



MERITOR®

STRAIGHT

TALK

ABOUT

U-JOINTS



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Straight Talk **About U-Joints**



KEEPING TRUCKS ROLLING

With over 70 years of worldwide experience, including designing, building and conducting training courses on drivelines and U-joints, you can certainly learn a whole lot.

And we did!

We also found out along the way a whole lot about the CAUSES that lead to failures. Now, in our mutual interest to help prevent equipment breakdowns, we want to pass along our storehouse of "straight talk" information to help boost YOUR technical know-how about driveline failures.

Our experience has confirmed this fact: When you are able to understand the reasons WHY a failure occurred plus the ability to "READ" damaged or broken parts, repeat failures often can be prevented.

"Reading" the damaged or broken part is another way of saying "FAILURE ANALYSIS," which is simply a way we've developed to determine the basic causes of failure through a visual inspection.

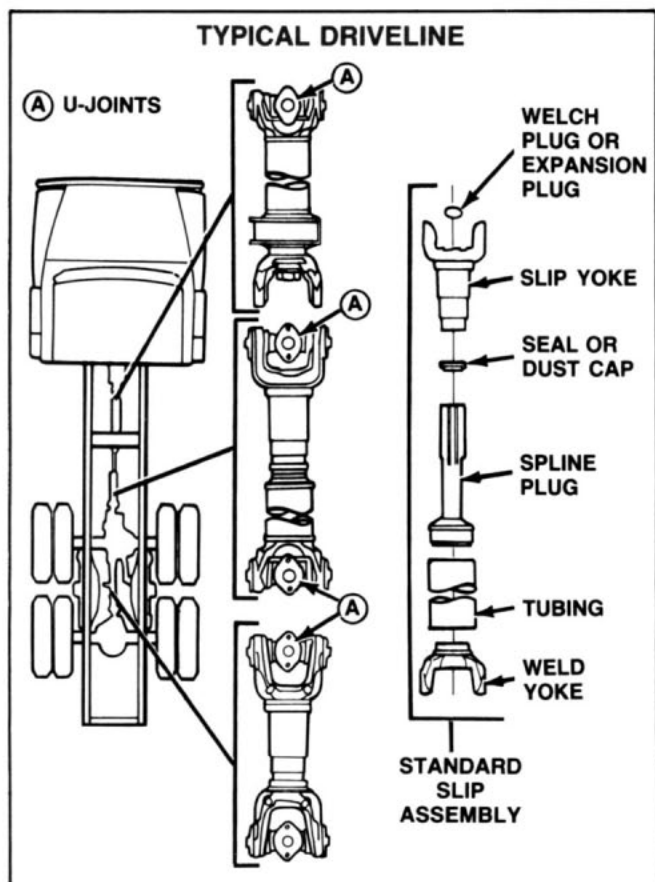
You don't need expensive test equipment . . . just a good pair of eyes . . . and a review of the material in this handy reference booklet. We tailored the contents in a straight-from-the-shoulder style to meet YOUR specific needs.

Straight Talk About U-Joints

COVERING THE BASICS

By quickly covering the basics of U-joints and their common parts terms, you'll find the technical material covered in the reference booklet will be much easier to understand and remember.

For a brief review, let's first mention the purpose of driveshafts. Frankly, we can sum it up by saying that their sole function is to **transmit power** from the transmission to the driving axles. Of course, it must also **change length** as the truck's suspension moves according to road surface conditions.



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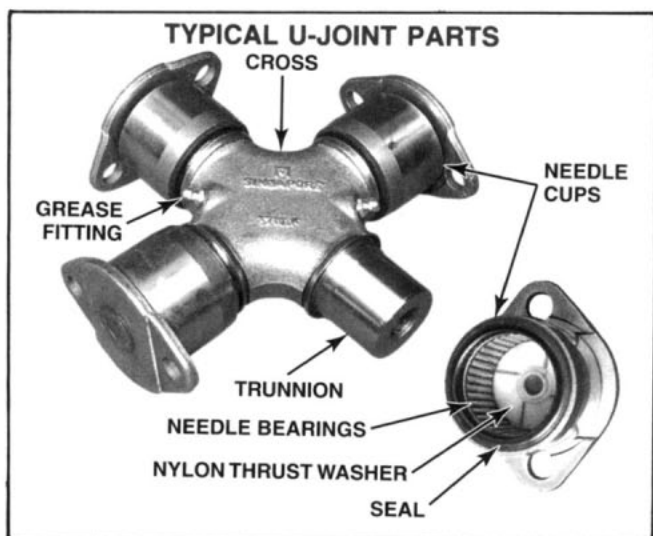
Many large trucks use more than just one shaft, especially those equipped with a long wheelbase and others with tandem rear axles. At each end of a drive-shaft (or coupling shaft), U-joints are required since the driving axle (or axles) is forced up and down as the wheels roll over bumps, large cracks and pot holes. Without the flexibility that U-joints provide, shafts would soon break from flexing fatigue.

Splined slip yokes are also needed to permit smooth "fore and aft" movement of shafts whenever the rear axle moves up and down.

For the splines to move easily, without "binding," they must be lubricated by a specific high-pressure and high-temperature type of grease.

NOTE: Lubrication of U-joints requires a good quality NGLI Grade 2 Grease with Extreme Pressure Additives (EP) and high temperature capability.

U-joint cups, bearings, and other parts of the assembly are shown in the following illustration. Take a moment to review what each part looks like so that you can quickly identify them.



Straight Talk About U-Joints

THE FULL-TIME PART

UNIVERSAL JOINTS — A universal joint must be able to deliver brute power and high torque from a big diesel engine (or a large displacement gasoline power plant) into a rear axle (or axles) in order to drive a fully loaded truck from New York to Los Angeles, Boise to Buffalo or wherever.

And all that horsepower, torque and payload hooked up to a \$100,000 rig isn't going to deliver the load if these U-joints fail. Remember, downtime, regardless of payload or destination, is extremely costly to independent truckers and of course all trucking companies. You must realize that U-joints work **FULL TIME** every mile driven . . . and they are an important operating member of the entire drivetrain.

ASSEMBLED U-JOINT



Straight Talk **About U-Joints**

CAUSES, CONDITIONS AND CLUES

Let's take just a moment or two and talk about U-joint problems that can develop, especially those found to be **major** causes of driveline failures. These "causes" generally fall into two categories:

- **PREMATURE FAILURE**
- **NORMAL WEAR** (eventually leading to the need for replacement)

PREMATURE FAILURE

Also Known as "SHOCK" or "ULTIMATE FAILURE"

One of the most common causes of driveline failure is **STRUCTURAL OVERLOAD**, also known as "Shock" or "Ultimate" failure.

This unexpected damage occurs when the U-joint or any other part of the driveline receives a sudden, hard shock that is far more severe than what it was expected to handle. As a result, the part either ends up bent, twisted or broken.

You can easily spot this type of damage by "eyeballing" the entire length of the driveline. And by the way, if you find such damage, inspect **ALL** of the parts that transmit power to the drive wheels. You may find additional damage has occurred. Generally, this condition is caused by a driver who "revs" the engine up to a high RPM and then lets the clutch engage suddenly. That's true "shock."

**ONE CAUSE OF
SHOCK FAILURE:
HIGH ENGINE
RPM PLUS
SUDDEN CLUTCH
ENGAGEMENT**

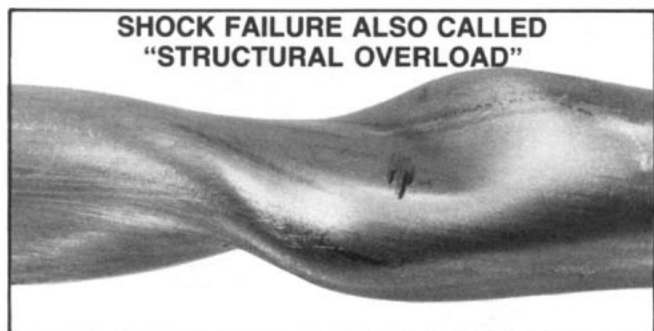


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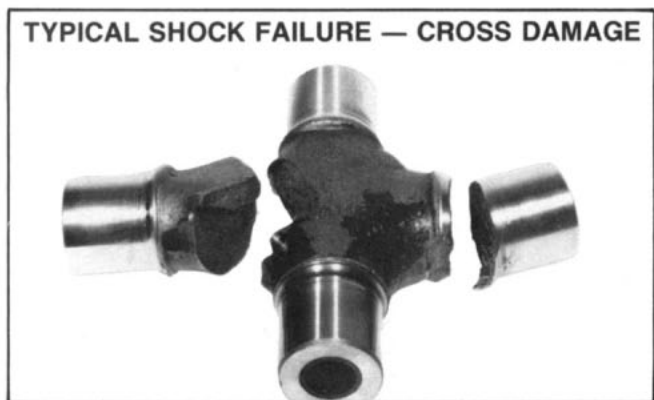
STRUCTURAL “SHOCK” — OVERLOAD FAILURES

Where To Look for Damage and What You’ll See

TUBING DAMAGE — Usually, one of the hollow shafts (either a coupling, main or interaxle) is the first part of the driveline to “let go” under the strain of a severe structural overload condition. Twisted tubing is your clue to a failure caused by a load placed on the part that far exceeds its expected capacity.



CROSS DAMAGE — Here again is another result of a severe structural overload condition. This excessively high shock load often causes U-joint crosses to crack. At times, they will break off completely.

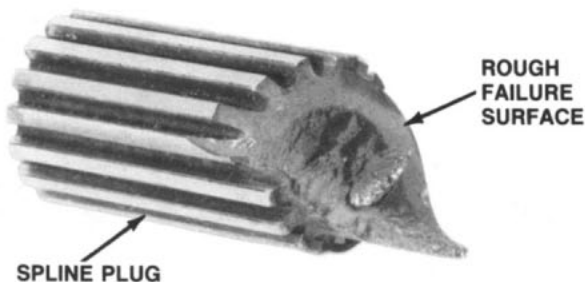


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SPLINE PLUG DAMAGE — Another clue to excessive overloading of the driveline is a spline plug completely broken across its entire cross section. There are three types of “break” to look for:

- **COMBINATION BENDING AND TWISTING** — Spotting this common kind of damage is easy since the excessive shock generally results in a rough surface on the face of the break. And it's usually at an angle across the spline plug.

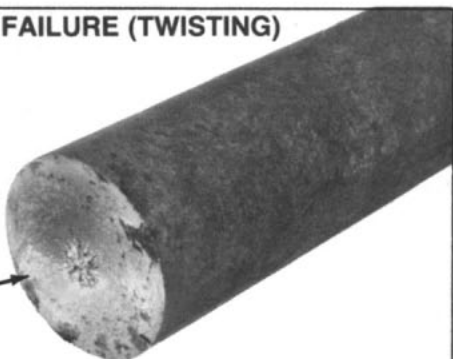
SHOCK FAILURE (BENDING AND TWISTING)



- **TWISTING** (Also called torsional) — You can easily detect this kind of break because the shock load that has caused the damage usually results in a smooth, flat surface failure. In other words, the shock exceeded the capability of the part.

SHOCK FAILURE (TWISTING)

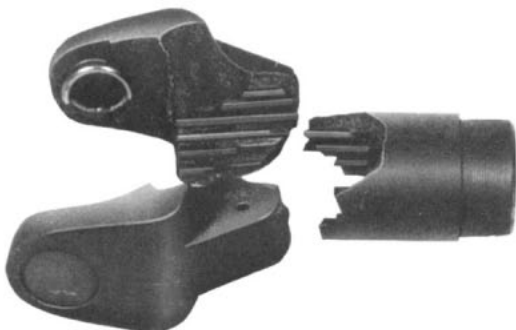
TYPICAL
SPLINE
PLUG
DAMAGE



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- **YOKE DAMAGE** — Since the yoke is generally the strongest part of the entire driveline, it is generally the least likely to crack and break. However, an excessively severe structural overload can cause breakage or distortion. Yoke hole alignment should always be checked whenever there is any indication of severe shock loads.

YOKE BROKEN CAUSED BY SHOCK (STRUCTURAL) OVERLOAD



PARTS GET OLD AND TIRED — NORMAL WEAR

NOTE: Keep in mind that parts in the driveline must operate under tough driving conditions day after day, mile after mile.

Under critical road operating conditions, parts get battered from the constant torque and power they must deliver. Also, wear on critical surfaces is a **normal and expected process**.

Overload vs. Fatigue

There's a quick way to compare **STRUCTURAL OVERLOAD** to **STRUCTURAL FATIGUE**. Think of structural

Straight Talk **About U-Joints**

overload (SHOCK) failure as the sudden snapping and breaking of a match stick. On the other hand, you can compare STRUCTURAL FATIGUE to the flexing of a wire coat hanger. It takes repeated bending back and forth before the metal finally cracks and breaks.

SHOCK FAILURE (EXAMPLE)



FATIGUE FAILURE (EXAMPLE)



CAUSES OF STRUCTURAL FATIGUE

This type of failure will occur when driveline parts must operate under continuous long-term "high" load conditions that are far above their endurance limits.

Going beyond the "endurance limit" simply means that the maximum operating load on the part (or parts) is greater than what it was rated to handle. Of course, such a condition must happen time after time before the part finally weakens and fails completely.

We'd also like to point out that none of those "high" loads, by themselves, are ever so severe that they cause an immediate shock failure. As mentioned, it takes repeated high loads over an extended period of time before failure occurs.

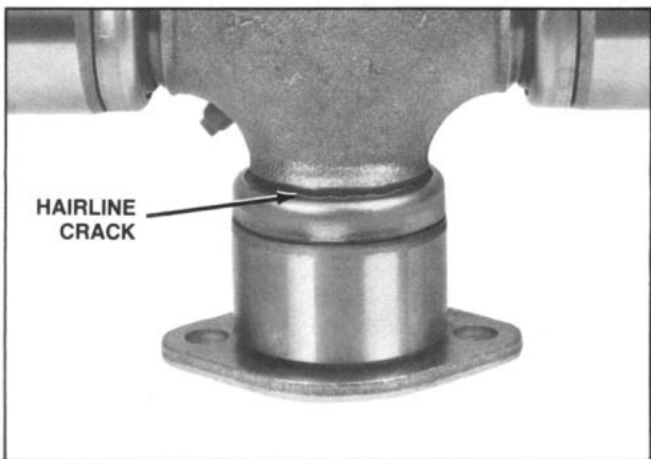
Straight Talk About U-Joints

STRUCTURAL FATIGUE FAILURES

Where To Look for Damage and What You'll See

To begin with, **FATIGUE FAILURE** begins as tiny cracks that develop on metal surfaces over a long period of time or mileage.

- **CRACKS** — They may start out as almost invisible to the naked eye. Such a surface condition is a real challenge to spot. Close inspection of the welds should also be part of your overall check when looking for cracks or fractures.



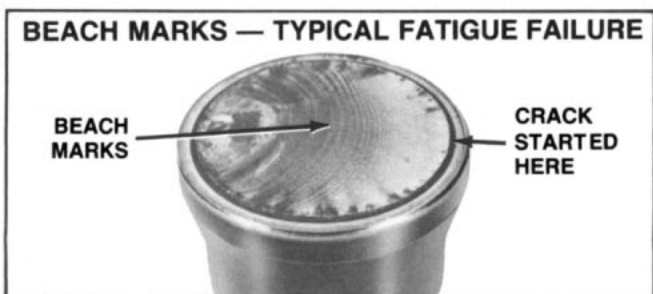
Then too, cracks often develop in the **INTERNAL** structure of the metal **BEFORE** they appear on the **OUTER** metal surfaces. This, of course, is almost impossible to detect during a visual inspection. But gradually, such hidden cracks weaken the part until it finally gives up and breaks.

By now you're probably wondering how to determine whether you have a case of shock failure or fatigue failure, especially since in both instances the part breaks.

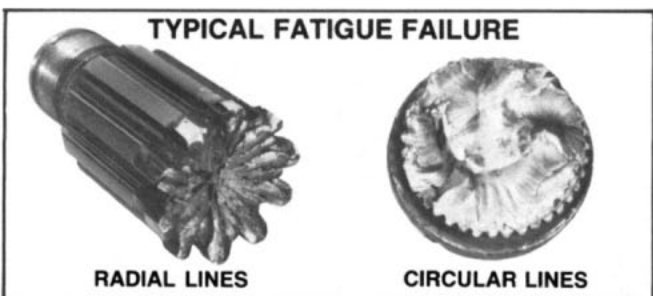
Straight Talk About U-Joints

Here are several things to look for that will indicate the failure was caused by **FATIGUE**:

- **BEACH MARKS** — This is simply a term used to describe a failure that leaves a smooth metal surface with the appearance of contoured lines . . . much like the lines left on a sandy beach by wave action. When you spot this condition it means the failure began as a small initial crack . . . then continued on to fatigue failure and breakage.



- **RADIAL OR CIRCULAR LINES** — When these appear throughout the failure surface along with a “cone” shaped fracture, this is a clue that indicates fatigue failure rather than shock failure.



- **SURFACE WEAR** — This is probably the easiest of all part failures to detect. It results from the constant friction of two surfaces rubbing together until the part simply wears out (normal) or fails from excessive wear. There are a number of causes that lead to such a condition and are covered in the following material.

Straight Talk About U-Joints

CAUSES OF SURFACE WEAR

Premature Surface Wear

This is usually caused by one or more of the following conditions:

- Lack of lubricant
- Wrong lubricants
- Contaminated lubricants
- Inadequate or infrequent lube intervals
- Improper parts installation
- Constant "high load" operating conditions

Normal Wear

Remember, even properly lubricated operating parts and assemblies of the driveline have not been granted eternal life. Eventually, all mechanically operated parts and devices that transmit power simply wear out in time.

When thinking of NORMAL WEAR and comparing it to PREMATURE WEAR there's a comparable situation — surface wear of brake linings. Even properly maintained and properly applied brakes gradually wear out over a period of time. That's normal. Of course, riding the brakes or making repeat high speed panic stops will wear out the linings much more rapidly. That's premature.

Now for a brief review of several examples of SURFACE WEAR.

Brinelling

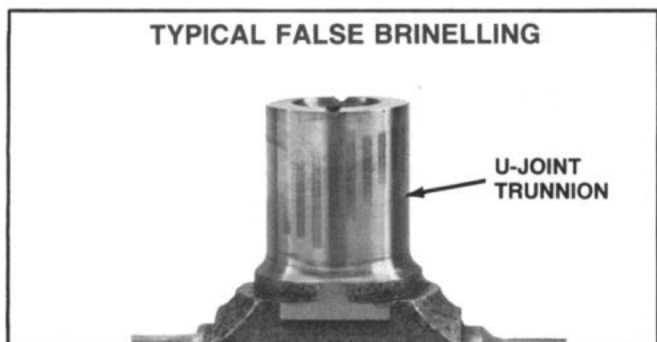
This is a condition in which the needle rollers wear grooves into the surface of the trunnion or needle cup. Replacement is the only cure.



Straight Talk About U-Joints

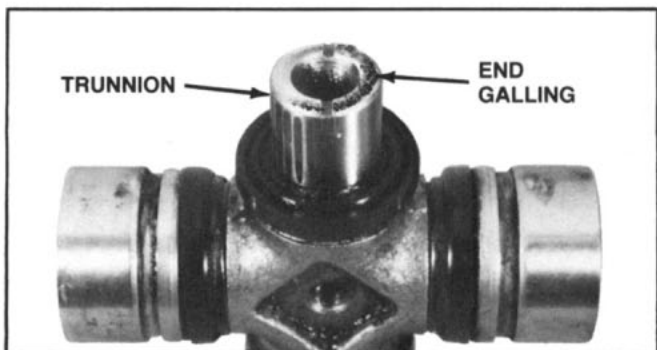
False Brinelling

As the name implies, this condition is NOT a true case of brinelling. Needle rollers sometimes polish the trunnion or needle cups so that they **APPEAR** to have brinelling . . . even at low mileage. You can quickly determine false brinelling by rubbing your thumbnail across the surfaces. If you do not feel any roughness or indentations, then the condition you see is simply **FALSE BRINELLING**. False brinelling does **NO DAMAGE** to the metal surfaces and the part is still okay for continued service.



End Galling

You'll find this often takes place on U-joint trunnion ends and is the "scraping off" or displacement of metal. High levels of friction between two surfaces is the real cause. Replacement is the only cure.

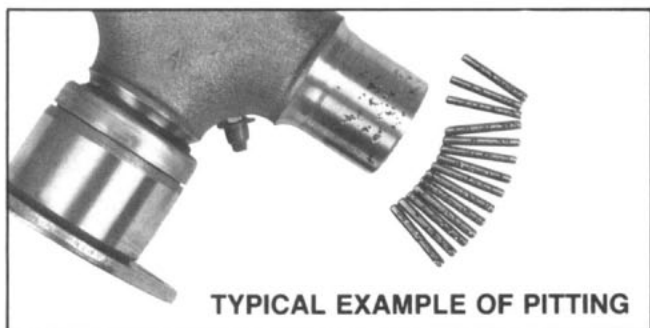


Straight Talk About U-Joints

Pitting

Corrosion is the major cause of pits or craters that develop on polished metal surfaces. Excessive pitting causes an increase in friction which often results in rapid surface wear. Replacement is the only cure.

Up to this point, we've been talking about surface wear failures. Now, let's jump into a new subject dealing with metal fatigue.



Spalling

This is a term used to describe metal that flakes off the surface of a part. Spalling is caused by **metal fatigue**, NOT FRICTION. You can compare this type of failure to the "wearing out" of brake linings and pads. It develops after the bearings have placed high loads on the U-joint cross or cups millions of times. This physical breakdown of the part's metal structure takes place **BELOW** the metal surface and causes the metal to **FLAKE**. Replacement is the only cure.



Straight Talk About U-Joints

As you know, extremes in the working conditions under which a driveline operates directly affects the life of each part. So, in an effort to help make clear such vital information, we've prepared the following chart. It spells out those specific conditions and presents the results and an explanation for each.

EFFECTS OF WORKING CONDITIONS

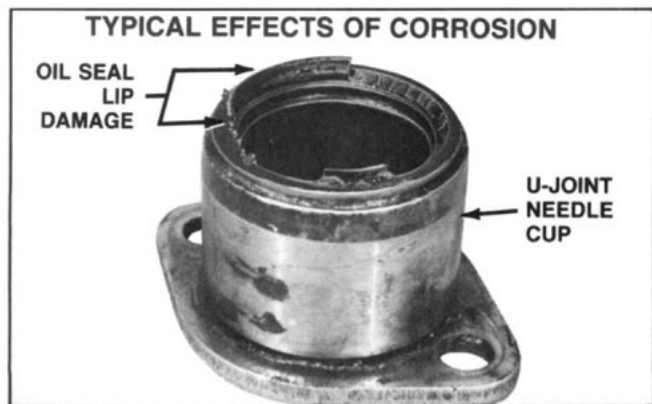
CONDITION	RESULT AND EXPLANATION
ON-HIGHWAY TRUCKS OPERATING OFF-HIGHWAY FOR LONG PERIODS OF TIME	<p>MAY LEAD TO PREMATURE FAILURE BECAUSE:</p> <ul style="list-style-type: none"> ● On-highway parts and assemblies are specified to withstand high speed, low torque. Off-highway conditions are generally just the opposite.
OFF-HIGHWAY TRUCKS OPERATING ON-HIGHWAY FOR LONG PERIODS OF TIME	<p>MAY LEAD TO PREMATURE FAILURE BECAUSE:</p> <ul style="list-style-type: none"> ● Off-highway parts and assemblies are specified to withstand high torque, low speeds. On-highway conditions are just the opposite.
TRUCKS OPERATING CONTINUOUSLY OVER STEEP GRADES	<p>MAY LEAD TO PARTS FATIGUE OR SURFACE WEAR FAILURE UNLESS THE DRIVELINE IS SPECIFIED FOR USE UNDER SUCH OPERATING CONDITIONS BECAUSE:</p> <ul style="list-style-type: none"> ● An entire torque load is placed on parts and assemblies.
TRUCKS EQUIPPED WITH A DIESEL ENGINE	<p>PREMATURE FAILURE OF DRIVELINE PARTS MAY RESULT IF THE PARTS ARE NOT ABLE TO WITHSTAND HIGHER TORQUE LOADS THAT DIESEL ENGINES PRODUCE BECAUSE:</p> <ul style="list-style-type: none"> ● Diesel engines develop more torque at lower speeds than most gasoline engines.
TRANSMISSIONS WITH OVERDRIVE EQUIPMENT	<p>DRIVELINE PARTS AND ASSEMBLIES MAY FAIL PREMATURELY UNLESS THEY ARE SPECIFIED TO WITHSTAND HIGH RPM BECAUSE:</p> <ul style="list-style-type: none"> ● Transmissions with overdrive develop high RPM with greater frequency of load application on the bearings.
CORROSIVE CONDITIONS	<p>SURFACE WEAR FAILURE MAY RESULT WHEN LUBRICANT LEAKS OUT AND CONTAMINANTS ENTER THE PART BECAUSE:</p> <ul style="list-style-type: none"> ● Acid, solvents, chemicals and other corrosive elements damage seals.
EXTREMES IN OPERATING CONDITIONS	<p>SURFACE WEAR DAMAGE MAY RESULT BECAUSE:</p> <ul style="list-style-type: none"> ● Lubricants thicken in extreme cold climates or break-down under extremely high temperatures.

Straight Talk About U-Joints

THINGS TO CONSIDER

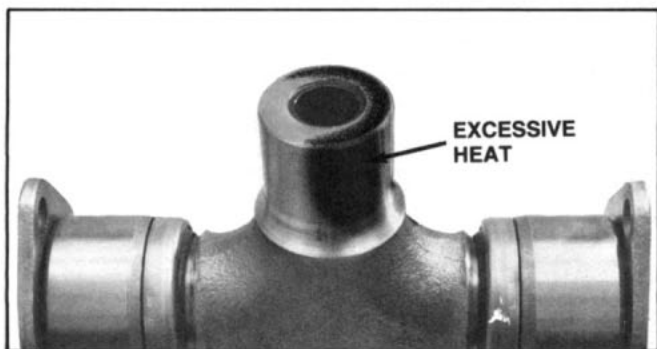
First, let's discuss ON-HIGHWAY and OFF-HIGHWAY parts and assemblies that are specifically designed for an expected application.

- It's a fact of life that long-term operation of an ON-HIGHWAY truck in an OFF-HIGHWAY working condition causes unusual strain on all driveline operating parts and assemblies. Early driveline failure often results.
- OFF-HIGHWAY drivelines are designed for high torque, low-speed conditions while ON-HIGHWAY drivelines are designed for trucks that operate under low torque and higher speeds.
- Trucks that are being loaded to their full capacity a greater percent of the time than originally called for may require a driveline assembly of a larger size and rating.
- Corrosive elements such as acids, solvents and chemicals that may be present in road splash, truck wash systems or within the truck's operating range can seriously attack oil and grease seals. When the seal goes, lubricant escapes and contaminants enter. This can only lead to early failure of the part or assembly that the seal is protecting.



Straight Talk About U-Joints

- Large diesels develop more torque than comparable gasoline engines. Because of that, diesel driveline applications are purposely "beefed-up" to handle those higher torque loads.
- Transmission output must be seriously considered when selecting a driveline since certain types of gear boxes may develop higher torque loads than what the driveline is capable of handling.
- A truck that operates under extreme operating temperatures, either higher or lower than called for, can directly affect the lubricant's ability to do its important job. When a truck operates under such extremes, other driveline failures may also result. A good clue to this condition are signs of a blue coloring on metal surfaces. This indicates the part reached an excessively high temperature.



- Continuous operation over **STEEP GRADES** may lead to early driveline failure through fatigue and accelerated surface wear. Trucks running under those conditions place extra torque loads on all operating parts.

And last, but equally important . . .

- Any driveline installation that requires a **LARGE** operating angle reduces the normal life of a U-joint. The **LARGER** the angle, the **SHORTER** its normal life becomes.

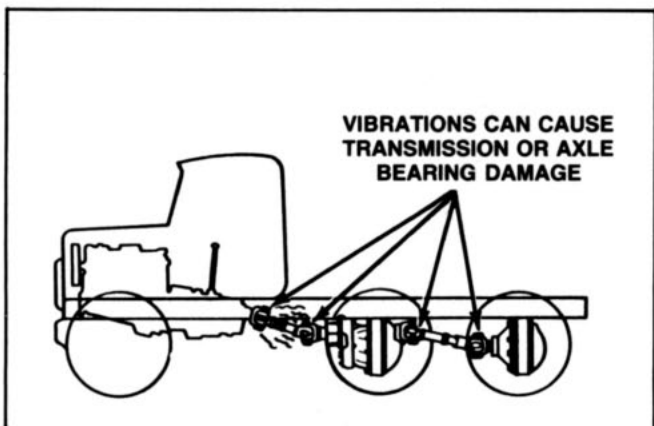
Straight Talk About U-Joints

DRIVELINE VIBRATIONS

What To Look For

Driveline vibrations can develop from several different sources. They are not only annoying to the driver, they lead to serious damage to the internal parts of the transmission and axle bearings as well as the driveline itself.

At the first indication of vibration, make a complete inspection of the driveline.



Driveline Inspection

Look for these major causes:

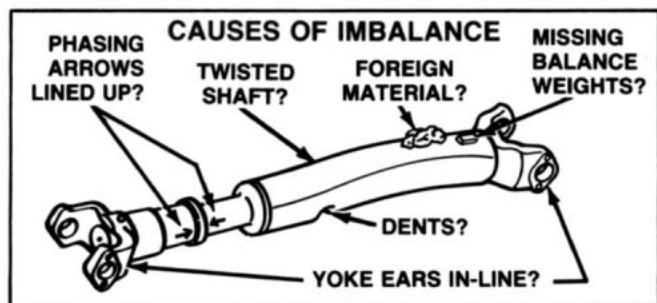
- U-joints and slip joints that have excessive wear.
- Drive shafts that are out-of-balance.
- U-joint yokes that are not in correct phase. That is, they are not aligned properly in relationship to each other.
- Possible angle misalignment of the driving shafts.
- U-joint yoke "ears" that are not spaced equally.
- Excessive runout of the drive shafts.
- U-joints that operate at too high an angle.

Straight Talk About U-Joints

CAUSES OF VIBRATIONS

After thousands and thousands of miles, drivelines can gradually become "out-of-balance" even though the parts and assemblies are NOT excessively loose or worn out. Some of the more common causes that you may spot when looking for the source of the problem can develop from foreign material that becomes lodged on rotating parts of the driveline. Is there any asphalt or concrete that appears "glued" to the shafts? Is there a bent shaft, is it twisted or does it have large dents on the driving members?

Check carefully for balance weights (installed at the factory during final balancing before assembly) that may have been knocked off.

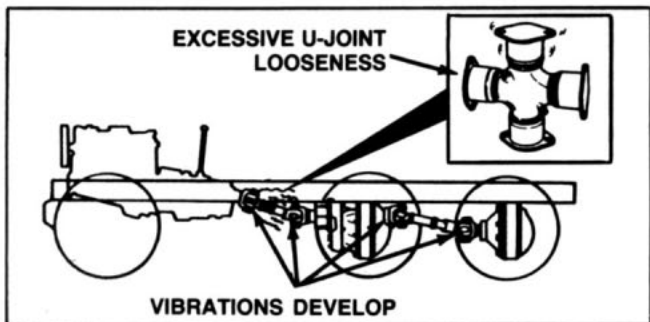


As mentioned earlier, the yokes must be properly aligned to each other. If not, the speed of the shaft will change even though the speed of the driving shaft is constant. By the way, the latter condition is not a "true" balance problem. However, it appears to be so because the "out-of-phase" yokes create vibrations in the same manner that an "out-of-balance" assembly does.

Effects of Worn U-Joints

When excessive wear develops between the U-joint trunnions and needle cups, this looseness is transmitted into the yoke connections. As a result, vibration of the driveline occurs at varying shaft speeds. Replacement with a new U-joint kit is the only answer.

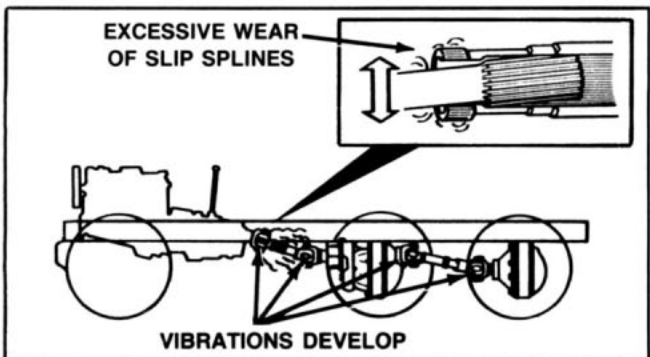
Straight Talk About U-Joints



And one more important point we'd like to make: Improper lubricants or improper lubrication methods including "stretching" maintenance intervals beyond factory recommendations is one of the major causes of premature wear. Of course, some wear is normal and is to be expected on high mileage trucks.

Effects of Worn Slip Splines

Slip joint splines (both external and internal) are designed to critical, close clearances. As wear increases, which is a normal condition, "play" between the spline plug and the slip yoke also increases. At a certain stage in their "life", the looseness reaches a point that causes driveline vibrations to develop. Improper lubrication (including wrong lubricant or failure to lubricate) is a leading cause of premature wear. The only solution for correcting the vibration is to replace BOTH parts of the driveshaft that have the worn splines.



ADDITIONAL TECHNICAL POINTS

- Some driveline malfunctions frequently lead to failures of other parts in the entire drivetrain assembly. For example, slip joints that bind or have excessive resistance to their usual smooth in-and-out sliding movement is often one of the causes of damage to seals, bearings, yokes or gears. Damaged input and output shafts of axles and transmissions is another end result of such poor slip joint operation.
- Whenever you find driveline parts that are fractured, be sure to check for damage to the center bearings and of course, as a good shop practice, inspect all undercarriage operating parts of the truck.

SPECIAL NOTE

On the odd chance that you cannot determine what caused an unusual failure of the driveline part, or have experienced a repeat failure that does not fit into any of the conditions we've described and illustrated in this reference booklet, we suggest that you get in touch with the Meritor Service Engineer in your area. If necessary, contact us at the address listed on the back page for the location of his headquarters. We can help you by offering sound technical advice for solving unique driveline problems.

Be Sure To Make a Note of The Following:

- IN-SERVICE DATE
 - DRIVELINE DESCRIPTION
 - VEHICLE DESCRIPTION AND POWERTRAIN COMPONENTS
 - WORKING CONDITIONS
 - MILEAGE
 - OTHER HELPFUL INFORMATION
-
-



Meritor Heavy Vehicle Systems , LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
meritor.com

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