chipping theory relates to many different factors and may be influenced by a variety of reasons. Wood approaches the disk at the infeed angle. As soon as the knife engages the wood, the wedge of the knife begins to produce compressive forces that are translated parallel and perpendicular to the grain of the wood. These forces are referred to as:

- Cleaving splitting the chip away (perpendicular) from the grain.
- Shearing - splitting the chip along (parallel) the grain.

As the knife penetrates further into the wood, the cleaving and shearing forces increase, overcoming the strength properties of the wood. At this point in time, chip formation begins. The complimentary angle and the physical properties of the wood determine if chip formation is mainly by cleaving or by shearing.

Small knife angles and large complimentary angles cause the chips to form primarily by cleavage. Under these conditions chip quality will be high, power consumption will be low, and knife life will be low.

Large knife angles and small complimentary angles will cause the chips to form primarily by shearing. Shearing tends to damage the ends of the chips resulting in poor chip quality. In addition, the power consumption will be high and the knife life will be high.

With knife life increasing from larger knife angles, a compromise must be made between chip quality, power consumption, and knife life. The chipper settings should ensure most of the chips are formed by cleavage without sacrificing knife life.

In addition to chip formation, the forces developed parallel to the infeed angle (with the grain) provide the forward force that pulls the wood into the disk. The rate of how fast the material is pulled into the disk is limited by the relief angle (pull-in angle).

The ideal relief setting will allow the wood to contact the faceplate (behind the knife system) at the same time the knife finishes cutting through the wood. If the relief angle is too small the wood will not feed into the chipper. Since the wood doesn't get pulled into the faceplate it will be uncontrolled. When the next knife contacts the wood it will pull the wood down causing it to turn in the infeed spout. In this situation there will be degradation in chip quality. A large anvil clearance or worn anvil will cause similar wood turning problems.

If the relief is too large, the wood will contact the faceplate while the knife is still engaged in the wood. The knife is still trying to pull the wood into the chipper. However, the wood doesn't advance because it is rubbing on the faceplate. The heat caused by excessive friction increases wear, power consumption and decreases chip quality.

Chip thickness is largely dependent on the physical properties of the wood. The ratio of the compression strength (parallel to the grain) to the cleavage and shear strengths determines, to a great extent, the chip thickness.

In some cases, not all the chips will separate from one another. These groups of chips that cling together are referred to as cards and do not seriously impact the pulping process. However, they do create problems in screening as they are classified as being over-thick or over-length.

The customer purchasing the chips often defines the chip length. With the desired chip length known the extension and gap can be calculated and set.

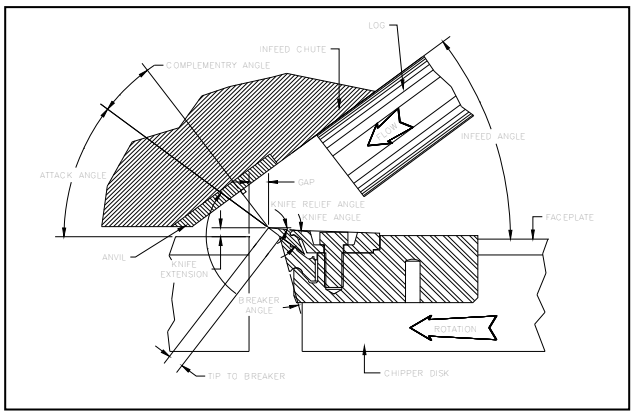
Problems can present themselves when the chipper settings are incorrect. Typically, these will appear with a variety of symptoms. A troubleshooting guide, in Chapter 6, provides additional information as to the cause of the problems. If additional assistance is needed, please contact your Key Knife Representative.

KPS Chipper Theory

To produce high quality wood chips, it is important to understand the theory behind wood chipping with the KPS. The KPS allows for customization ability beyond any other knife system on the market. In order to maximize the value that this provides the mill, Key Knife conducted an intensive research project on chipper theory and chip formation. Key Knife's thorough understanding of wood chipping and the wood chipping business, led to the creation of the KPS. The following is a diagram of all the variables and settings involved in chip formation.

Key Knife identified four crucial variables where a cutting edge chipping system could add value, and incorporated flexibility to meet every need. There are four variables that the KPS has the most influence over:

- **Attack angle**
- **Extension**
- **Gap**
- **Relief**



Attack Angle

Description: The angle from the bottom of the knife to the cutting plane of the disc.

Function: Provides shearing forces to generate chip formation.

Measurement: Angle from cutting plane to bottom of knife (keyway side), (see figure 4-1)

Key Knife Customization Ability: The wide variety of knives that are offered by Key Knife allow for changes in attack angle in different operating environments**.**

Effects of Attack: Higher attack angle generally has the following results:

1. Decrease in chip thickness
2. Increase in power consumption

Note: a lower attack angles have the opposite effect

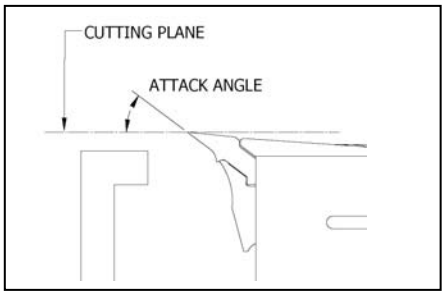


Figure 4-1 Attack Angle

Extension

Description: Extension is the position of the knife tip from the faceplate.

Function: Extension controls the formation of the chip length.

Measurement: Distance from knife tip to trailing edge of faceplate, measured perpendicular to the disc, (see Figure 4-2)

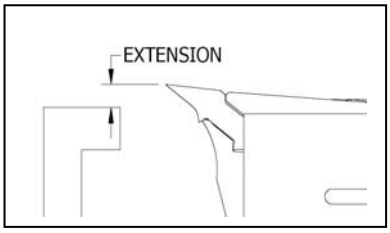


Figure 4-2 Extension

Key Knife Customization Ability: The use of control plates in the Key Knife system allows for the adjustment of the extension to meet mill needs.

Relationship to Knife Gap: The knife extension and gap settings determine the chip length. A change in extension should be accompanied by a change in the gap to maintain proper chip formation.

Effects of Extension: A higher Extension generally has the following results:

1. Increase in chip thickness
2. Increase in chip length
3. Increase in power consumption

Note: a lower extension has the opposite effect

Gap

Description: Gap is a clearance between the knife tip and the trailing edge of the faceplate.

Function: Gap position is used to control the formation of chips. It is also a clearance opening for chips to flow through and exit the chipper disc.

Measurement: Distance from knife tip to trailing edge of faceplate, measured parallel to the rotational axis of the chipper disc. (see Figure 4-3)

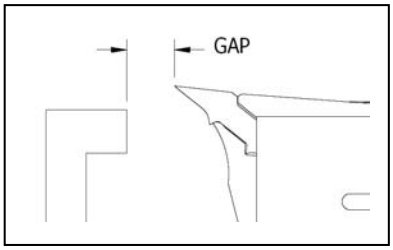


Figure 4-3 Gap

Key Knife Customization Ability: The Key Knife gap plate is used in pie-style chippers as an easy and economical way to control gap.

Relationship to Knife Extension: The knife gap and extension settings determine the chip length. A change in the gap should be accompanied by a change in the extension to maintain proper chip formation.

Effects of Gap: A larger Gap generally has the following results:

1. Increase in chip thickness
2. Larger chip distribution

Note: a smaller than optimum gap has the opposite effect.

Chip Length	Extension	Gap
0.500	0.304	0.397
0.625	0.380	0.496
0.750	0.457	0.595
0.875	0.533	0.694
1.000	0.609	0.793
1.125	0.685	0.893

Table 4-1 Extension and Gap settings for a 37.5º infeed angle and given chip lengths.

Knife Relief

Description: The angle between the top of the knife and the cutting plane of the disc.

Function: The knife relief provides a clearance for the top of the knife. This clearance prevents heat generation and premature dulling of the knife. Knife relief is set at least 1-degree more that the system relief (clamp relief).

Measurement: Angle between the top of knife and cutting plane, (see Figure 4-4)

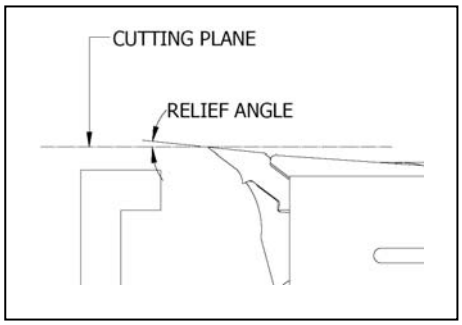


Figure 4-4 Knife Life

Key Knife Customization Ability: The wide variety of knives that are offered by Key Knife allow for changes in knife relief simply by using a different knife.

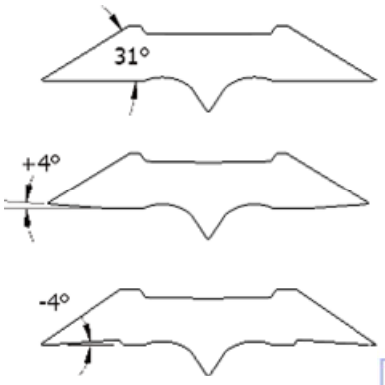
Effects of Knife Relief: A change in Knife Relief has the following effects:

- More Relief generally has the following results:
  1. More aggressive feeding
  2. Increased knife life in some environments
- Less Relief generally has the following results:
  1. Less aggressive feeding
  2. Increased log control

KPS Knife Options

The KPS system has separated the *attack angle* and the *relief* by simply changing the Uniridge Knife. By changing the bottom grind on the ridge knife, a 31-degree knife may have different attack angles. These customization features allow a mill to adapt to changes in the operating environment quickly and easily.
There are nine different knife combinations available with the KPS to match a mill's given operating environment. These different combinations are all based off of the 29º, 31º, 34°, and 35º, +4° & -4° knives.

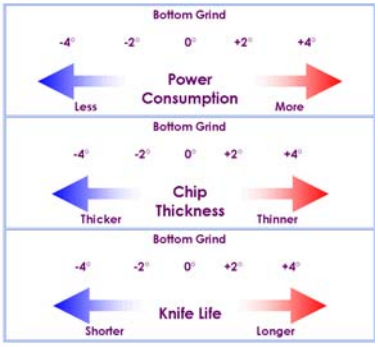
For a majority of mills (90% +) the 31º knife is the best option. However, the flexibility provided by offering different knives can be advantageous when the operating environment changes.



Basic Knife Angles	29º 31º 34º
Knife Bottom Grind Options	-4°
	0°
	+4°

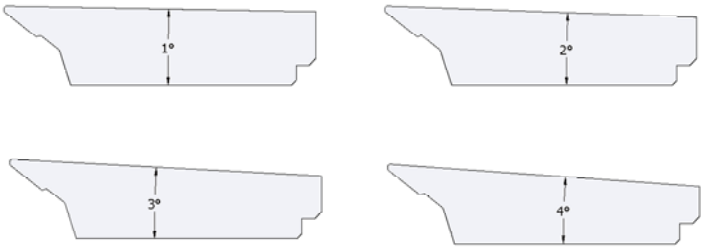
The KPS knife set up is based on the mill's operating environment and priorities:

1. Target chip quality (thickness and length)
2. Log Diameter
3. Species
4. Operational set up (horizontal feed or drop feed, style of disc, etc)



KPS Clamp Options

The different clamp options allow the KPS to provide the necessary pull in force for log stability and to minimize wear on the faceplate. Using a different relief angle on the clamp rather than the counterknife takes the pressure off the knife and extends the knife life.



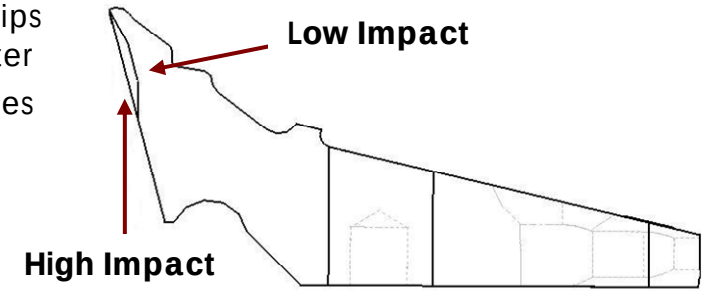
Using different clamps allows the appropriate relief to the faceplate. This relief is based on the typical log diameter and also regulates friction on the faceplate. Too much clamp relief will drive the log into the faceplate, increasing power consumption and wear. The appropriate relief will add log stability and minimize friction on the faceplate.

KPS Counterknife Options

Key Knife offers two counterknife options: High Impact and Low Impact.

Low Impact: Provides a smooth chip transition to reduce the potential of acceptable chips breaking up upon contact with the counterknife. Chips flow directly from the ridge of the knife through the low impact zone of the counterknife with minimal breakage.

High Impact: Reduces oversized chips by providing a high impact area after the chip is formed. Key Knife provides two different styles of high impact counterknives, 45 degrees and 38 degrees, with 45 degrees being the most aggressive.



Using the proper counterknife helps the KPS adapt to each mill's specific chipping conditions. Before requesting a different style of counterknife, your Key Knife representative will review your operation with you and help you decide if it is necessary to make a change.

Operating Parameters

In order to maximize the value of your Key Knife KPS System, these recommended operating parameters should be followed wherever practical.

Anvil clearance	0.015" to 0.020" from the high knife*
Knife run-out	0.010" (+.000 / -.010 from High Knife)
Knife Extension	Per chip length needs and system assembly drawings
Knife Gap	Per chip length needs and system assembly drawings
Target Knife Speed	5500 FPM / 1676 MPM
Minimum Knife Speed	3500 FPM / 1067 MPM
Maximum Knife Speed	8500 FPM / 2591 MPM
Maximum rim speed	10,000 FPM / 3048 MPM

* Refer to the Manufacturer's specification for anvil clearance to ensure the minimum safe clearance for the chipper is not exceeded.

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Chapter Five

KPS Maintenance

- Section A – Daily Operations Pg. 1
- Section B – Routine Preventive Maintenance Pg. 1-2
- Section C – Component Wear Pg. 2-6
- Section D – Operating with Frozen Wood Pg. 7
- Section E – Parts Rotation Pg. 7-8
- Section F – System Crash Recovery Pg. 8
- Section G –Spare Parts Inventory Pg. 9
- Section H – Key Knife Service Overview Pg. 9

Over time and heavy use, the KPS will wear. Worn parts must be replaced as soon as possible to minimize the possibility of component failures. Proper daily knife changes and routine maintenance on the system will help ensure it runs optimally.

Section A. Daily Operations

The routine knife change is an opportune time for operatior to note and report potential issues with the machine. Evidence of impact damage should always be noted and the appropriate actions taken to prevent further damage to the system.

Section B. Routine Preventive Maintenance

This section highlights the maintenance requirements for the KPS to run efficiently and effectively. Because each mill has different operating conditions, this schedule is considered the minimum requirement. Your Key Knife Representative can work with you to develop a maintenance schedule that fits your mill's needs.

*Appendix **E** includes examples of maintenance schedules that can be used to effectively manage your mill's maintenance program.*

Weekly Maintenance

- *Lubricate the exposed thread of the load screw with anti-seize when it is backed out*
- *Visually inspect the clamps and counterknives for impact damage or wear; change or rotate as needed*
- *Note packing between the knives and counterknives (see troubleshooting, Chapter 6)*
- *Spot Check Clamp Bolt Torque*
- *Note the anvil wear. Replace as necessary*
- *Measure and adjust the anvil clearance*

Monthly Maintenance or every 200 tons per knife inch of production, whichever comes first.

In addition to the weekly maintenance checklist, do the following:

- *Remove all knives, clamps and counterknives from the chipper (or as needed)*
- *Clean the pocket and all parts, removing all debris (or as needed)*
- *Thoroughly clean keyway and clamp*
- *Measure gap and extension; system wear in the chip chute will effect chip quality*
- *Replace wearplate / gap plate components as needed*
- *Note the wear on the holder and end plates; change as needed*
- *Ensure proper torque on all fasteners*

Quarterly Maintenance or every 600 tons per knife inch of production, whichever comes first.

In addition to the monthly maintenance checklist, do the following:

- *Visually inspect the Holder for wear; change as needed*
- *Replace all components following the instructions in Appendix **G***
- *Measure and confirm Run-Out on the chipper*

Annual Maintenance

In addition to the monthly and quarterly maintenance items, do the following:

- *Remove all system components from the disc*
- *Inspect the disc for wear and cracks*
- *Inspect all system components for wear or impact damage. Change as needed.*

*Replace the system components, following the installation instructions found in Chapter 2 and Appendix **G**.*

Section C. Component Wear

As stated in Chapter 1, your new Key Knife KPS Chipping System is designed for maximum wear ability. It also has a modular design, allowing for component rotation into and out of the work zone. This allows for longer part life.

There is a critical balance that must be maintained when deciding when / if a component is ready to be changed out. Parts must be run up to, or near their designed life. Changing too early results in waste, changing too late can result in system failure, which can outweigh savings from running a little longer.

The main components that must be watched are:

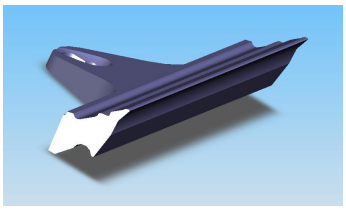
- **KPS Counterknife**
- **KPS Clamp**
- **KPS Holder**
- **Wearplate**
- **Gap Plate (not in all systems)**

KPS Counterknife:

The counterknife is probably the most important part in the system to monitor. It experiences some of the highest wear and stress in the entire system. Counterknives will wear differently from part to part, and system to system. It is important to learn to visually recognize when a counterknife needs to be replaced, since a precise measurement, is not practical or accurate.

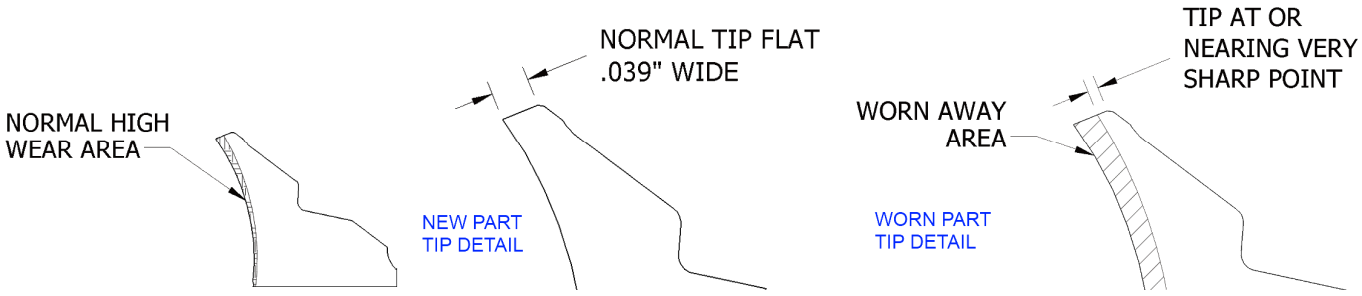
There are several typical types of wear seen on counterknives, and some are more serious than others.

1. *Normal Chip Surface Wear*
2. *Junction Wear*

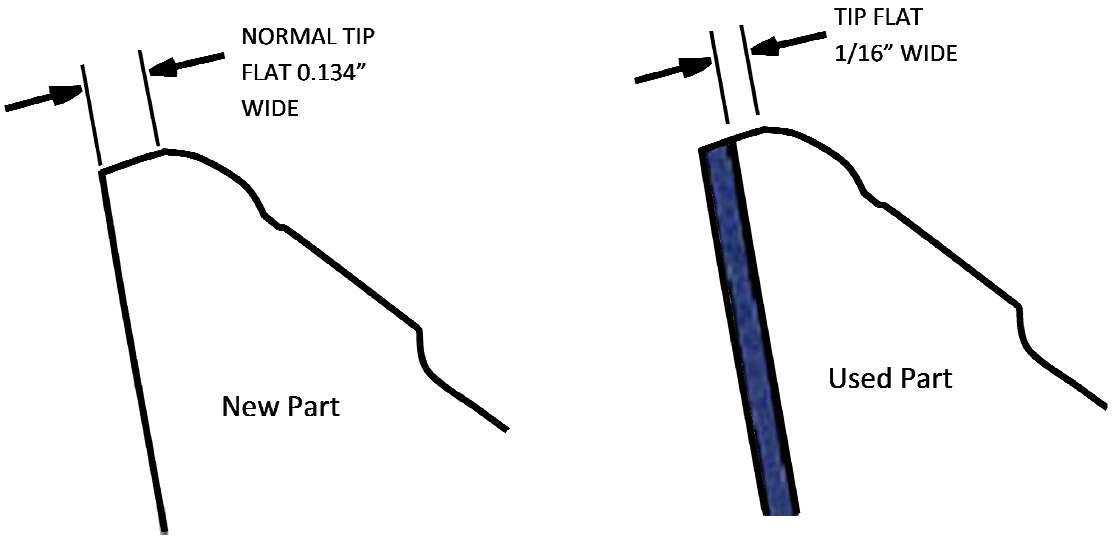


1. **<u>Normal Chip Surface Wear</u>:** *The most common, and serious, type of wear. Chip Flow will eventually break through the hard surface, and begin to remove base metal. The overall strength of the part depends on the depth of wear, how much of the length of the part is worn, and width of the wear away from the tip.*

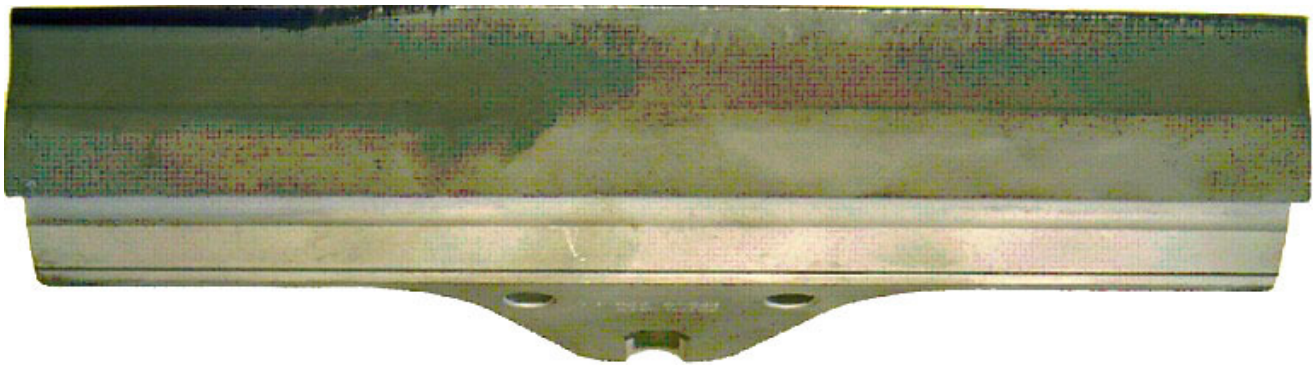
   - **KPS XL Parts.** *If a third (1/3) of the length of the counterknife is worn to a sharp point (as shown in detail below), it is time to change the part, or rotate to a position in the pocket where the highly worn area is not in a hard work zone.*



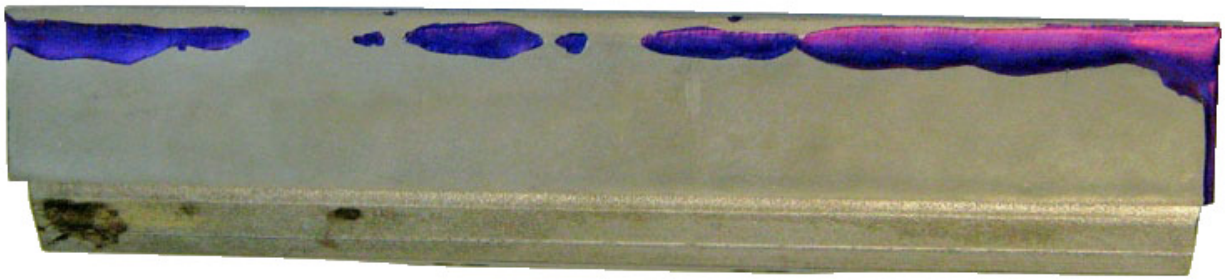
   - **KPS Uni-Ridge Parts.** *The Uni-Ridge counterknife is a beefier part and can take a little more wear. When a third (1/3) of the part is worn down to about 1/16" (about half-way), the part should be rotated or changed.*



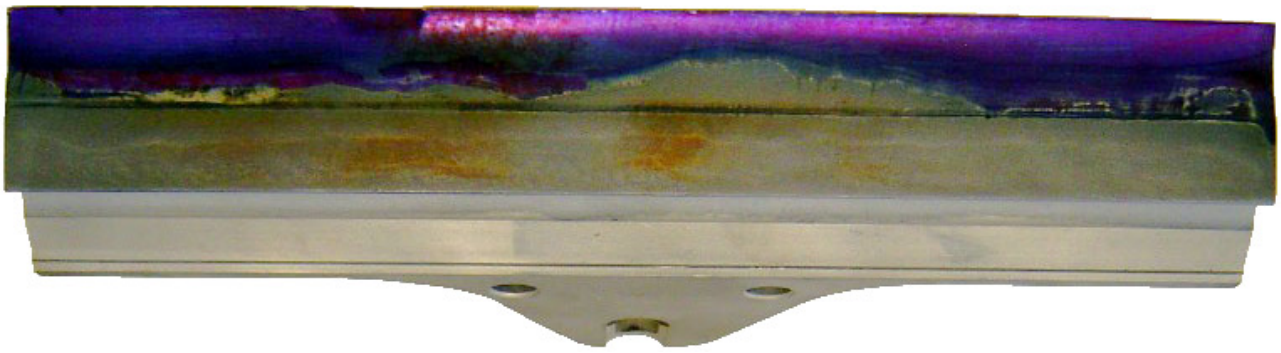
These pictures show Normal Tip Wear Processing:



This Counterknife still has life remaining, and is a candidate for rotation into a work zone that will wear the opposite side.



This Counterknife that is due for rotation or change out. The tip is nearly at a sharp point across a third of the part's length.



This Counterknife has severe Normal Tip Wear. The tip is nearly at a sharp point all the way across the length of the part. The width of the wear is half the face of the counter-knife at points. This part needs to be replaced.

2. ***Junction Wear***: *This is a form of wear that takes place between components, where chip flow gets underneath the hard surface around the very edge of the part. Junction wear is not serious in the fact that it does not really affect the strength of the part. Parts with junction wear should be changed only when the wear leads to packing that will jeopardize a clean knife change. Parts with junction wear on one side only should be rotated to another work zone.*

This photo shows junction wear on the right hand side. It also shows surface intersection and normal chip wear beginning. This part still has life, and its life could be extended by rotating to another work zone.

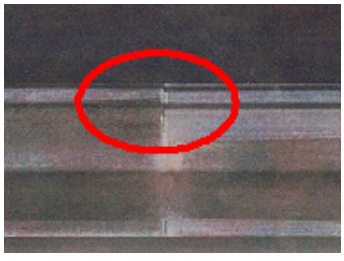
CAUTION: *Rebuilding of KPS counterknives is not recommended. The counterknife has a very precise heat treatment and several other processes, including shot peening and plating. Simple rebuilding, or "re hard surfacing" erases the effects of these processes, and will result in a drastically weakened part.*

KPS Clamp:

The KPS Clamp is the second most important component to monitor with respect to wear. While the top of the clamp can wear down from logs being pulled across it, the nose is the most important feature to watch.

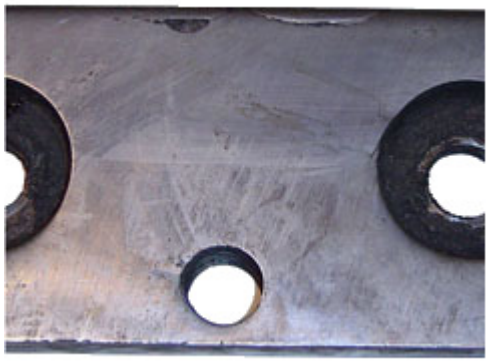
Slight deformation or peening of the KPS clamp nose where it clamps the end of the knife is not uncommon; however severe deformation that reduces the cross section, or causes poor/uneven knife clamping is not acceptable.

CAUTION: *KPS clamps should not be rebuilt under any circumstance.*



These pictures show clamp nose deformation where the knife junction is, both on the end of the clamp, and in the middle. Minor deformation is to be expected. Clamps with deformation on the end can be rotated so the deformation is out of the work zone.

This picture shows a KPS Clamp with significant watermarks. Watermarks are easily confused with hairline cracks. They usually start from inside a hole, and will always move towards the outside of rotation. They are a result of erosion, and are usually harmless. They will usually be consistent from part to part all the way around the disk, if the parts have been running the same amount of time.



This is a picture of a clamp with cracks. It should be changed immediately.

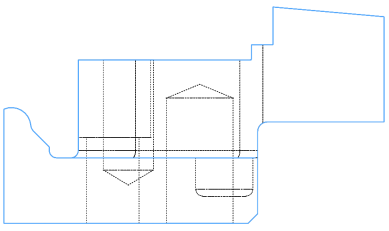
KPS Holder, Wearplate & Gap Plates:

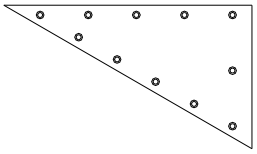
The KPS Holder is the foundation of the system. It is strong, and can take significant wear without sacrificing durability.

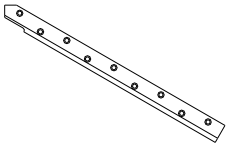
Wearplate and Gap Plates are not highly stressed components. They can usually be run until chip quality is affected.

The flatness of rebuilt Wearplate & gap plates is a concern. The thickness must be correct so that the logs have a smooth transition, with no reverse steps, and no significant change in extension.

Please consult your Key Knife representative for more information.







Section D. Operating in Frozen Wood

Operating in extreme cold weather presents many challenges to wood chipping. As the wood fibers freeze, the wood reacts differently. Often, a mill operating with frozen wood will see their pins and fines increase, in addition to a shift in their distribution towards thinner chips. The flexibility of the KPS allows the mill to compensate for these environmental changes.

A change in the knife in the KPS can have a positive effect on chip quality. Decreasing the knife angle or decreasing the knife relief are both methods of thickening the chip distribution in frozen wood.

Example 1. Changing from a 34° knife to a 34° - 4 knife decreases the attack angle and will help to make thicker chips.

Example 2. Changing from a 31° knife to a 34° knife decreases knife relief and will create a more controlled feeding situations.

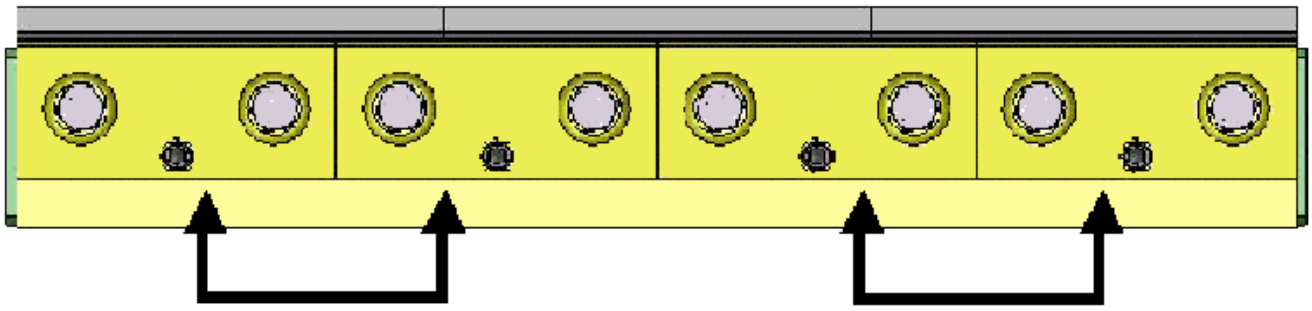
The ease of increasing knife extension is also a benefit when adjusting to frozen wood. The KPS's modular design allows for easy increases in extension. By doing so, the chip length, and subsequently the chip thickness, is increased.

The troubleshooting chapter (Chapter 6) provides additional guidance for dealing with chip quality issues. Your Key Knife representative is also available.

Section E. Parts Rotation

Unlike all other whole log chipper systems, the KPS utilizes a segmented pocket design. This allows for the rotation of wear parts in and out of the cutting zone for a longer part life.

The following example demonstrates how the knives, clamps and counterknives for a chipper that feeds to the middle of the pocket can be rotated.



One example of parts rotation that provides extended part life. Clamps and counterknives from the inside of the pocket are rotated with the clamps and counterknives on the outside of the pocket for increased part life.

Because each individual mill is different, your Key Knife Representative will be happy to assist you in developing a parts schedule that meets your needs and provides you with the most value.

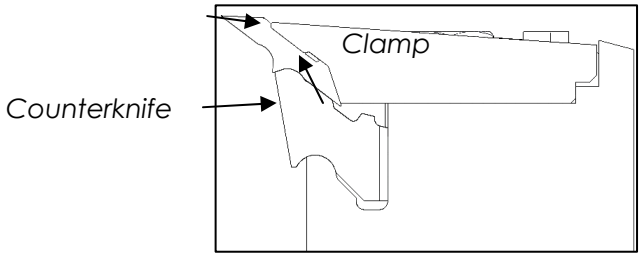
Section F. System Crash Recovery

Although the Key Knife KPS is extremely durable, it is not completely" bulletproof". The inadvertent entrance of metal contaminants into the chipper is unfortunately a fact of life. Fortunately, the advanced segmented pocket design of the KPS is of significant value when metal contaminants enter the system. Instead of having to replace the entire assembly, simply replacing the damage parts saves time and money.

After a system crash simply follow the following guidelines to get your operation up and running in a **safe** *and* **timely** *manner.*

1. *Inspect all system components in the pockets where damaged has incurred. Pay close attention to the components responsible for clamping the knife into place, as highlighted below.*
   - *KPS Clamps – Pay close attention to the KPS Clamp nose's (see section C). With enough force from a crash, this locating surface can flatten out, thus lose its ability to function properly. Any evidence of cracking is cause to replace the clamp as well.*
   - *KPS Counterknives – Pay close attention to the Keyway Locating surface on the counterknife. The front edge of the counterknife can sustain impact damage, reducing its ability to effectively clamp down on the knife.*
2. *Replace all damaged components.*
   - *Always replace Clamp Bolts when changing clamps*
   - *Always replace Holder Fasteners when changing Holders.*
3. *Replace knives and continue operations.*

   WARNING: -Bolts and studs often sustain damage that is not readily visible. Hairline cracks are often common after a crash. If these fasteners are then put back in the chipper, you risk another crash when they fail. Always replace bolts and studs when the component they are holding is damaged.



Key Knife is committed to the welfare of your business. If you are unable to determine the exact cause of a crash, set the damaged parts aside and contact your Key Knife Representative who will be happy to assist you.

Section G. Spare Parts Inventory

Maintaining an adequate supply of spare parts is a responsible method of hedging against unneeded down time resulting from a crash.

Your Key Knife Representative will work with you to provide an Operations Model that will show your projected parts usage for the year as well has the recommended quantity of spare parts. From this analysis, you can establish a scheduled deliveries program with Key Knife to ensure you have the right parts in the right place at the right time.

Although each mill is different, and there is no standard spare parts list, Key Knife recommends that at least one full set of spare parts be maintained on site. Use this general rule of thumb, and the expert knowledge of your Key Knife Representative for establishing proper inventories for success.

Section H. Key Knife Services Overview

Key Knife services are not structured around typical maintenance programs. Instead our services focus on your operation as a whole and on the areas of your operation where we can add the most value.

Your Key Knife Representatives are knowledgeable and skilled in chipping application and chip theory. Most of our Account Managers have extensive backgrounds in the forest products industry and have seen and worked on just about every type of machine running in a mill today. This knowledge is utilized to provide you with the resources necessary to increase your mill's overall operating efficiency.

At no added cost, we provide scheduled deliveries, Operations Model Analysis, benchmark reporting, and frequent checkups of your operation. By taking advantage of these value adding service programs you will lower your purchasing costs, optimize inventory levels, and always receive the right products, in the right place, at the right time.

We also offer regularly scheduled maintenance programs to ensure your Key Knife system always performs at an optimum level. This extra level of service can be customized to meet the needs of your operation, including maintenance of individual machine centers, machine center performance analysis, troubleshooting and providing solutions.

Contact your Key Knife Representative for more information on our Service Programs.

KPS™

Manual

Chapter Six

KPS Troubleshooting

- Introduction Pg. 1
- Chip Quality Pg. 1-2
- Knife Life Pg. 2
- System Troubleshoot Pg. 3

Introduction

This chapter provides some commonly seen problems that occur in all chipping operations. Most issues arrive as a result of worn or damaged components or as a result of insufficient torque on critical knife clamping fasteners.

These troubleshooting tools are not meant to be all-inclusive. They are tools to assist you in your chipping operation. If you have tried unsuccessfully to fix a problem, or have any questions, call your local Key Knife Representative who will assist you to maximize the operation of your chipper.

Chip Quality

Condition	Possible Cause	Corrective Action
Pins & Fines	Dry wood, Short wood, Thin wood	Decrease the attack angle by changing the knife.
	Dull knives	Replace knives
	Worn Anvil	Replace anvil
	Targeted chip length to short	Increase extension
	Knife Relief to low	Increase knife relief
	Frozen Wood	Decrease the attack angle by changing the knife.
		Decrease the knife relief.
Over-Thick	Targeted chip length too long	Decrease extension
	Worn anvil	Replace anvil
	Worn faceplates	Replace faceplates
	Excessive knife to anvil clearance	Adjust anvil clearance
	Excessive end play in the bearings	Adjust to proper tolerance
	Knives are not aggressive enough in the wood	Increase attack angle, with new knives
	Chips breakage not aggressive enough on counterknife	High impact counterknife
	Knife speed too slow	Increase disk speed, not to exceed 10,000 FPM rim speed
Over-Lengths	Wood turning to different infeed angle	Lower extension **or** Decrease knife relief
	Worn anvil	Replace anvil
	Excessive knife to anvil clearance	Adjust anvil clearance
	Targeted chip length to long	Decrease extension
	Excessive gap	Adjust gap
Thin Chips	Targeted chip length to short	Increase extension
	Chips breakage too aggressive on counterknife	Low impact counterknives.
	Knife speed to fast	Reduce disk speed
	Frozen Wood	Decrease the attack angle by changing the knife.
		Decrease the knife relief.

Condition	Possible Cause	Corrective Action
Slivers	Excessive knife to anvil clearance or worn anvil	Adjust anvil clearance or replace anvil
	Logs are not stable in infeed – the Wood is turning to different infeed angle	Lower extension **or** decrease knife relief
Damaged Edges	Dull knives	Replace knives
	Worn anvil	Replace anvil
	Gap setting is to large	Decrease gap setting to optimal
Cards	Slow knife speed	Increase knife speed, where possible
		Use high impact counterknives
		Use chip breakers

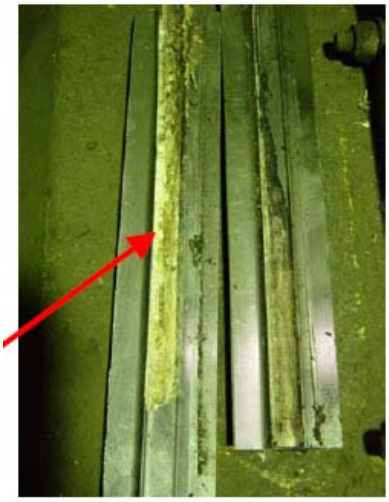
Knife Life

Condition	Possible Cause	Corrective Action
Reduced Knife Life (unexplained)	Knife Flutter from reduced clamping force	Replace worn / damaged counterknives
		Replace worn / damaged clamps
		Ensure proper Load Screw torque
		Ensure pockets are properly cleaned during knife change
		Insufficient clamp bolt torque
	Excessive knife to anvil clearance	Adjust anvil clearance
	Foreign debris, excessive bark, sand, dirt, etc entering the chipper	Excessive amounts of the listed materials will degrade knife life.
Knife Burn	Not enough knife relief	Change to knives with increased relief

System Troubleshoot

Condition	Possible Cause	Corrective Action
Packing between knife and counterknife	Worn / Damaged Counterknife	Replace worn / damaged Counterknives
	Worn / Damaged Clamp	Replace worn / damaged Clamps
	Knives incorrectly clamped	Ensure knives are properly located on the bottom Keyway and top locating surface
	Insufficient Load Screw torque	Ensure Load Screws are properly torqued
	Insufficient Clamp Bolt torque	Ensure Clamp Bolts are properly torqued
Knife separation in the pocket	Worn / Damaged End Plate	Replace worn / damaged End Plate
	Insufficient Load Screw torque	Ensure Load Screws are properly torqued
	Worn / Damaged Counterknife	Replace worn / damaged Counterknives
Clamp Bolts come loose	Insufficient Clamp Bolt torque	Ensure Clamp Bolts are properly torqued
Clamp Bolts Break	Excessive torque on Clamp Bolts	Ensure the proper torque is applied to Clamp Bolts
Knife Tips not properly aligned	Clamp not properly seated in the pocket	Loosen the clamp bolts and reseat in the pocket by tapping the clamp into the back of the pocket. Re-torque the clamp bolts and continue with knife change.
	Knife not properly located on the bottom keyway	Loosen Load Screw and ensure the knife is properly seated on the keyway.

Example of packing and “popsicles” formed behind the knife.



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Anvil: A stationary (either vertical or horizontal) knife opposing the main knife assembly. The knife passes the anvil like scissors blades to cut the wood. Anvil is a sawmill term; also known as the cutter bar or bed knife to the Tree Industry.

Application: The task needing to be done with the wood, such as edging, canting, etc.

Assembly: All parts needed for a system setup (segment, clamp, holder, counterknife etc.) and the necessary hardware (bolts, screws, etc.) as a unit.

Babbitting: 1) The molten metal added to the bottom of a non-indexable knife after grinding to correct the height. 2) The process of adding babbitting to the knife.

Band Saw: A saw used as a canter or in primary recovery consisting of a continuous piece of flexible steel with teeth on one or both sides.

Bent Knife: 1)An old bent blade knife design used on conical saw heads 2) Key Knife updated the design by replacing the one knife with two smaller knives set at an angle. This term is now outdated, and the knife/knife systems should be referred to as High Recovery.

Board: A piece of lumber nominally less than 2" thick and 1 " or more wide.

Board Foot: The basic unit of measurement for lumber; equal to a 1 by 12 by 12-inch board. An 18 foot long 2 X4 would be 10 board feet, as would a 9 foot long 2X8.

Bottom Head: A cutting head/saw responsible for processing the bottom of a log.

Bow: A Flatwise deviation along the length of a piece of lumber measured at the point furthest from the optimal shape line. Bowing is the curving of the wood.

Butt: The bottom of the tree after being cut down; this end is wider and directly above the bottom-most cut on the tree (right above the stump).

Butt Log: The first log from the butt of the tree.

Camber: The curve or bend found in lumber not under stress.

Cant: 1) A log with two or more sides squared 2) A log that has gone through primary recovery and is destined for processing by other saws.

Canter: 1) Sawmill application, a) top and bottom already flat; sides are squared. b) all sides are squared 2) A cutting device to square two or more sides of a log.

Cards: Blocks of chips un-separated from each other.

Carriage: A track-mounted vehicle that carries the log through the head saw in a sawmill.

Chip: A small, thin wafer of wood cut at a precise angle to the grain with both side corrugated or striated as a result of being split from the parent wood (a log, slab, etc.) Chips are thicker and coarser than sawdust, and usually headed for a pulp mill.

Chip Accept: Any chip suitable for making pulp; not too wide or small like overs, fines, etc.

Chip 'N' Saw: A type of sawmill knife system; disk shaped segments are stacked to make a drum/barrel shaped head. Each segment has several knife pockets, and the knives are staggered along the head surface. (Note: Originally a brand name of one type of chipping head-rig, it has come to mean all such machines).

Chipper: A machine used solely for converting wood into chips.

Chipper-Canter: A machine that makes cants from logs using only chipping heads (no saws).

Chipping Head-rig: A machine that mills small logs simultaneously into lumber and chips; the outside is chipped away and the inside is sawn, usually into 2X4's.

Chute: A dry trough for moving logs from the logging area to a landing, body of water for rafting/ storage, or a mill. The trough may be wooden or gouged into the earth.

Circular Saw: A round saw with cutting teeth around the perimeter; it has been largely replaced in sawmills by band saws.

Clam Shell: Tilts the upper infeed portion of the gang upward to allow easy access to the saw guides.

Clamp: The clamp is placed on top of the knife, holding it in the knife pocket. It also provides a full length clamping force on the knife.

Clearance Angle: The angle between the ground bevel of the knife and a line tangent to the cutting circle at the knife cutting edge.

Coarse Grain: Wood grain with wide, conspicuous annual rings of less than four rings per inch.

Counterknife: An angled plate used in some knife assemblies to protect the knife assembly and aid in separating the wood. The counterknife is placed under the knife and braces it the knife pocket. Also known in the Tree Care industry as a gib.

Crook: Deviation along the edge of a piece of lumber from end to end, and measured at the point on the deviation furthest from the ideal line of cut.

Cup: Deviation along the face of a piece of lumber, measured at the point(s) not conforming to the ideal line of cut from end to end and edge to edge.

Curve Sawing: Applications performed on a curved log; generally the log remains stationary as the saws move around.

Cutter Head: Rotating planer piece that contains the knives/planers. See HUB.

Cutting Angle: The angle between the ground bevel of a knife and a line tangent to the cutting circle at the knife cutting edge.

Cutting Circle: The range of the knives on a cutting head in motion; diameter measured as the distance from the tip of one knife to the tip of the opposite knife

Cylinder: See CUTTER HEAD.

Depth of Cut: The thickness of material removed by a knife from the surface of a piece of lumber.

Dog: 1)A sawmill machine for gripping a log; for example, a dog holds a log in place prior to sawing. 2) Any device designed to bite into and hold something securely. 3) A spike designed to hold the chains on a log raft to the log.

Disk: A style of cutting heads shaped like a flat, narrow disk.

Drum: A style of cutting heads shaped like a cylinder. The head may be one piece, or made up of many segments stacked together .

Edger: 1) A sawmill application; cutting the sides off of tapered or misshapen boards. 2) A cutting device that performs this application.

Edging: Waste wood cut from misshapen lumber by an edger.

Extended Counterknife: A continuation of the counterknife designed to protect High Yield segments from chip flow wear.

Extension: See KNIFE EXTENSION.

Face: 1) A flat, rather than rounded, side of a cutting head, where the axle runs through. 2) The best looking side of a piece of lumber; the side from which the grade is determined.

Feed Speed: The rate lumber passes through a cutting assembly or assemblies. Usually measured in Feet Per Minute (FPM).

Feed Rolls: Any rolling piece of machinery, usually power driven, for moving wood up to and/or through a cutting machine at a specified speed.

Fines: Any chips very short in length, and/or less than 5.3 mm in cross-sectional measurement. Coarser than sawdust, but not big enough for accepts.

Fine Sawn: A term to describe surfaced lumber that has been passed through a saw to gain a textured face. Rougher than actual surfaced lumber, but smoother than unsurfaced lumber.

Gang: A machine designed to cut a cant into multiple boards. Usually a guided machine with multiple saw heads; to begin cutting, the cant is rotated, or the saws rotate around the cant.

Gang-saw: 1) A saw used in a gang to cut the cant into boards. 2) A number of saws on a common arbor.

Grain: A general term referring to the appearance, direction, and arrangement of wood fibers; examples include fine, coarse, spiral, vertical, and curly.

Gullet: The place on a cutting head between the cutting edge of the knife and the saw one head below; where any resulting chips/wood particles strike. This area of the cutting head wears out quickly.

Head: The entire body of the cutting assembly, hub/segments etc. and the knife assembly.

Head Rig: A carriage on rails that can transport a variety of saws/cutter heads.

Hood: In planers; part of the blower pipe that fits over the cutting head.

Holder: Is the support for the base for the counterknife, knife and clamp. It also provides a means to attach the assembly onto the hub.

Hub: The main body of a cutting assembly. The knife assemblies mount to special pockets on the hub, and as the hub turns on an axle, the knives spin to cut or chip the wood.(See HEAD). A hub can be called a cutting head, but the head can not be called a hub. Also called Rotor in the tree care industry; Segment or Drum in Chippers and Chip 'N' Saws.

Infeed: The end of the edger, gang, or planer where the wood enters the machine.

Kerf: The width of a saw cut; the amount of wood lost to sawdust after each pass of the saw (For example; 3/32 of an inch is considered narrow kerf).

Knife Extension: The amount a knife projects beyond the cutter head body/hub.

Lead Bar: See MAIN GUIDE.

Live Rolls: Powered rollers used to move lumber or cants in a sawmill.

Main Guide: A straight metal bar extending from the first bottom infeed roll to the inside saw head. The main guide directs lumber flow precisely in to the inside head.

Multi-spline: Sawmill application. A number of splines are cut into the bottom of a log to control it during processing.

OEM: Original Equipment Manufacturer.

Outfeed: Refers to the discharge end of the edger, gang, or planer.

Overs: Oversize and/or overly thick chips; any completely separated material over 76mm long and/or 10mm thick.

Pins: Very narrow chips; any material within the normal length range but less than 9.5mm and over 5.3mm wide. May also include very short chips.

Pocket: The location on a cutter machine hub where knife assemblies are mounted ('pockets' are cut into the hub).

Primary Breakdown: 1) Sawmill application; the whole log is round, cut off all sides. 2) The first processing the log experiences after being in log form.

Roll: A series of long large cylinders on individual axles mounted side by side lengthwise. Logs, lumber, and wood scraps can roll or be rolled (as in an electricity powered live roll) from one location to another.

Screening: Passing chips through a wire mesh or similar type screen in order to separate accepts from unacceptable chips.

Segment: A round, disk shaped foundation of metal that can be stacked with other segments to form the main body of a cutter head.

Setup: The preparation of a series of cutting assemblies designed to cut a specific size and pattern of lumber (planer, gang) prior to cutting a batch, including aligning and adjusting the equipment.

Shim: A thin piece of metal for filling spaces between machine parts, adjusting part extension, or bracing two pieces (i.e., filling the gap between a converted cutting head pocket and the new holder).

Side Head: A cutting assembly in a mill placed to process one side of a log.

Side Head Hold down Shoe: An adjustable metal bar positioned directly above the matcher plates at the side heads. The hold down shoe prevents lumber from moving vertically as it passes the side head knives.

Slab: A side of a log that has been cut off. See SLABBER

Slabber: Sawmill application; whole log is round, one side is cut off.

Snipe: When a log moves laterally in the machine, creating a tapered end.

Snatching: When a log jumps or surges as it goes along the mill line and does not feed through at an even rate.

Spline: A 'track' that can be sawn into the bottom of a log to make it easier to lead the log down the log line. The splines can be chipped off later.

Sweep: The curvature in a log, pole, or piling, classified as a defect.

System: A type of knife assembly used for certain applications, such as basic High Recovery, Chippers, or Chip 'N' Saw.

Tear-out: When wood splits or pulls out deeper than the knife depth of cut while being processed; resulting in a ragged, uneven surface.

Top Head Reman: Sawmill application; board is round on top or too thick; cut off top.

Torn Grain: An irregularity in the surface of a piece of wood or log.

Warp: Any variation from a true or plane surface. See CROOK, BOW, or CUP.

Wastewood: 1) Unusable wood such as ends, edges, scraps, etc. 2) The wood industry application for processing this type of waste and scrap wood into useable chips. The chippers used can be very large; free standing monoliths in sawmills, or very small; truck mounted portable chippers for arborists in the field.

Tool List

This appendix lists the tools required to install and operate the Key Knife KPS in your chipper. Table one lists the tools needed to install your KPS and Table two lists the tools needed during the daily operation of the system*.

To ensure fast and smooth knife changes, and change out of wear components, Key Knife recommends that two air-lines be available at the chipper to operate pneumatic tools.

For your convenience, Key Knife offers a Tool Cart that comes complete with all the tools required to operate and change wear components on your Key Knife KPS.

Vendor names and part numbers are provided for your convenience only and do not represent any endorsement by Key Knife, Inc.

* Note that some of the tools needed for installing the Key Knife KPS can also be used during the daily operations of the system.

Installation of KPS System

Item Description	Key Knife Order Number	Store Name	Order Number
5/8" allen socket, 1/2" drive			J74415--8-
5/8" allen socket, 3/4" drive			J075905--8-
Socket, 1 1/8", 1/2" drive		NAPA	NHTNHPD636
Socket, 1 1/2", 3/4" drive		NAPA	NHTNHPD648
Socket, 1 5/16", 3/4" drive		NAPA	NHTNHPD642
Socket, Impact, 1/2", 1/2" drive, deep		GRAINGER	1AW36
Torque wrench, 3/4" drive, 300-600 ft/lbs		GRAINGER	4JW52
Torque wrench, 1/2" drive, 50-250 ft/lbs		GRAINGER	4LY37
Impact wrench, 1/2" drive		GRAINGER	3YU95
Impact wrench (3/4" drive)		GRAINGER	3YU98
Wire brush		NAPA	SER 2310
Lock-tite 242		GRAINGER	2A269
Anti-seize, Nickle Based		GRAINGER	4KM51
Feeler Gauges (size range)		GRAINGER	5C589
12" ruler		J&L INDUSTRIAL	PEC-26112H
Rubber Mallet		NAPA	NHT NR194
Pry bar		GRAINGER	3MM13
Dial indicator w/magnetic base		J&L INDUSTRIAL	MD2-41600E NOG-10100D
Tin snips		NAPA	NHT M468
Shim pack			

Operation of KPS System

Item Description	Key Knife Order Number	Store Name	Order Number
Key Knife Tool Cart	**27800**		
Impact wrench, 1/2" drive		GRAINGER	3YU95
Torque Stick, 80 ft/lb	17529		
Torque wrench, 1/2" drive, 50-250 ft/lbs		GRAINGER	4LY37
Torque wrench, 3/4" drive, 60-300 ft/lbs		GRAINGER	4JW51
5/8" Allen socket, 1/2" drive		PROTO	J74415--8-
5/8" allen socket, 3/4" drive		PROTO	J075905--8-
Socket, 1 1/8", 1/2" drive		NAPA	NHTNHPD636
Socket, Impact, 1/2", 1/2" drive, deep		GRAINGER	1AW36
Socket adapter, 3/4" to 1/2"		NAPA	NHTNHP 82
Pic Set		NAPA	SER3476
Rubber Mallet		NAPA	NHT NR194
Pry bar		GRAINGER	3MM13
Wire brush		NAPA	SER 2310
Scraping Tool		GRAINGER	5LM13
Anti-Seize, Nickle Based		GRAINGER	4KM51
Air Hose nossle for air line			

Torque Values

PART	DESCRIPTION	WRENCH SIZE	TORQUE (ft-lbs)	TORQUE (Nm)
Clamp Bolt	Hex Bolt 00.750 NC 01.750	1 1/8 Socket	300 - 330	407 - 447
Load Screw	KK SPECIAL	3/8 Allen Head	75 - 90	102 - 122
Holder	5/8 Step Stud		180 - 200	244 - 271
	3/4 UNC Hex Bolt / Stud	1-1/8 Socket	270 - 300	366 - 407
	7/8 UNC Hex Bolt / Stud	1 5/16 Socket	395 - 430	536 - 583
	1 UNC Hex Bolt / Stud	1 1/2 Socket	590 - 650	780 - 881
	1 1/8 UNC Hex Bolt /Stud	1 11/16 Socket	650 - 715	881 - 970
Cap Screws	1/2 Cap Screw	3/8 Allen Head	120 - 130	163 - 176
	3/4 Cap Screw	5/8 Allen Head	250 - 270	339 - 366
	7/8 Cap Screw	9/16 Allen Head	380 - 420	515 - 570
Base Plate Bolt		7/16 wrench / Socket	40 - 50	55 - 68

Key Knife KPS Monthly Maintenance Schedule

Month: _____

Task	Week 1	Week 2	Week 3	Week 4
Lubricate Load Screws				
Visually inspect Clamps and Counterknives for impact damage or wear. Change, or rotate, as needed.				
Note packing between Knife and Counterknife				
Thoroughly clean Keyway and Clamp				
Spot check torque on Clamp Bolts				
Note the anvil wear. Replace as necessary.				
Measure and adjust the anvil clearance.				
Remove all knives, clamps and counterknives from the chipper.				
Clean all components.				
Replace or Rotate clamps and counterknives				
Measure the system gap and extension. Replace wearplate / gap plate components as needed.				
Note the wear on the holder and end plates. Change as needed.				
Ensure proper torque on all fasteners.				

Week 1 Notes:

Conducted By: _____

Week 2 Notes:

Conducted By: _____

Week 3 Notes:

Conducted By: _____

Week 4 Notes:

Conducted By: _____

Key Knife KPS Quarterly Maintenance Schedule

Date: _____ Conducted By: _____

Task	Yes	No	N/A
Visually inspect Clamps and Counterknives for impact damage or wear.			
Replace Clamp Bolts when Clamps are changed.			
Check torque on Clamp Bolts			
Lubricate Load Screws			
Note wear on the anvil. Replace as necessary.			
Measure and adjust the anvil clearance.			
Measure the system gap and extension. Replace wearplate / gap plate components as needed.			
Note the wear on the holder and end plates. Change as needed.			
Ensure proper torque on all fasteners.			
Measure & Adjust Runout			

Extension: _____

Gap: _____

Run-out: _____

High Knife: _____

Notes:

LESSON PLAN

Basic Operator Training for the Key Knife Key Pivot System (KPS)

The following training checklist and testing materials are meant to serve as a tool for supervisors and shift leads to use in conducting new employee training, or refresher training on the Key Knife KPS.

The training checklist is meant to be used in conjunction with the content of this System Manual. Next to each topic is the chapter and section identification where the instructor can find the information to be taught.

Each item on the checklist is deemed critical knowledge for operators to safely and efficiently operate the KPS.

The Test in section two is another tool Key Knife has provided for use by the instructors to ensure that the presented material has been understood and retained by the operator(s).

Revised: ____date_____

KPS Basic Operator Training Checklist

1. Review the KPS Components. Identify the name and purpose for the following items Chapter 1
   a. KPS Clamp
   b. KPS Load Screw
   c. KPS Spring & Roll Pin
   d. Clamp Bolt
   e. KPS Counterknife
   f. KPS Holder
   g. KPS Ridge Knife

2. Installing and Replacing Clamps and Counterknives (See Appendix **G** Installation – Clamp and Counterknife)
   a. Review procedures for removing and installing components
   b. Emphasis the proper alignment of the KPS Clamps
   c. Emphasis proper Torque values for the Clamp Bolts

3. Knife Change (See Knife Change Procedures Chapter 3)
   a. Review the Required Tools to conduct a knife change
   b. Review the procedures for removing and replacing Key Knives
   c. Emphasize proper cleaning of the system during knife change
   d. Emphasize the need to close the Load Screws before rotating the disc
   e. Proper component fit of Knives and Counterknives
   f. Rotating knives in the pocket (as required)

4. Proper torque values Appendix **D**.
   a. Load Screw
   b. Clamp Bolt
   c. Emphasis that Torque values for the remaining fasteners can be found in the Manual

5. Troubleshoot the system Chapter 6.
   a. Packing & Popsicles
   b. Improper Knife tip alignment

6. Procedures for inspecting and replacing components after a crash, (Chapter 5)
   a. Review the critical areas to inspect on components
   b. Review part replacement procedures (including fasteners)

Test: Basic Operator Training for the Key Knife Key Pivot System (KPS)

Written Test

Q1 – Give the proper torque value for the Load Screw
- (a) 70 – 80 ft / lb
- (b) 120 – 150 ft /lb
- (c) 40 – 60 ft /lb
- (d) All of the above
- (e) None of the above

Q2 – Explain the importance of cleaning the pocket thoroughly during knife change
- (a) The knife will not locate on the keyway properly with excessive debris in the pocket
- (b) Tight tolerances in the design of the system
- (c) Excessive debris can cause a hydraulic effect in the chipper
- (d) All of the above
- (e) None of the above

Q3 – After a crash, the clamp bolts should:
- (a) Assumed to be fine and kept in the machine
- (b) Replaced only when the holder needs to be replaced
- (c) Replaced when the corresponding clamp and / or counterknife is replaced
- (d) All of the above
- (e) None of the above

Q4 – The Keyway on the KPS Ridge Knife is designed to:
- (a) Index the knives into place consistently
- (b) Makes packaging easier
- (c) Increase chip quality
- (d) All of the above
- (e) None of the above

Q5 – The Counterknife should be replaced when the tip is worn:
- (a) To approximately 0.039” wide
- (b) To a sharp point
- (c) All the way through
- (d) All of the above
- (e) None of the above

Q6 – The KPS Clamps should be replaced:
- (a) When the KPS nose is deformed
- (b) When watermarks appear on the surface of the clamp
- (c) When cracks appear on the clamp surface
- (d) All of the above
- (e) Both (a) and (c)

Q7 – Packing between the knives and counterknives could indicate:
- (a) Insufficient Load Screw torque
- (b) Worn or damaged Counterknives
- (c) The knives are not properly located on the Keyway
- (d) All of the above
- (e) None of the above

Q8 – If the knives are sticking in the pocket during a knife change, you should:
- (a) Replace all the Clamps, Counterknives and Load Screws
- (b) Tap the knives with the mallet to loosen them
- (c) Do nothing. Just leave them in the pocket and continue chipping
- (d) All of the above
- (e) None of the above

Q9 – When closing the Load Screws with the impact wrench and torque stick, you should always:
- (a) Assume the Load Screws are properly torqued
- (b) Spot Check the load screws with the torque wrench to ensure proper torque
- (c) Check the torque on each Load Screw with the torque wrench
- (d) All of the above
- (e) None of the above

Q10 – The proper torque value for the Clamp Bolt is:
- (a) 150 ft / lb
- (b) 250 ft / lb
- (c) 70 - 80 ft / lb
- (d) 300 ft / lb
- (e) None of the above

Practical Application Test

PA – Demonstrate a knife change

PA – Demonstrate changing a clamp and counterknife

Answer Key

Written Test

Q1 – Give the proper torque value for the Load Screw
(a) 70 – 80 ft / lb

Q2 – Explain the importance of cleaning the pocket thoroughly during knife change
(d) All of the above

Q3 – After a crash, the clamp bolts should:
(c) Replaced when the corresponding clamp and / or counterknife is replaced

Q4 – The Keyway on the KPS Ridge Knife is designed to:
(a) Index the knives into place consistently

Q5 – The Counterknife should be replaced:
(b) To a sharp point

Q6 – The Clamps should be replaced:
(e) Both (a) and (c)

Q7 – Packing between the knives and counterknives could indicate:
(d) All of the above

Q8 – If the knives are sticking in the pocket during a knife change, you should:
(b) Tap the knives with the mallet to loosen them

Q9 – When closing the Load Screws with the impact wrench and torque stick, you should always:
(b) Spot Check the load screws with the torque wrench to ensure proper torque.

Q10 – The proper torque value for the Clamp Bolt is:
(d) 300 ft / lb

Practical Application Test

PA #1 – Provide the trainee with the necessary tools to change the knives in the chipper. Ensure the student properly follows the knife changing procedures as shown in Chapter 3. When the trainee has completed the procedures, check to ensure the knives are properly aligned in the pocket and that the load screws are properly torqued.

PA #2 – Provide the trainee with the necessary tools to change the knives in the chipper. Ensure the student properly follows the procedures for changing clamps and counterknives as shown in Appendix **G**. When the trainee has completed the procedures, check to ensure the clamps are properly aligned in the pocket and that the clamp bolts are properly torqued.

Appendix G

SOE's

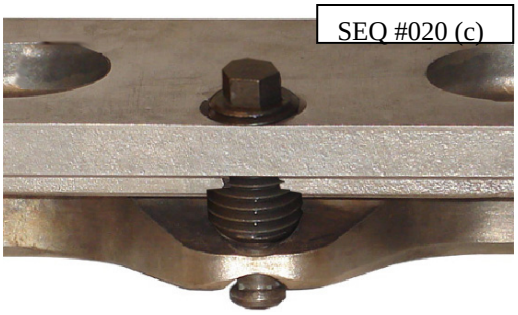
- Installation – KPS Holder Pg. 1-2
- Installation – Clamp and Counterknife Pg. 3-5
- Installation - Wearplate Pg. 6-8
- Measuring Run-Out Pg. 9-12
- Measure Gap & Extension Pg. 13-14

SEQ #	Task Description	Additional Information
010	Inventory on-hand KPS components.	
020	Thoroughly clean the chipper pocket.	
030	Place appropriate control plates in the pocket.	Reference engineering drawing.
040	Place the holder in the pocket.	

SEQ #	Task Description	Additional Information
050	Install the holder bolts and washers. Tighten until snug.	Use never-seize on all bolts.
060	Torque bolts in accordance with torque specifications. Torque the middle bolts first, then work outwards so that the outside two bolts are the last to be torqued.	Reference "torque specifications" See notes in Installation System. Use never-seize on all bolts.

SEQ #020 (a)

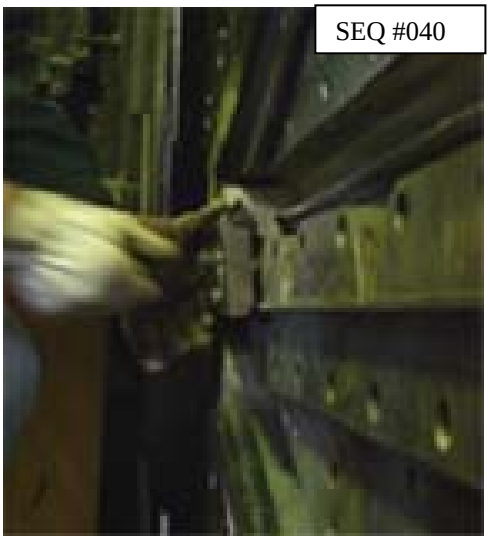
SEQ #020 (b)


SEQ #020 (c)

SEQ #030 (a)

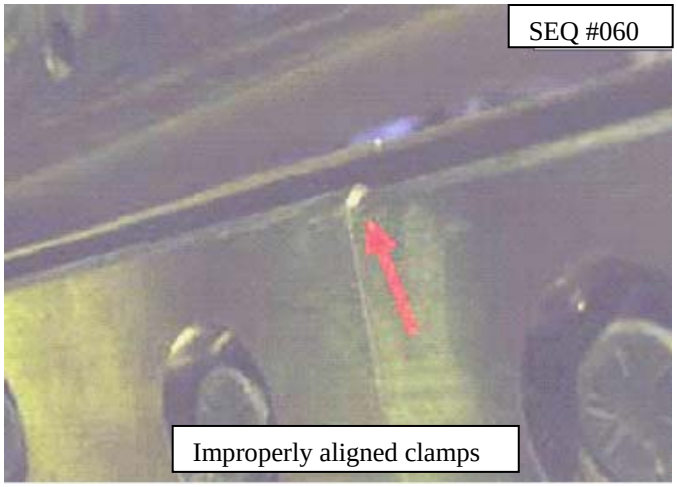
SEQ #030 (b)

SEQ #	Task Description	Additional Information
010	Inventory on-hand KPS components.	Reference the System Manual or Engineering Print (s).
020	Marry-up the KPS Clamp and counterknife with the Load Screw.	WARNING: Ensure the Load Screw is positioned above the clamp so that 2 or 3 threads are exposed to ensure the clamp seats properly on the holder.
030	Position the joined KPS Clamp and Counterknife in the holder.	


SEQ #040

SEQ #060

Properly aligned clamps


SEQ #060

Improperly aligned clamps

SEQ #	Task Description	Additional Information
040	Install Clamp Bolts loosely to hold jewelry in place.	Use Never-Seize on the clamp bolts.
050	Repeat sequence 020 - 040 for remainder of the holder.	The last clamp and counterknife to be put into the holder will be tight. Ensure they are aligned perfectly, and use a rubber mallet to gently tap them into place, if required.
060	Ensure the clamp and counterknives are properly aligned.	The joint between each counterknife and each clamp should be a smooth transition, both laterally and vertically. If parts are not properly aligned, use a rubber mallet to position appropriately, before torquing down.

SEQ #	Task Description	Additional Information
070	Torque Clamp Bolts utilizing the 300 ft/lb torque wrench.	Reference Torque Specification. See notes in the installation system.
080	Repeat sequence 060.	Loosen clamp bolts and adjust clamps, as required.
090	Repeat sequence 020 - 080 for remaining holders.	

SEQ #020 (a)

SEQ #020 (b)

SEQ #	Task Description	Additional Information
010	Inventory on-hand KPS components.	
020	Install the studs into the wearplate.	Use Locktite 242 (blue) on the studs. Reference the system manual to ensure the studs have the appropriate thread engagement.
030	Remove all knives from the Chipper.	Always remove knives from the chipper when working with the Wearplate and Gap Plates.
040	Remove the existing segment / wearplate from the disc	Use the overhead crane to move the component.

SEQ #040

SEQ #060

SEQ #	Task Description	Additional Information
050	Clean the disc thoroughly with a wire brush and scraping tool.	
060	Slide the wearplate onto the disc.	Use the overhead crane to lift the component into place.
070	Attach the appropriate washers and nuts to the studs on the back of the disc, only hand tight.	
080	Using a long pry-bar, lift the wearplate up so that it does not sag in the pocket and torque the nuts with the appropriate torque wrench.	Reference torque specifications. Caution: The wearplate must be positioned high in the pocket to ensure the back of the holder makes contact with the wearplate.

SEQ #090 (a)

SEQ #090 (b)

SEQ #090 (c)

SEQ #100

SEQ #	Task Description	Additional Information
090	Mount the gap plate into place and tighten the Cap Screws until they are snug.	As required: not all systems will have modular Gap Plates. Use the mounting studs, as appropriate.
100	Install and torque the Gap Plate Cap Screws in accordance with torque specifications.	Reference torque specifications Appendix D. Use Locktite 771 (Nickel Based Anti-Seize) on all bolts.

SEQ #	Task Description	Additional Information
010	Place the tip of the dial indicator on the tip of the first knife, perpendicular to the disc.	Measure approximately 1" - 2" from outside of the knife. Ensure the magnetic base mount is solidly attached to the frame or shroud. If two qualified personnel are available, you can measure the inside and outside of the disc concurrently.
020	Zero the dial on the knife tip.	Ensure the indicator tip is loaded properly to measure the extension distance.
030	Record the measurement.	Record on the Installation Report.
040	Rotate the disc backward to the knife in the next pocket. Stop the disc when the tip of the dial indicator is approximately on the heel of the knife.	

SEQ #	Task Description	Additional Information
050	Slowly rotate the disc backwards with the tip of the dial indicator on the knife until it rests on the tip of the knife.	Rotation is done manually.
060	Take the knife height measurement from the dial indicator.	Be sure to note appropriately if the knife is higher (+) or lower (-) than the zero knife.
070	Record the measurement.	Record on the Installation Report.
080	Repeat sequence 40 - 70 on all remaining knives	

SEQ #	Task Description	Additional Information
090	Repeat sequence 10 - 80 on the inside of the pocket.	Measure approximately 1" - 2" from inside of the knife. If two qualified personnel are available, you can measure the inside and outside of the disc concurrently.
100	Determine the high knife and the number of knives that are outside the product line standard for run-out, for both the inside and outside of the pocket.	Review the run-out measurements from steps 010 - 090 to determine the high knife. See the Chapter 4 for recommended for run-out.
110	Calculate the required shims for each pocket.	Each knife that is lower than the allowable run-out (see Chapter 4) needs to be raised with shims, so that it is within the allowable standard from the high knife. Determine the number of shims needed for the inside and outside of the pocket independently.
120	Record the required shims.	Record on the Installation Report.
130	Cut shims for each pocket	Cut whole length shims to fit the entire pocket. Cut shims required for either the inside or outside of the pocket to fit approximately 1/3 of the pocket.
140	Loosen the holder bolts for the first pocket to be shimmed. Push the holder out approximately 1/4" - 1/2".	
150	Position the appropriate shims behind the holder. Tighten bolts until snug	Refer to step #120 for appropriate number of shims

SEQ #	Task Description	Additional Information
160	Torque bolts in accordance with torque specifications. Torque the middle bolts first, then work outwards so that the outside two bolts are the last to be torque.	Torque the top row of bolts first for a pie-style holder. Reference Torque Specification. See notes in the installation system.
170	Repeat sequence 140 - 160 for remaining pockets that need shims installed.	
180	Repeat sequence 10 - 90.	Measure knife height after shim installation to determine if all the knives are within the appropriate operating parameter (Chapter 4)
190	Repeat sequence 10 - 180.	As required until all knives are within the appropriate operating parameter (Chapter 4)

SEQ #	Task Description	Additional Information
010	Place the tip of the dial indicator on the tip of the knife, perpendicular to the disc.	Ensure the magnetic base mount is solidly attached to the frame or shroud. Measure approximately 2" from the outside of the pocket for the given chipper.
020	Zero the dial on the knife tip.	Ensure the indicator tip is loaded properly to measure the extension distance.
030	Rotate the disc backwards across the gap. Stop the disc where the dial indicator tip is on the wearplate edge.	
040	Slowly drop the dial indicator tip down until it hits the wearplate.	Note - Remember to count off the 0.100" increments as you drop the tip to the wearplate.

SEQ #	Task Description	Additional Information
050	Record the Extension measurement.	
060	Measure Gap: Place a 12" ruler perpendicular to the knife tip.	Measure approximately in the center of the cut zone for the given chipper.
070	Measure the gap from the knife tip to the forward edge of the wearplate.	If the wearplate has a chamfered edge, measure to the front end of the chamfer.
080	Repeat steps #010 - 070 for the inside 2" of the pocket.	This measurement is to ensure that the system gap and extension is consistent.