

# INTRODUCTION

Universal joint failures, as a rule, are of a progressive nature, which, when they occur, generally accelerate rapidly resulting in a mass of melted trunnions and bearings.

Some recognizable signs of universal joint deterioration are:

- 1) Vibrations - Driver should report to maintenance.
- 2) U-joint Looseness - End play across bearings.
- 3) U-joint discoloration due to excessive heat build-up.
- 4) Inability to purge all four trunnion seals when relubing U-joint.

Items 2) thru 4) should be checked at re-lube cycle and if detected, reported to the maintenance supervisor for investigation.

Experience with universal joint failures has shown that a significant majority are related to lubricating film breakdown. This may be

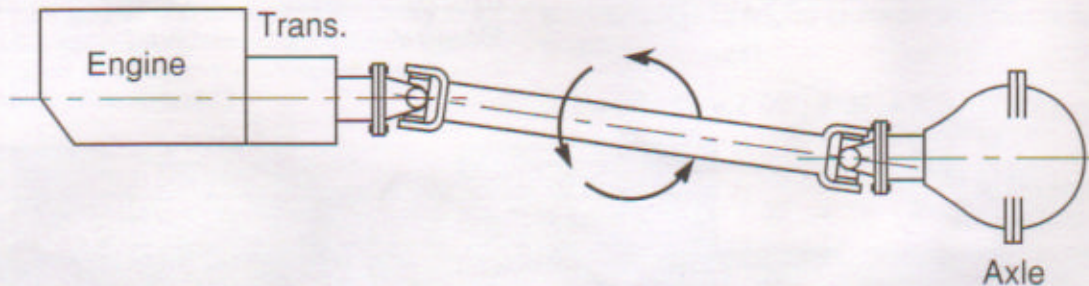
caused by a lack of lubricant, inadequate lube quality for the application, inadequate initial lubrication or failure to lubricate properly and often enough.

Failures which are not the result of lubrication film breakdown are associated with the installation, angles and speeds and manufacturing discrepancies.

Driveshaft failures through torque, fatigue and bending are associated with overload, excessively high U-joint angles and drive shaft lengths excessive for operating speeds.

The trouble shooting chart in this bulletin is intended to provide service people with an aid to enable them to associate complaints with some of the **probable causes** and **probable corrections**. Through normal vehicle maintenance and recognition of discrepancies, this may enable them to make necessary corrections to ward off a serious breakdown.

# DRIVESHAFT TORQUE



Twisted driveshaft tube?  
Broken yoke shaft?  
Broken journal cross?

Usually a result of torque overload— How much torque can be generated in your application?

Here is how to figure torque:

$$\text{L.G.T.} = \text{N.E.T.} \times \text{Trans L.G.R.} \times .85 \text{ (efficiency factor)}$$

$$\text{D.L.T. (to Slip Wheels)} = \frac{W_R \times \text{C.O.F.} \times \text{R.R.}}{12 \times \text{A.R.}}$$

A.R. = Axle ratio

C.O.F. = Coefficient of friction (.7)

D.L.T. = Drive line torque

L.G.R. = Low gear ratio

L.G.T. = Low gear torque

N.E.T. = Net engine torque

R.R. = Tire loaded rolling radius

$W_R$  = Weight on drive axle

Relate the lesser of above to Spicer U-joint ratings. If your torque exceeds the Spicer rating for the U-joint used in your application, switch to a size with a rating compatible to your calculation.



# U-JOINT OPERATING ANGLES

U-joint operating angles are a primary source of problems contributing to:

- Vibrations
- Reduced U-joint life
- Problems with other drivetrain components that may include:
  - Transmission gear failures
  - Synchronizer failures
  - Differential problems
  - Premature seal failures in axles, transmissions, pumps or blowers
  - Premature failure of gears, seals and shafts in Power Take-Offs

Every U-joint that operates at an angle will vibrate.

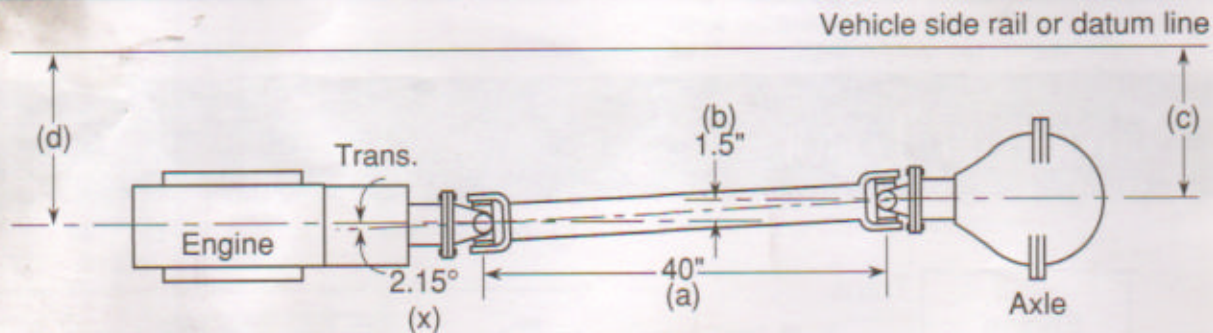
U-joint operating angles are probably the most common causes of driveline vibrations in vehicles that have been re-worked or in vehicles that have had auxiliary equipment installed.

To correct or eliminate these causes of driveline vibrations from your vehicle or new installation, you must determine the TRUE OPERATING ANGLE of each U-joint in your system.

The TRUE OPERATING ANGLE of a U-joint is a combination of the angle that occurs in the top view and the angle that occurs in the side view.

To determine the TRUE OPERATING ANGLE of a U-joint you must follow the instructions outlined in the following sections, numbered I and II, and calculate the TRUE OPERATING ANGLE using the information detailed in Section III.

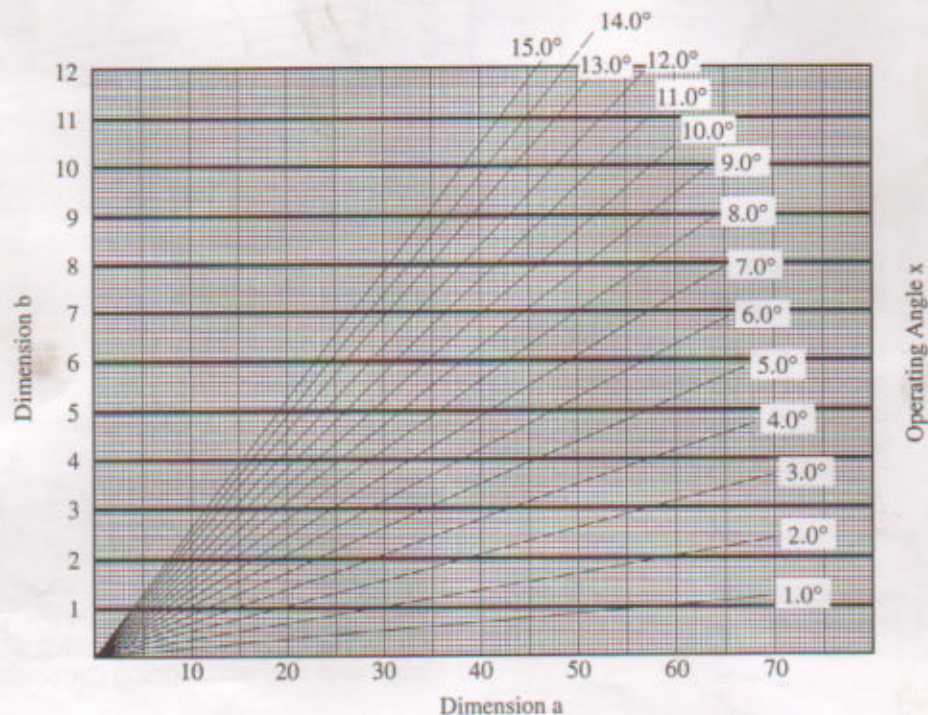
## I. TO DETERMINE OPERATING ANGLES IN TOP VIEW



1. From side rail or convenient datum, measure offset dimensions c & d.
2. Calculate dimension  $b = d - c$
3. Measure dimension a
4. Using dimensions a & b, determined through measurement, calculate U-joint angle x by using the chart provided.

### Example:

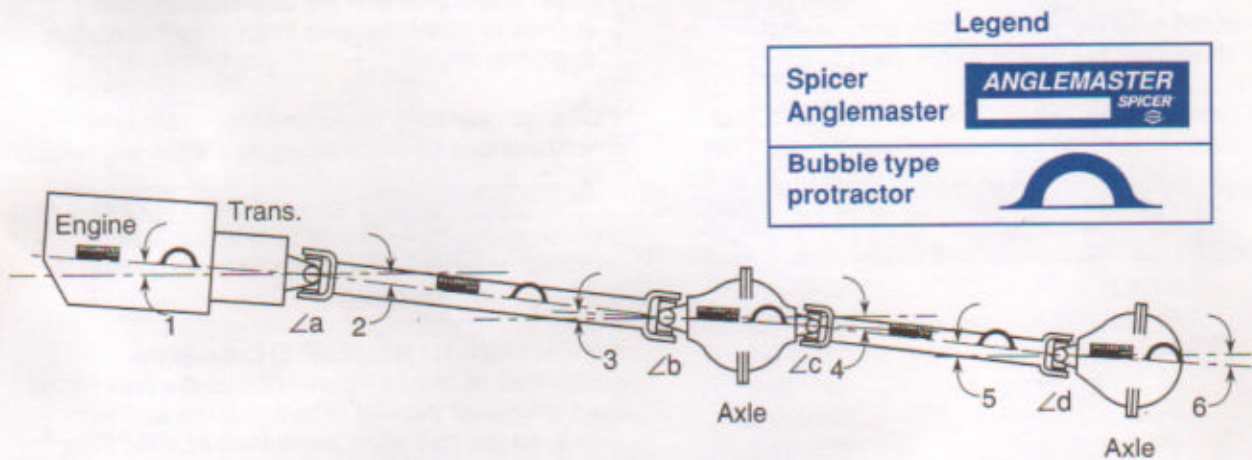
Where  $a = 40.0''$   
 $b = 1.5''$   
 $X = 2.15^\circ$  operating angle





# U-JOINT OPERATING ANGLES

## II. TO DETERMINE OPERATING ANGLES IN SIDE VIEW



The most convenient way to determine U-joint angles in the side view is through use of a Spicer Anglemaster™ or a bubble type protractor. Procedure is as follows:

Step I. Using an Anglemaster or a bubble protractor, record inclination angles of drivetrain components. Set Anglemaster or protractor on machined surfaces of engine, transmission, axle or on machined lugs of transmission output and axle input yokes.

Note: U-joint angles can change significantly in a loaded situation. Therefore, check vehicle loaded and unloaded to achieve the accepted angle cancellation. (See Step IV.)

### Example:

Eng-Trans Output	4°30' Down (1)
Main Drive Shaft	7°00' Down (2)
Input 1st Rear Axle	4°00' Up (Input Shaft Nose Up) (3)
Output 1st Rear Axle	4°00' Down (4)
Inter-axle Shaft	7°00' Down (5)
Input 2nd Rear Axle	4°15' Up (Pinion Shaft Nose Up) (6)

Note: If inclination of driveshaft is opposite connecting component, add angles to obtain the U-joint operating angle.

$$\begin{aligned} \angle a &= (2) - (1) = 7^{\circ}00' - 4^{\circ}30' = 2^{\circ}30' (2.50^{\circ}) \\ \angle b &= (2) - (3) = 7^{\circ}00' - 4^{\circ}00' = 3^{\circ}00' (3.00^{\circ}) \\ \angle c &= (5) - (4) = 7^{\circ}00' - 4^{\circ}00' = 3^{\circ}00' (3.00^{\circ}) \\ \angle d &= (5) - (6) = 7^{\circ}00' - 4^{\circ}15' = 2^{\circ}45' (2.75^{\circ}) \end{aligned}$$

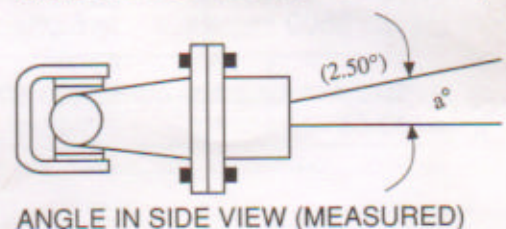
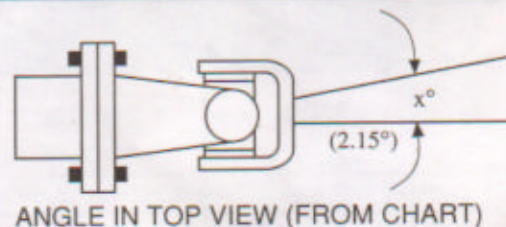
## III. CALCULATING THE TRUE U-JOINT OPERATING ANGLE

The true U-joint operating angle is the sum of the U-joint angles in both the top view and the side view. The true U-joint operating angle is calculated in the following manner:

True operating angle =  $\sqrt{x^2 + a^2}$   
Where  $x = 2.15^{\circ}$  as determined by use of chart in Section I.

$a = 2.5^{\circ}$  as determined in Section II.

$$\begin{aligned} \text{True operating angle} &= \sqrt{2.15^2 + 2.5^2} \\ &= 3.297^{\circ} \text{ or } 3^{\circ}18' \end{aligned}$$





## IV. U-JOINT ANGLE CANCELLATION

After calculating the TRUE OPERATING ANGLE of each U-joint in your driveline:

- Make sure the inboard yoke ears of each driveshaft are in line within each other.
- Compare the TRUE OPERATING ANGLE of each U-joint on each end of each shaft. They must be within one degree of each other or they will be a potential source of vibration.

If adjustments must be made to the system:

- Install shims between the axle housing and springs to rotate the axle input yoke to change operating angles.
- Change operating angle on torque arm type suspensions by lengthening or shortening torque arms.
- Raise, lower, or shift side to side a pump, blower or other piece of auxiliary equipment to change operating angles.

**IMPORTANT TO REMEMBER:** Keep the centerlines of two components that are connected by a driveshaft parallel in both the top and side views, so the operating angles will ALWAYS be equal.

## V. MAXIMUM TRUE OPERATING ANGLES\*

### For Two Joint Shafts with Equal or Intersecting Angles

When you settle on a true operating angle that is correct, make sure it doesn't exceed the angles shown in this chart for the driveshaft RPM.

R.P.M. is the main factor in determining maximum allowable operating angles. As a guide to maximum normal operating angles, refer to the chart below.

Driveshaft RPM	Max. Normal Operating Angles	Driveshaft RPM	Max. Normal Operating Angles
5000	3.2°	3000	5.8°
4500	3.7°	2500	7.0°
4000	4.2°	2000	8.7°
3500	5.0°	1500	11.5°

\*Based on application experience (1000 rad/sec acceleration).