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**CATERPILLAR**<sup>®</sup>

# Custom Track Service Handbook



CUSTOM  
TRACK  
SERVICE

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# **CATERPILLAR<sup>®</sup> CUSTOM TRACK SERVICE HANDBOOK**

15th EDITION

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Caterpillar, Inc.

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# Table of Contents

## I. General Information

Measurement Tools .....	8
Variables That Affect Undercarriage Life	
Controllable Variables .....	11
Non-Controllable Variables .....	21
Partially Controllable Variables .....	25
Percent Worn Charts .....	27
Component Discussions	
Links .....	28
Former Link Service Limits .....	34
Sealed and Lubricated Track Pins and Bushings .....	36
Sealed Track Pins and Bushings .....	44
Shoes .....	51
Idlers .....	56
Carrier Rollers .....	59
Track Rollers .....	61
Sprockets .....	66
Guards .....	71

## II. Management & Merchandising

Track Management .....	74
Destruction Wear Limits .....	74
Track Seal Replacement Recommendations .....	75
CTS Inspection Report .....	76
Calculations .....	79
The Total Life Scale .....	81
Cost Per Hour .....	87
CTS on the Personal Computer .....	91
Competitive Machine Undercarriage Conversion .....	92

## III. Elevated Sprocket Machines

Management .....	96
D4H, D5M, D5N, 561M, 561N .....	110
D5H, D6M, D6N, 517 .....	130
D6H, D6R, 527 .....	148
D7H, D7R, 572R .....	168
D8L, D8N, D8R, 578, 583R .....	188
D9N, D9R .....	202
D9L, 589 .....	212
D10N, D10R .....	220
D10 .....	228
D11N, D11R .....	236

## IV. Low Sprocket Machines

Management .....	248
Genuine Cat® Undercarriage	
D3, D4B, D4C, D4G, 931, 933, 935 .....	258
D4, D4D, D4E, 941 .....	278
D5C, D5G, 939.....	294
D5, D5B, 951, 955, 561 .....	310
D6, D6B, D6C, D6D, 955 .....	326
D7, D7D, D7E, D7F, D7G, 977, 571, 572 .....	348
D8, 983.....	366
D9, 594.....	378
Cat Classic Undercarriage	
D5B .....	390
D6 .....	400
D7 .....	410
D8 .....	418

## V. Hydrostatic Loaders

Management .....	428
943 .....	436
953 .....	444
963 .....	460
973 .....	472

## VI. Excavators

Management .....	490
307, 308 .....	498
311, 312, 313, 314.....	508
315, 317, 318, 320, 322, 320 FM .....	516
320S, 322 FM, 325, 325 FM .....	530
330.....	544
330 FM, 345 .....	556
350.....	566
365, 375, 385, 5080, 5090 .....	574
5110 .....	584
5130 .....	592
5230 .....	602
205, 211, 213 .....	608
215.....	616
225, 219, 215S.A., FB221, FB217, DL221 .....	630
225.....	646
227, 229, 231, 225S.A., LL225 .....	656
235, LL235.....	666
235 .....	684
245 .....	692

# Table of Contents

E70B.....	710
E110B, E120B.....	720
E140.....	728
E180, EL180.....	736
E200B, EL200B.....	744
EL240B, E240B, EL240, E240.....	752
E300B, EL300B, EL300.....	760
E300.....	768
E450.....	776
E650.....	784

## VII. Paving Products/Drive Belts

PR1000, PR750B, SF550, SF500, TR500.....	794
AP1050.....	800
PR450B, SF350, SF250B, TR225B.....	808



Edition Fifteen is a comprehensive update to the CTS Handbook. Nearly every wear chart in the book was updated. The General Information section, the Management & Merchandising section and the Management section of the four product types were also updated.

Some of the changes you will notice include:

- Cat Classic was added as a new section following Low Sprocket Machines.
- Nearly all wear charts were updated to some extent.
  - The rounding was removed from all measurements for the Ultrasonic Wear Indicator.
  - The carrier roller wear limits were increased for use with Heavy Duty, Rotating Bushing and Extended Wear Life Track.
  - Track roller wear charts for elevated sprocket machines now extend to the point at which the wear surface meets the retainer bolt holes.
  - Greater and Lesser Allowable wear columns were combined into one for large excavators.
- The machine layout is now similar to the PSK, starting with small machines and ascending to the large ones.
- The machine models are up-to-date.
- Pipelayer model numbers were added to the applicable section headers.
- The three excavator sections, the 300-Family, 200-Family and E-Family, can be more easily located with the new, individual tabs.
- Undercarriage Codes for use with the CTS computer program were updated and included in the front of each section and below each wear chart.
- The track seal replacement guidelines were updated.



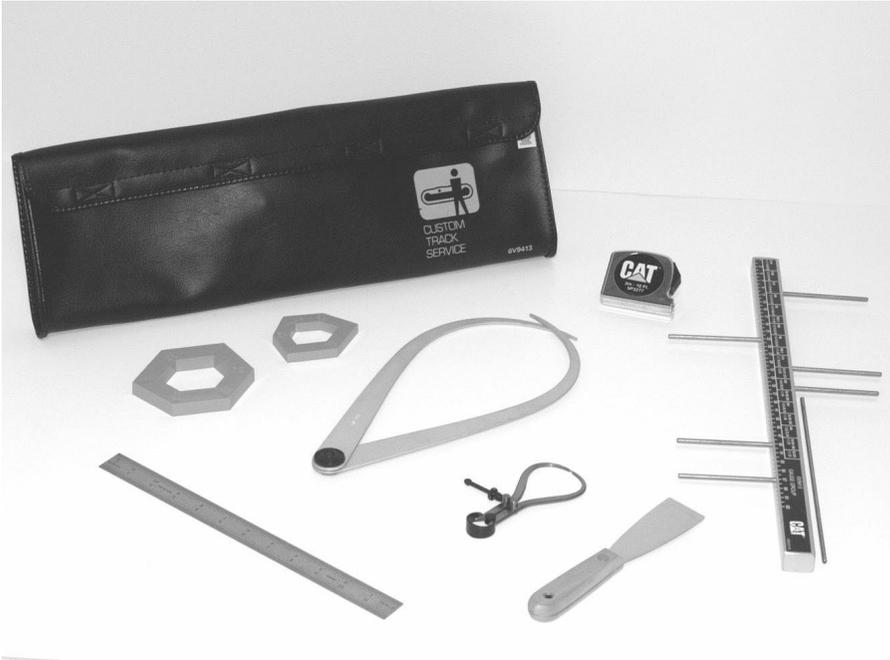
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# General Information

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# General Information

## MEASUREMENT TOOLS



### 6V9413 CTS Tool Kit

#### Separate Tools

Part Number	Description	Use
6V7784	CTS Pouch	Carrying Tools
8H8580	Scraper	Cleaning U/C Components
5P3920	12" Steel Rule	With Caliper And Depth Gauge
4S9404	4" Caliper	Bushing O.D.
8T7790	6" Caliper	D11N, D11R Bushing O.D.
4S9405	12" Caliper	Roller Diameter
5P3277	12' Tape	Track Pitch, D4H-D11R Sprockets
5P8616	Sprocket Gauge	D4-D5-D6 Sized Segments
5P8617	Sprocket Gauge	D7-D8-D9 Sized Segments
6V9410*	Depth Gauge	Multi-Purpose All Models

\* Replacement parts for the 6V9410 Multi-Purpose Depth Gauge:

6V9409 — 10" Probe

6V9408 — 4" Probe

The complete CTS tool kit allows you to quickly and accurately measure all undercarriage components. Order the complete kit or individual tools from Parts Distribution.

The tools provided in the Caterpillar CTS tool kit are high quality, high accuracy tools which will allow measurements to the closest 0.01" or 0.25 mm. Locally purchased substitutes should have this accuracy and the depth gauge should have at least an 18" base to be used for track roller measurement.



## 168-7720 Ultrasonic Wear Indicator III Group

### Separate Tools

Part Number	Description
168-7720	Ultrasonic Wear Indicator III Group
168-7721	Ultrasonic Wear Indicator III
168-7722	Ultrasonic Probe
9U-7981	Couplant
4C-5490	Couplant Holder
6V-7145	Case (without foam insert)
4C-4772	Foam Insert
4C-3024	Battery Charger (120 or 230 volts, 50/60 Hertz)
9U-6000	Paper Towels (16 towels)
1U-7445	Rechargeable Batteries, Nickel Cadmium (AA)
9U-6175*	Ultrasonic Wear Indicator Soft Protective Case
1U-9533*	Non-rechargeable Batteries, Alkaline (AA)
4C-5488*	Cable Assembly, 9-pin female connector, for PC
4C-5489*	Cable Assembly, 25-pin female connector, for PC
4C-5897*	Cable Assembly for Telephone Modem
NEHS0730	Tool Operating Manual

\*Not included with the Ultrasonic Wear Indicator Group

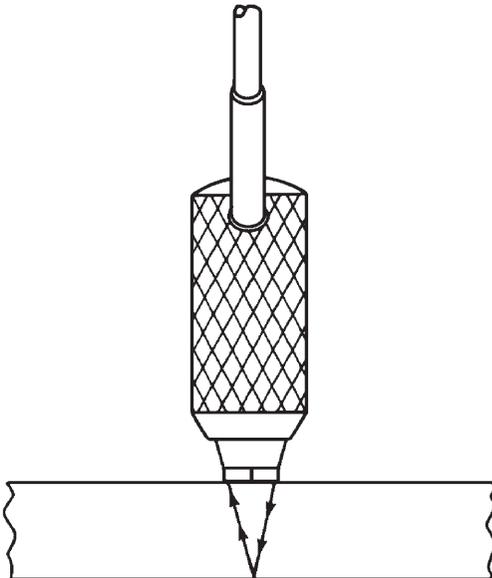
NOTE: A 12-volt automotive power supply adapter (6 volts DC) and an earphone are available through many electronic supply retailers.

### Ultrasonic Wear Indicator

The ultrasonic wear indicator measures component thickness by sending high frequency sound waves through the material to be measured. The elapsed time between sending and receiving the sound waves allows the tool to determine thickness.

This electronic CTS tool has the following key features and benefits:

- Ultrasonic wave emitting probe
  - Reduces time spent cleaning parts (especially bushings and shoes).
  - Eliminates measurement errors due to dirt packing around parts.
  - Measures bushings after turning.
  - Eliminates errors due to measurement technique differences among inspectors.
  - Measures idler center flange wear.
- Memory
  - Reduces on-site measurement recording.
  - Stores inspections for 64 machines.
  - Downloads to CTS computer program for automatic percent worn and projected life calculations.
  - Uploads previous inspections from CTS computer program to improve speed and quality
- Language capability
- Earphone connector
- Backlight feature
- English, French, German, Portuguese, Spanish
- Allows users to hear “Coupled” beeping indicator
- Allows users to see the display in poor lighting conditions



## Variables That Affect Undercarriage Life

The variables that determine complete undercarriage system life and wear balance between components can be divided into three major groupings. The first are those which, to a great extent, are controllable. Controllable variables include track tension adjustment (controlled by user operating and/or maintenance personnel), shoe width (controlled by user operating and purchasing personnel) and on some models, alignment (controlled by user and/or dealer service personnel).

The second major group, non-controllable variables, discussed later in this major section include those life determining factors which are “givens.” They come with the job. They are 100 percent determined by the underfoot conditions and include impact, abrasiveness, packing, moisture, terrain and even application, meaning what the machine is doing.

The final major group is sometimes called partially controllable variables and mainly involve machine operator controllable events such as “habits.”

A thorough knowledge of each of the elements of all these three major groups is essential if the CTS expert is going to be able to not only explain “what has happened,” but also “what could be expected to happen,” especially as any of these variables were to change. Awareness of the relative interplay between these variables on the final wear or structural life of specific components, and even on the system is so important that their discussion has been placed at the front of this book. To use the rest of the book before understanding these would be counterproductive.

### Controllable Variables

Controllable variables that affect undercarriage life must be separated out for discussion because, in the case of at least the first two, they can have major economic

effect on the operation of undercarriage systems.

Track adjustment can have a very large effect on external bushing life, even to the extent of deciding whether a costly turn will or will not be required to use up the link-roller system. Track tension can also affect track seal integrity. Track adjustment is controllable because the user can change it.

Shoe width, for which a detailed discussion follows, is controllable because the user, with your advice, chooses which shoe to order on his new machine and/or changes to when the machine changes tracks or even jobs. Shoe width as you will learn can effect such widely ranging items as track seal and lubricant integrity to link cracking to roller flange wear to bushing wear rate.

Alignment, the third and least critical controllable variable is discussed here because, particularly on low sprocket machines, it is wrongly blamed as a cause for many symptoms. It is beneficial to know how misalignment does and does not affect wear patterns so you can better identify the real cause, controllable or not. A short discussion on track-excited vibration is also placed in this area even though it is only controllable at machine design time.

### Track Adjustment

Although the method of measuring the reference sag and adjusting the track varies by machine type, the importance for these different machine types does not. As discussed earlier, track over-tightening can drastically affect external bushing life (increasing wear rate as much as three times) and for this reason alone is listed frequently as a “cause” or “accelerator” under the wear and structural problems section for many components. See separate machine sections for complete instructions on track adjustment.

### Shoe Width For Track-type Machines

Track shoe width and degree of impact (bumpiness) can affect the wear life of the undercarriage. Since shoe width is a controllable variable, you can improve performance and wear life of the components by choosing the right shoe.

Use the chart on page 54 to help choose the right shoe for a customer based on the following factors.

---

### Factors Affecting Machine Production

#### Flotation

Choose shoe width to provide adequate flotation, but not more than is needed. The narrowest shoe which provides adequate flotation will prevent the machine from digging in or sinking into underfoot material. Flotation increases proportionally to shoe width.

#### Penetration-Traction

Additional shoe width does not provide greater penetration or traction and consequently does not increase production assuming adequate flotation.

#### Maneuverability

Additional shoe width increases turning resistance, making the machine harder to handle and decreases productivity.

#### Versatility

Increased shoe width improves machine versatility allowing it to change from “hard” to “softer” underfoot conditions without losing flotation. However, increased shoe width accelerates wear and structural damage.

### Undercarriage System Wear and Structural Life Factors

#### Shoe Wear Life

Wider shoes do not improve wear life. The extra wear material provided by wider grousers gives a little extra life. The largest variable affecting shoe wear life is slippage.

#### Shoe Structural Life

Bending stress on the shoe increases proportionately to the distance from the outer edge of the link to the end of the shoe. Cracking, bending and hardware loosening increases as shoe width increases.

Basic Rule of Thumb: Always specify the narrowest shoe possible that will provide adequate flotation and traction without excessive track slippage. See chart on following page.

#### Link-Roller-Idler Wear Life

Wear rates increase on link rail sides, rollers and idler flanges as shoe width increases because of increased load interference. Increased shoe width can also aggravate link cracking.

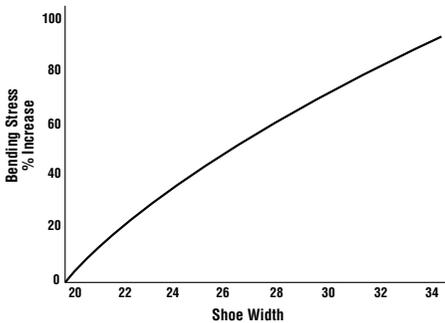
#### Pin and Bushing Wear Life

External bushing wear rate on Sealed and Sealed and Lubricated Track and internal wear rate on Sealed Track increases as shoe width increases in a given underfoot condition. This is due to the increased loads, weight and twisting.

#### Pin and Bushing Structural Life

Too wide shoes in high impact or steep terrain can cause pins and bushings to loosen in the link bores. This becomes more evident with high single grouser shoes. Loss of pin and bushing retention prevents successful turn and replacement maintenance.

The following chart shows the effect of track link assembly bending stresses as shoe width increases.



## Sealed and Lubricated Track Joint Life

The most costly effect of too wide shoes in high impact conditions and/or steep terrain is the loss of lubricant and seal life resulting in premature dry joints. The wider the shoe, plus the higher the impact, the greater the chance of a pressed track joint “opening up,” allowing loss of lubricant. The loss of lubricant occurs when the bushing slides back and forth along the pin. The clearance between the links created by this “opening up” is called end play. End play is permanent and can only be eliminated by pressing the components tight as at initial assembly or when track press work is performed. For maximum lubricant and seal life the machine should be equipped with the narrowest possible shoes which will provide adequate flotation.

In addition, shoes may have grouser corners cut off to reduce turning resistance and bonding forces without loss of flotation and with little loss of overall wear life.

---

## Conclusion

Users should be aware of all the advantages and effects in productivity and wear/structural life factors when choosing shoe width. If all the symptoms of wide shoes are considered on the user’s machine and the causes are explained then he will be able to choose the shoe width based on a better compromise between productivity and wear life.

# General Information

## ALIGNMENT

Alignment for all Track Type Machines excluding \*D9R (SN 7TL1212-up and 8BL1422-up) \*D10R (SN 3KR1331-up) and \*D11R (SN 9TR202-up and 9XR154-up).

Proper roller frame, idler and sprocket alignment is important to avoid accelerated, unbalanced wear on moving undercarriage components (roller tread and flanges, link rails and rail sides and sprocket segment or rim sides).

As a general rule any wear pattern differences between left and right, inner and outer, or front and rear may be due to

improper alignment of one or more parts of the roller frame, idlers or sprocket.

Complete discussion on checking and measuring roller frame alignment plus straightening procedures are discussed in Special Instruction SEHS8146-01 available from Service Publications.

Here is a description of the more common types of alignment problems, their cause, effect, and the steps required to correct the cause:

\*Note: These machines have unique Track Roller Frame alignment to increase link and roller life. This is further detailed in Service Magazine SEPD0469.

## Roller Frame

(including diagonal brace)

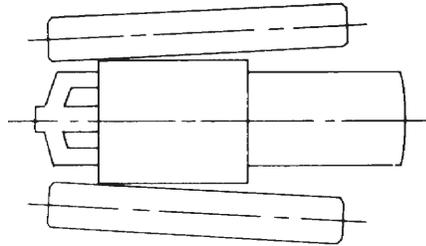
### Toe-In and/or Toe-Out

When viewed from the top, either or both of the roller frames is not parallel to the center line of the tractor.

**CAUSE:** temporarily (during load only) or permanently bent diagonal brace or roller frame

**EFFECT:** unbalanced wear when comparing inboard versus outboard roller and idler flanges and rail sides — rollers worsen from rear to front

**REMEDY:** straighten diagonal braces and repair mounting bearings



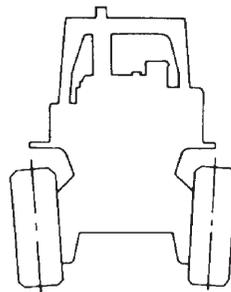
### Tilt

When viewed from front or rear the roller frame tilts toward or away from tractor.

**CAUSE:** permanently bent diagonal brace, broken mountings or bearings

**EFFECT:** unbalanced wear when comparing inboard versus outboard roller, idler, link treads and flanges — unbalance from front to rear on rollers

**REMEDY:** straighten diagonal brace and/or repair mountings



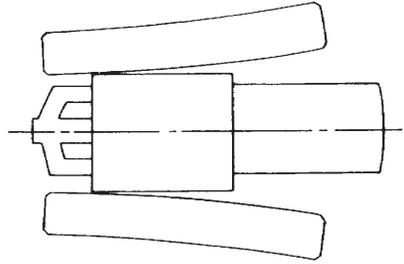
### Bow

Similar to toe-in and toe-out, but roller frame is bent and curves in or out with respect to tractor.

CAUSE: bent roller frame

EFFECT: similar to toe-in and toe-out except rear rollers are not affected

REMEDY: straighten roller frame



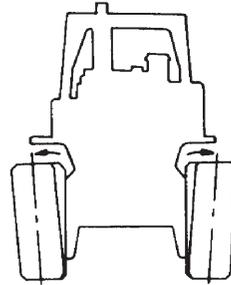
### Twist

When viewed from the front, the roller frame is twisted, with the front end of the roller frame tilted out.

CAUSE: roller frame twisted around a horizontal axis parallel to the tractor

EFFECT: similar to effect of tilt except that rear rollers should not be affected

REMEDY: straighten roller frame



### Idler Mounting

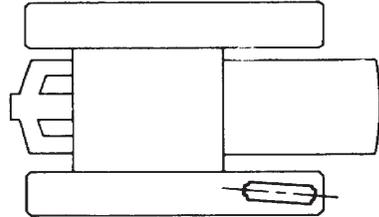
#### Toe-in or Toe-out

When viewed from top, idler is not parallel to center line of roller frame.

CAUSE: bent idler support box sections or bent idler yoke

EFFECT: wears inner rail sides and idler flanges most — may affect wear on front roller flanges

REMEDY: straighten idler support box sections or yoke



#### Idler Height

The distance that the tread of the track idler is above the tread of the adjacent track roller.

CAUSE: insufficient or excessive idler height

EFFECT: as track roller tread wear and damage, deterioration or loss of bogie pads occur, and excessive machine vibration may result. Vibration is the result of insufficient idler height. Excessive idler height results in poor dozing control, particularly while performing finish dozing operations.

REMEDY: correct shimming

# General Information

## ALIGNMENT

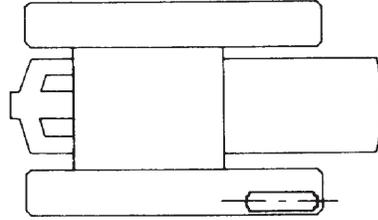
### Lateral Displacement

When viewed from top, idler is parallel to, but moved toward or away with respect to the tractor and roller frame.

CAUSE: improper shimming

EFFECT: wears inner or outer idler flanges and inner rail sides selectively and may affect front roller(s) if severe

REMEDY: correct shimming



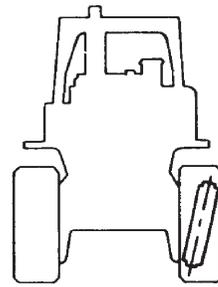
### Twist — Tilt

When viewed from front, idler tilts out of vertical plane.

CAUSE: bent idler support box frame (inner and/or outer up and/or down with respect to each other)

EFFECT: same as toe-in or toe-out

REMEDY: same as toe-in or toe-out



### Sprocket

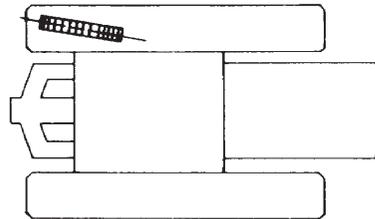
#### Toe-in, Toe-out

When viewed from top, sprocket not parallel to center line of roller frame.

CAUSE: sprocket shaft bent forwards or backwards

EFFECT: wears both inner link sides and both sides of segments

REMEDY: straighten or replace sprocket shaft



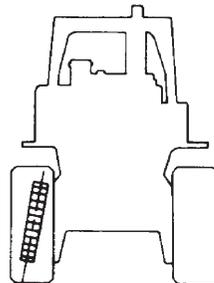
#### Twist

When viewed from rear, sprocket is leaned or tilted in or out with respect to the roller frame.

CAUSE: sprocket shaft bent up or down

EFFECT: inboard or outboard sprocket sides and rail insides worn selectively, may affect rear roller flanges

REMEDY: straighten sprocket shaft



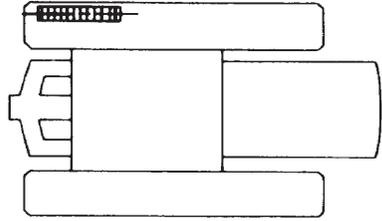
### Lateral Displacement

When viewed from top or rear, sprocket is parallel to but moved in or out with respect to tractor and roller frame.

**CAUSE:** sprocket not pressed proper distance onto shaft

**EFFECT:** inboard or outboard sprocket sides and rail insides worn selectively, may affect rear roller flanges

**REMEDY:** re-position sprocket on shaft



### General Statements about Alignment Problems, Symptoms, Causes, Effects and Remedies:

1. The larger and heavier the machine and the more severe impact, the greater likelihood of temporary and permanent alignment problems.
2. Alignment problems of roller frame idler and sprocket will affect all links the same.
3. Alignment problems of roller frame, idler and sprocket will affect rollers unequally from front to rear and from inner to outer flanges and treads.
4. Horizontal straightness of roller frame will not affect track but will affect front and/or rear roller treads compared to center.
5. Snaky track will not cause near the degree of damage as compared to misalignment.
6. Carrier rollers can be used as a more visual indicator of roller frame alignment but are not as reliable as comparing track rollers.
7. If left side of tractor has different misalignment-type wear patterns than right side, the problem is probably due to permanent, rather than temporary, (working loads) causes.
8. Unbalanced loads due to side hill operation will result in front to rear and left side to right side similarly in wear patterns on all parts affected.
9. If misalignment is suspected, it is important to at least measure the misalignment degree, if not completely correct it before installing new undercarriage components.
10. Tight track increases the effect of all types of alignment problems because it increases the loads between the interfering components.

For more complete descriptions and cross reference of specific component wear patterns that may be caused by misalignment, refer to the discussions under each component and model.

### Track-Excited Vibration

Track-excited vibration is the most widely encountered vibration on track-type machines. However, it is not understood by many persons who work with these machines. As the machine moves, each link, as part of an endless rail, makes contact with two curved surfaces — each with a different radius. These are the idler and the track rollers. Contact between the links, idler and rollers results in wearing of the links' once-straight surface. The contact between the idler and the link creates a worn radius in the center of the link similar to that of the idler.

The track rollers have a similar effect on the ends of the links, which are narrowed to permit them to overlap where they are connected together. Because this overlap isn't 100 percent, the greatest amount of wear is near the ends of the links, and the size of the worn area has a radius similar to that of the track rollers. As a result of this wear, a scallop pattern is formed on the surface of each track link. (See page 30).

This type of link wear can be accelerated by three factors — abrasiveness and moisture content of the soil, machine weight and travel speed and underfoot conditions. Rough underfoot conditions can place higher loads at a given point on a link. It is possible, on rocky or rough terrain, to have a higher load on a link on one side of the machine than on the other side. Although rough terrain can accelerate wear, it is sometimes possible that track-excited vibration will go unnoticed on rough terrain, yet be apparent when the machine is working on a smooth surface.

Along with the depth of scallop, the scallop-roller spacing relationship is what determines how smoothly the machine will travel on the links. If the spacing of the track rollers and scallops are uneven, so that some of the rollers are on the high points of the links while others are over the low points, the machine will move across the scallops smoothly. However, if the spacing is the same, the rollers will rise

and fall in unison with each scallop as they pass over the links, thus creating vibration.

Two factors, machine speed and the depth of the scallops, affect the amount of vibration. The speed of the machine determines the frequency of the vibration while the depth of the scallops controls the amplitude of the vibration. In addition, natural frequencies, which occur in all structures, can respond to the vibration. Because of this response, it is possible for certain parts of a machine, such as the roll-over protection structure, sheet metal components, or, sometimes, the whole machine, to respond to the initial frequency and begin vibrating.

The vibration can be reduced by replacing deteriorated isolation mounts where necessary, replacing any broken or missing fasteners and by generally keeping the machine in good repair. A change in operating speed or technique, or a change of counterweights or attachments may reduce the effect.

---

### Testing and Adjusting Front Idler Position and Machine Balance (D4H to D7R)

Operator complaints of ride arise when a machine is vibrating more than normal. Abnormal vibration is generally caused by an idler that is lower than the track rollers, a machine that is not balanced, or scalloped track links.

Special Instruction entitled "Adjustment of the Position of the Front Idlers and the Balance of the Machine for Improved Ride or Improved Fine Dozing," REHS0862-02, dated June 01, 2001, covers the following topics:

- Correct Track Installation
- Measuring Grouser Rise Height
- Verify the Installation of the Correct Idlers
- Measuring the Depth of the Link Scallop
- Shim Charts for Idlers
- Measuring the Height of the Front Idler Tread

- Checking the Balance of the Machine
- Adjusting the Height of Center Tread Idlers

### Procedure to Determine Idler Height (D8L, D8N, D8R, D9L, D9N, D10, D10N, D11N Tractors)

Model	Applicable Serial Numbers
D8L	All
D8N	All
D8R	All
D9L	All
D9N	All
D9R	All
D10	All
D10N	All
D10R	All
D11N	All
D11R	All

As track roller tread wear and damage, deterioration or loss of bogie pads occur, and excessive machine vibration may result. This vibration is the result of insufficient idler height. Idler height is the distance that the tread of the track idler is above the tread of the adjacent track roller. See Illustration 1 for the area to be measured.

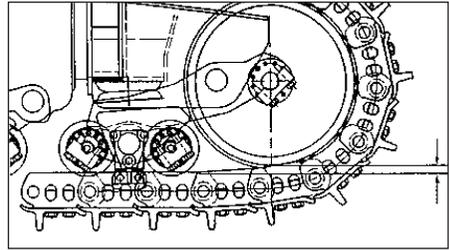


Illustration 1. Idler Height.

Under typical operating conditions, wear causes the diameter of the track roller treads to decrease at approximately twice the rate of the track idlers. When the front or rear rollers reach approximately 70 percent wear, the idler height may approach the minimum recommended value. Variations in operating conditions influence the wear rates.

Additionally, the installation of new or rebuilt idlers on machines with partially worn track rollers directly affects idler height.

To measure idler height, use the following procedure.

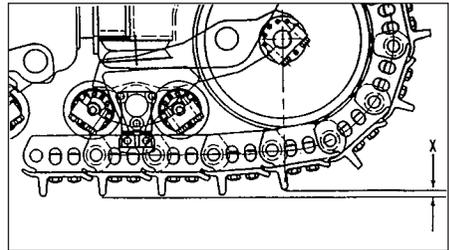


Illustration 2. Measurement points on a hard surface.

1. Move the machine to a hard, level surface. Inspect to make sure all bogie pads are in place. If any pads are missing or unserviceable, they should be replaced.

Model	Front Idler Nominal	Front Idler Minimum	Rear Idler Nominal	Rear Idler Minimum
D8L	29 mm (1.142 in)	17 mm (.670 in)	34 mm (1.339 in)	10 mm (.394 in)
D8N, D8R	15 mm (.591 in)	10 mm (.394 in)	16 mm (.630 in)	10 mm (.394 in)
D9L	23 mm (.906 in)	11 mm (.433 in)	27 mm (1.063 in)	11 mm (.433 in)
D9N, D9R	24 mm (.945 in)	11 mm (.433 in)	21 mm (.827 in)	11 mm (.433 in)
D10	25 mm (.984 in)	14 mm (.551 in)	32 mm (1.260 in)	12 mm (.472 in)
D10N, D10R	26 mm (1.024 in)	14 mm (.551 in)	23 mm (.906 in)	12 mm (.472 in)
D11N, D10R	32 mm (1.260 in)	14 mm (.551 in)	23 mm (.906 in)	12 mm (.472 in)

# General Information

## VIBRATION

2. To check front idler height, carefully move the machine in REVERSE until a track shoe grouser is directly below the center of the idler shaft. See Illustration 2.

3. Measure the distance (dimension X), between the bottom of the track shoe grouser in full contact with the surface and the bottom of the track shoe grouser directly below the idler shaft.

4. Repeat the procedure of aligning the track shoe grouser directly below the center of the idler shaft on the rear idler by carefully moving the machine forward. Measure dimension X for the rear idler.

5. Idler height varies from model to model and between front and rear idlers. Compare dimension X with the recommended nominal and minimum values for the front and rear idlers that correspond to your model as shown in Chart A.

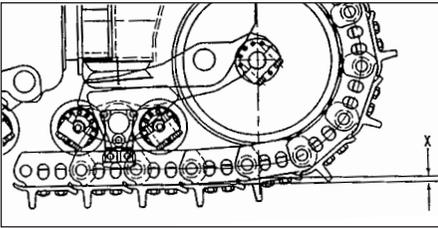


Illustration 3. Measurement points on a soft surface.

**Note:** In the event that a suitable hard surface is not available for checking idler height, a less accurate method may be used. See steps 6 and 7 below.

6. Carefully move the machine in REVERSE until a track shoe grouser is directly below the center of the idler shaft.

7. Stretch a length of string along the top edge of the track shoes. Dimension X is measured from the string to the point where the center line of the idler shaft intersects the top of the track shoe which is directly below it. See Illustration 3 for the location of dimension X.

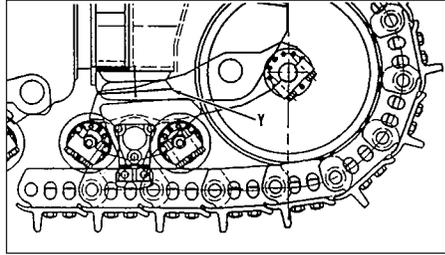


Illustration 4. Add plates at point Y.

Chart B		
Model	Plate Part No.	Plate Thickness
D8L	9P5543	5 mm (.196 in)
D8N, D8R	7T4699	5 mm (.196 in)
D9N, D9R	7T5422	5 mm (.196 in)
D9L, D10N, D10R	9P2704	5 mm (.196 in)
D10, D11N, D11R	8P8884	5 mm (.196 in)

### ⚠ WARNING

Prior to adding plates under the bogie pads, raise the machine until the bogies are hanging free. Carefully support the machine. See the disassembly and assembly module in your machine's Service Manual for the correct procedure.

8. If dimension X is less than the minimum shown in Chart A, plates should be added between the lower bogie pad and the top of the major bogie assemblies at point Y. The appropriate plates and their part number are listed in Chart B. See Illustration 4 for the correct location to add plates.

The addition of one plate installed under a front or rear bogie pad increases idler height by approximately 7.50 mm (.295 in). In order to maintain uniform roller loading, equal number of plates must be installed under the intermediate bogie pads. Take care not to install more plates than are necessary to achieve the proper idler height dimension. Excessive idler height results in poor dozer control, particularly while performing finish dozing operations.

## Non-Controllable Variables

There are a number of variables that affect rates and patterns of wear which cannot be controlled. These should be understood so you can explain their effects.

Non-controllable variables include soil and underfoot conditions (abrasion, impact, packing, etc.), application conditions (what the machine is doing) and terrain conditions.

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## Soil & Underfoot Conditions

Generally, soil and underfoot conditions cannot be controlled. They include the abrading, impacting, packing and even corrosive and temperature effects of the immediate environment.

### Abrasiveness

Abrasiveness of underfoot conditions is the most difficult to accurately measure except by its effect. We use these descriptions to identify relative abrasiveness in terms of high, moderate and low:

### Abrasiveness Ratings Descriptions

**High** — Saturated wet soils containing a majority of hard, angular or sharp sand particles.

**Moderate** — Slightly or intermittently damp soils containing low proportion of hard, angular or sharp particles.

**Low** — Dry soils or rock containing a very low proportion of hard, angular sharp sand or rock chip particles.

The amount of moisture plays a big role in defining abrasiveness. For example, *dry*, pure quartz sand may be only 1/10 as abrasive as saturated wet, pure quartz sand slurry and only 1/2 as abrasive as it is in a damp condition. This is because moisture affects the rate that particles are carried to and stuck to the metal surface being worn. Some abrasive combinations tend to attack the bushing, others the grousers and still others the links and rollers. These differences are difficult to quantify except by actual

experience, but you should be aware of the possibility.

Usually, the link is the best component to use for comparing overall relative abrasive effects because it is least subjected to other variables at the same time. This is why we use the link as the “base” or “barometer” component when comparing wear lives to the service limit of different components in different abrasive conditions.

### Impact

Impact is not affected by other variables such as moisture or hardness of the particles that make up the soil. It can be defined as high, moderate or low. Impact is determined by weight of the machine and speed is defined under APPLICATION CONDITIONS later in this subsection.

### Impact Ratings Description

**High** — Non-penetratable hard surfaces with constant exposure to 6" (15 cm) or higher “bumps.”

**Moderate** — Partially penetratable surfaces with constant exposure to smaller bumps.

**Low** — Completely penetratable surfaces (which provide full shoe plate support) with low exposure to any height “bumps”.

The most measurable effect of impact is on structural problems such as bending, cracking, breaking, chipping, spalling, roll-over and hardware and pin and bushing retention. However, the degree of impact when combined with abrasiveness may affect component wear rates and wear life by a factor of two or more. For example, a D6 dozing at a given speed on completely compacted or frozen sandy soil with a deeply furrowed surface (high impact) may get only one-half the wear life on links as it would if the same *soil* were loose, soft and smooth (low impact).

Generally, wear life of larger machines are less affected by variations in impact than smaller machines.

# General Information

## UNDERFOOT CONDITIONS

Wide shoes accentuate the effects of impact conditions. Machines with single grouser shoes are more susceptible to higher impact effects than those with lower profile or multi-grouser shoes.

### Packing

Packing describes any condition where underfoot material sticks to or packs between moving undercarriage components. It has two major effects. First, it can prevent mating parts from properly engaging each other causing interference, high loads and increased wear rates. The best examples of this effect is sprocket teeth packing, or packing between shoe and bushings, causing the teeth to engage the bushings under interference.

The second major effect of packing is it binds abrasive particles to moving components thus increasing the wear rate. The best example of this is a sand-clay mixture packed around idlers, carrier and track rollers causing constant abrasion when these components turn. The result is similar to a grinding or polishing wheel. Parts subjected to this effect are usually polished smooth.

Severe cases of packing will prevent the rollers, particularly carrier rollers, from turning. Then links must slide across roller treads causing flat spots which are easily recognizable.

Packing materials vary widely and extend far beyond clay and mud that are normally associated with the above effects. The following list of materials can result in one or both of the major effects listed above. Obviously, the moisture content of most of these materials helps determine its stickiness and its compactability. Many underfoot conditions are composed of various combinations of these materials and the effect may be cumulative. Packing materials fall into two categories; (A) those that can usually be extruded (squeezed out) from between the parts when *wet* and (B) those which cannot be extruded with the pressures and opening sizes normally available in track type machines.

### Packing Materials

#### A Extrudable (when wet)

- Sanitary Landfill (garbage)
- Silt soils
- Clay soils
- Sandy soils
- Snow and ice
- Metallic ores (taconite)
- Non-metallic ores (gypsum)

#### B Non-extrudable

- Sanitary Landfill (garbage)
- Branches, twigs and brush
- Stones, rocks and gravel
- Demolition debris
- Sod-like materials

Generally, packing effects cannot be controlled except by constant cleaning or removal.

The most common modification to undercarriage components or use of option attachments involves providing Trapezoidal openings for the packing type material to extrude (squeeze) or fall out, thus relieving the pressure. These modifications or attachments should only be used in the presence of extrudable type materials. (List A above)

1. Trapezoidal Openings in shoes. Caterpillar recommends that track shoes with trapezoidal openings be used in the presence of extrudable type material (see list A above). Track Shoes with trapezoidal openings are available for most models from Caterpillar. The procedure for dealers or users to cut trapezoidal openings in shoes is described in Information release memo *UC89-17* dated *Oct. 4, 1989*.
2. Roller guards should not be used in packing type materials except when rocks could enter between the rollers and cause crushing damage. Roller guards prevent most materials from extruding or falling out and cause more damage than they prevent.

3. Mud and snow sprockets and segments should only be used in the constant presence of soft extrudable packing materials. In any other material they will result in much accelerated external bushing wear due to reduced contact area in the sprocket root where the slots are located. This is particularly true of Sealed and Lubricated Track because the bushing spends a greater period of time exposed to the root area of the sprocket tooth.

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## Other Environment Variables

There are other conditions that may or may not be associated with the soil and underfoot conditions.

### Moisture

The effects of moisture as contributing to abrasiveness and packing have been explained in the previous section. Moisture or water in itself can corrode (rust) steel resulting in the loss of wear material.

Moderate amounts of moisture increase the corrosive effects of many other chemicals and compounds; both those found in nature and man made, such as sulfur, salt and fertilizers.

Water in liberal amounts has the beneficial effect of washing abrasive particles away, softening many packing materials to ease their extrusion and finally, diluting some chemical corrosion agents to lessen their effect.

### Chemicals

Corrosive chemicals found in nature plus man-made compounds may have the effect of either eating away at wear material or increase the rate of certain types of cracks. Ironically, most hardened steels are more susceptible to corrosion and corrosion cracking than softer, unhardened steels. Highly acidic and saline soils can contribute to these effects.

Organic chemicals such as petroleum products can attach rubber load rings and toric rings in rollers and idlers causing these to swell and fail.

### Temperature

The effect of higher temperatures is to increase the rate of chemical action. Extremely high temperatures like those found in slag removal in steel mills can damage seals and soften hardened steels found in undercarriage parts reducing their strength and wear resistance.

The effect of temperatures below 32°F (0°C) is to freeze soils and water, creating all previously discussed packing effects from normally non-packing materials. Very low temperatures at -40°F (-40°C) can result in increased steel brittleness, (loss of cracking resistance) loss of rubber type seal resiliency and reduction in the lubricant flow necessary in Sealed and Lubricated Track and Lifetime Lubricated roller and idlers.

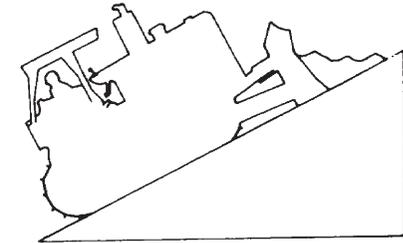
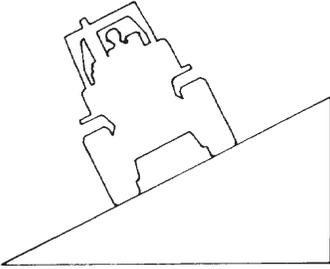
# General Information

## UNDERFOOT CONDITIONS

### Terrain Conditions

All application effects are influenced by the terrain on which the work is being done. The most common effects are described here regardless of the degree of impact, or the operating condition.

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### Working Uphill

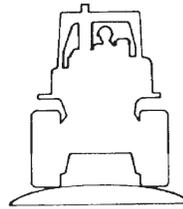
Shifts weight balance to the rear causing relatively higher wear on rear rollers and increasing forward drive side sprocket and bushing wear.

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### Working on Sidehill

Shifts weight balance to the downhill side of the machine; this increases the wear rate on the components on the downhill side of the machine. This increases wear on rail sides, roller and idler flanges, bushing ends, and grouser ends.

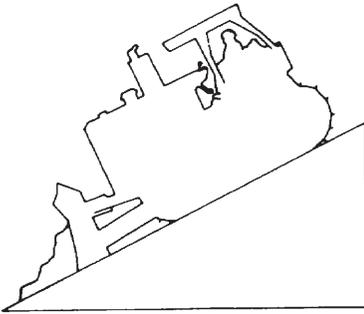
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### Working on a Crown

The inner components carry heavier loads. This results in increased wear on inner links, rollers, idler treads and grouser ends. In extreme cases, the inner bushing-to-sprocket contact surfaces also may experience greater wear.

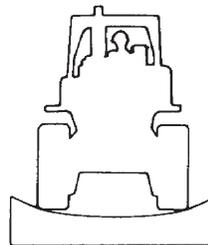
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### Working Downhill

Shifts weight balance forward causing relatively higher wear rate on front track and carrier rollers. Due to design of track, working in forward minimizes rate of bushing and sprocket wear.

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### Working in a Depression

Causes loads to be carried by outer (or outboard) components, increasing wear rates on outer links, roller and idler treads, grouser ends and the outer bushing-sprocket contact surfaces in extreme cases.

## Application Conditions

The word “applications,” often misused to describe underfoot condition, should be thought of as describing what the machine is doing. Below is a brief description of the possible wear and structural effect of each of several common “applications,” but without regard to what underfoot conditions the machine is in.

### Dozing and Push Loading

Shifts machine weight toward the front causing faster wear rate on front rollers and idlers than on rear rollers.

### Ripping and Drawbar

Shifts the weight balance towards the rear of the machine with the effect of relatively increasing wear rate on rear rollers than front, and the sprocket and bushing in extreme cases.

### Loading

Shifts weight from front to rear of machine as it changes from digging to carrying respectively. The greatest effect is increased wear on front and rear rollers as compared with center rollers.

### Excavating with Hydraulic Excavators

Shifts weight balance from left to right of machine with the possible effect of wearing outer link treads, roller treads and flanges at a greater rate than inner flanges and treads.

---

## Partially Controllable Variables

Some of the variables affecting undercarriage life can only be partially controlled. To some extent they may be influenced by uncontrollable variables but they can be offset by the operator. We call these operating conditions.

The word “operating,” often misused to describe the underfoot or application conditions, should be thought of in describing

what the machine operator is doing. These operator induced variables may or may not be a function of the underfoot conditions, the type of machine or even the application and terrain.

### Speed

Wear rate is a direct function of speed because wear is a function of distance traveled and not just the time worked.

As speed increases, wear rates increase proportionally on all components. Wear rates and impact (structural) effects also increase proportionately with speed due to the increased material loads caused by the rate at which the parts contact each other. Link-roller, link-carrier roller, link-idler and bushing-sprocket wear rates increase as a result of the increased impact between these parts. Shoe and grouser wear rates increase due to the increased impact with the ground. High speed reverse has a particular effect on the bushing-sprocket contact wear rates due to the design of the track. Non-productive speed should be discouraged. Non-productive forward-reverse direction changes should be avoided.

### Turning

Wear rates increase with increased turning. Turning increases interference loads between links and rollers and links and idlers, particularly on rail sides and roller and idler flanges. Turning in reverse can accelerate bushing sprocket wear as compared to turning in forward. The effects of always turning in one direction can be balanced by changing tracks from one side of the machine to the other half way through their life.

### Slipping Tracks

Wear rates on all components increase when tracks are slipped. Track shoe grousers particularly are affected when tracks are slipped due to the increased sliding between the grouser and the ground. The increased loads that slipping tracks cause is accelerated when the ground is resistive to shear.

### **Preferred-Side Dozing or Other Work**

Wear rates on the loaded side of a dozer will increase on all components if only one side of the machine is used. Wear rates increase as more power is applied to the loaded side. More slippage and packing will occur on the loaded side; this also increases wear.

Putting more loads and packing onto one side of the machine may result in up to twice the wear rate on that side. This wear rate effect may be balanced by switching all components from one side to the other. This should be done when the link and/or rollers reach 1/2 their potential wear life on the most worn side.

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## Components

Each component has individual measurement techniques, wear limits, wear charts, rebuildability criteria, wear patterns and structural problems. The general information for each component is covered in the following section. Specific additions and exceptions are covered in the individual product sections.

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## Percent Worn Charts

The percent worn charts section of this handbook translate direct component measurements into percent worn for Caterpillar parts only.

Remember — all percent worn figures shown are percent of time used and not percent of material used. This allows them to be used to directly calculate or project total potential time (or life left) to the service limit. These charts consider the slower rate of wear when the hardened case is still there and the faster rate of wear that occurs when softer material is exposed. In some cases they also take into account different expected wear rates after the service limit. In most cases they are not “straight-line” relationships.

Charts are provided for high and low impact applications where applicable. Measurements corresponding to 100 percent worn (the service limit) are underlined.

In most cases, service limit projections made from less than 30 percent worn can not be considered accurate. However, such projections can be used to determine call back dates for remeasuring.

Percentages above 100 percent have been provided so projections to 120 percent worn can be calculated. Backward projections to service limit (100 percent) can also be made to determine when the service limit was reached. The extent of percentages shown beyond 100 percent has no particular significance.

Guidance for the selection of high, moderate or low impact and lesser or greater allowable wear charts is provided at the front of each section of wear charts.

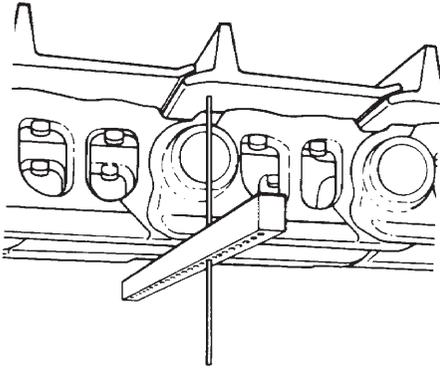
A separate discussion under each component sub-section (links, bushings, etc.) describes how the service limit was derived and the risk involved when the component is worn past that point.

*NOTE: Competitive undercarriage inspection, wear life and maintenance/rebuild projection cannot be determined from information contained in the handbook because of a lack of information about design, expected wear rates and service limits even when some important dimensions are similar.*

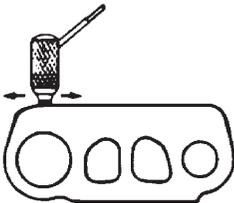
### Link Rail Wear

#### Measurement Technique

Track links may be measured by the depth gauge or by the ultrasonic wear indicator.



The depth gauge measures link height from the rail surface to the track shoe. The correct location for track link measurement is outside of the links at the end of the track pin. Position the depth gauge as close to the end of the pin as possible, making sure links and shoe surface are clean. Ensure the gauge is flat against the link rails and perpendicular to the shoe surface. Measurement should be made to the closest 0.01" or 0.25 mm.



The ultrasonic wear indicator measures the distance from the rail surface to the bushing bore. Place the probe on the link above the centerline of the bushing and slide the probe along the tread surface to get the smallest reading.

#### Wear Limits

Link wear limits are determined by setting the allowable wear equal to some fraction of the clearance between the link and the roller. On some machines this clearance is between the link pin boss and the roller flange. On other machines the clearance is between the bushing and the inner flanges of a double flange roller.

On a 100 percent worn link matched together with a 100 percent worn roller, the roller flanges are in contact with either the link pin bosses or the bushing. As wear proceeds past 100 percent, wear on the link pin boss reduces pin retention, wear on the bushings may cause cracking, and wear on the roller flanges reduces track guiding and roller rebuildability.

If the link is worn to approximately 120 percent, structural damage may result in the form of cracking, breaking and pin and bushing loosening.

#### Wear Charts

Wear charts for links have a built in factor allowing for faster wear rate as the hardness of the steel decreases below the hardened case depth. This is true for all components where the allowable wear is greater than the hardened case depth.

Different wear charts are provided for different links, and for the same link running with different rollers, each of which is determined by part number within a given undercarriage or machine size.

#### Rebuildability

Track links can usually be successfully rebuilt with submerged and/or automatic welding to replace the worn away rail (top) surface if the link meets the following criteria:

1. Rail wear measured over the pin boss is between 70 percent and 100 percent.
2. Unevenness of rail height is not excessive.

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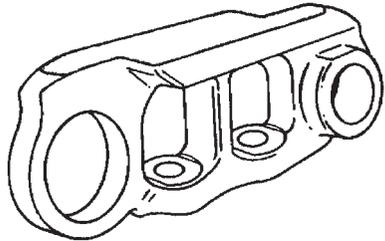
3. Rail side wear due to roller flange or guiding guards or inside rail gouging by the sprocket hasn't reduced rail width significantly.
4. Pin boss is not worn enough to cause reduced pin retention.
5. Counterbore depth and elongation wear (with Sealed Track) will not significantly affect resealing of the pins and bushings.
6. Face wear (area surrounding the link, bushing and counterbores) has not reduced the thickness of the rail in that area by more than 20 percent.
7. Rail spalling hasn't caused more than 30 percent of the rail surface to be removed.
8. Links are not cracked through in the rail, pin and bushing bores or shoe strap sections.
9. Bolt holes are not wallowed out or elongated to prevent adequate shoe retention.
10. Pin and bushing bores are not damaged (broached) as to prevent adequate pin and bushing retention.

With proper welding techniques and materials, the fully rebuilt (to 0 percent worn height) rail should provide about 80 percent of the original life to the service limit. This percentage may be reduced as impact level increases. By running the rebuilt rail to 120 percent it should provide about 100 percent of the original rail life to the service limit potential.

### Sealed and Lubricated Track vs. Sealed Track — track link effects

Due to the expected absence of internal wear, counterbore depth and elongation wear and face wear should be eliminated. This increases successful rebuildability compared to the same link used with Sealed Track. Absence of internal wear and snakiness should also reduce the degree of rail side wear, uneven rail wear, inside rail gouging and guiding guard wear, and possibly increase original and rebuilt rail wear life. If snakiness is experienced with Sealed Track, the lack of snakiness in Sealed and Lubricated Track may extend link life by up to 20 percent.

### Link Wear Patterns



#### Rail (Top) Wear

(Normal expected wear position)

**CAUSES:** Rolling and sliding contact with roller and idler treads.

**ACCELERATORS:** Horsepower, weight, speed, impact, abrasiveness, shoe width, tight track and snakiness.

**EFFECT:** Wear limit reached when roller flanges begin to contact top of pin boss.

**REMEDIES:** Eliminate or reduce controllable accelerators listed above and rebuild (weld) to desired rail height.

Sample of manual. Download All 826 pages at:

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