Eaton Axles & Brakes

Technical Service Bulletin

Subject: Driveline Angles

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Models: All

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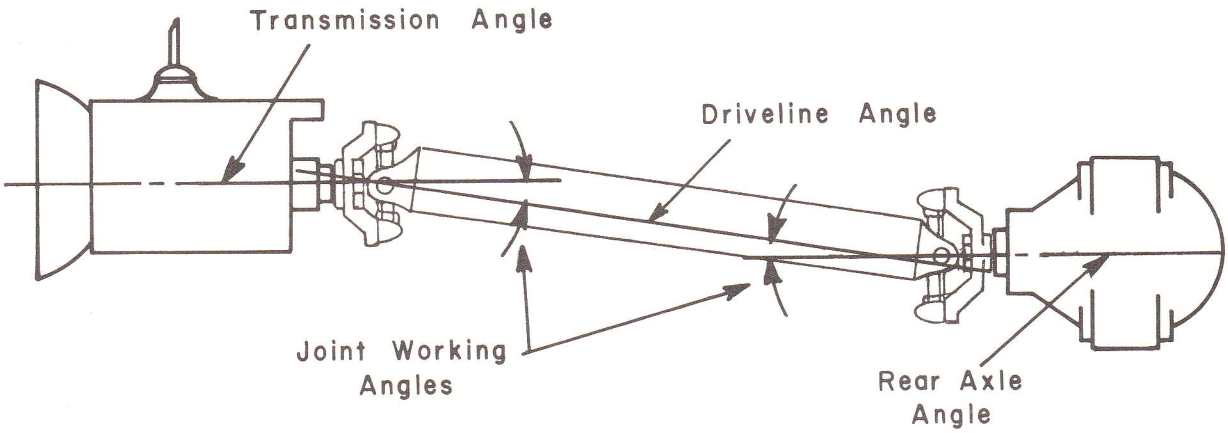
(Supercedes TSB 60)

Description of Change(s):

1. The Necessity for Equal Universal Joint Working Angles

Drive line components must be placed in the chassis so that working angles of transmission, rear axle and (if applicable) inter-axle universal joints are as nearly equal as possible. Equal working angles compensate for the variations in velocity found between two angled universal joints rotating together.

As an example, consider the diagram below. Note that the first universal joint, because it is coupling two angled shafts, will not transmit a constant speed. In this particular position, the drive line is moving slower than the transmission output shaft. The second universal joint, however, has the effect of causing the pinion shaft to move faster than the drive line. If the two working angles are equal, then the two effects will cancel; the pinion shaft will move at the same speed as the transmission shaft, and the net result is a constant velocity system.



In one complete revolution, the drive line will first move slower than the transmission shaft, then faster. The exact opposite condition will exist between the drive line and pinion shaft, thereby resulting in constant velocity.

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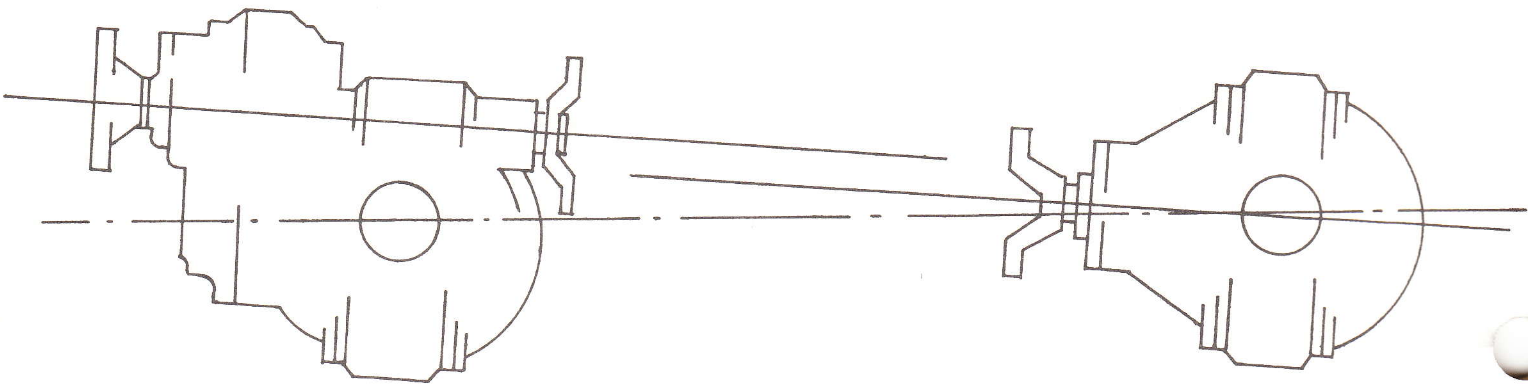
Unequal working angles cause the rotating members of the drive train to work without this speed cancellation effect, resulting in noise, vibration and premature universal joint or drive shaft wear. In severe cases axle and transmission failures can also result.

2. Axle Installation Methods

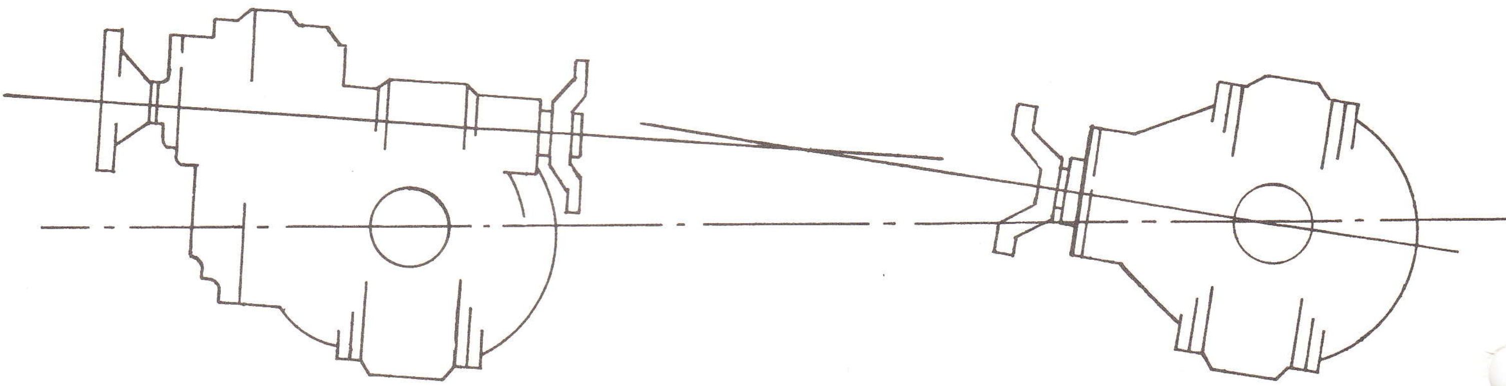
Although it became traditional to install transmission and axle so that universal joints were parallel to each other, modern truck design with its emphasis on the use of tandem axles made this approach impractical in some cases. As a result, the non-parallel or "broken-back" installation method was developed for tandem inter-axle applications. Illustrated below are examples of both parallel and broken-back installations.

PARALLEL INSTALLATION



Parallel Installation: Axle assemblies are mounted at equal angles, resulting in parallel yokes and equal working angles at each universal joint.

NON-PARALLEL INSTALLATION



Non-Parallel Installation: Axle assemblies are not mounted at equal angles, but working angles are equal at each universal joint. In this type of installation, the forward axle must be mounted parallel to the transmission. The maximum mismatch for working angles is $1^{\circ}30'$.

3. Characteristics of Unequal Drive Line Angles

Unequal drive line angles are most easily identified by the presence of noise or vibration within certain speed ranges which diminish or disappear when the vehicle is not in those ranges. Persistent and otherwise unexplainable drive line component failure can also point out a drive line angle problem. Noise or vibration which is consistent throughout the vehicle's entire operating range, varying only in intensity with change of speed, is generally related to an unbalanced condition in one or more drive train members and is not necessarily related to improper driveline angles. Should this condition exist, insure that driveline balance is restored and the vehicle tested before continuing with angularity checking.

4. Checking Driveline Angles

Universal joint working angles can be checked by measuring them with a bubble protractor from the machined surfaces present on most driveline components. This measurement process normally requires partial disassembly of the driveline to expose machined surfaces. A chart made-up beforehand showing each component and universal joint in the drive train will simplify the checking procedure by providing a place to record all critical angles. Appendix A shows measuring tools and procedures for measuring from various universal joints. Before checking angles, the vehicle must be parked on level ground. Tires should have normal air pressures. The transmission must be in neutral with the parking brake "off". If the vehicle has a movable body (such as a dump), it should be placed in normal operating position. Ideally angles should be checked with the vehicle both loaded and unloaded.

⚠ CAUTION: Insure the vehicle is secured from rolling by means of blocks before continuing.

5. Points of Measurement

Driveline angle readings should be made from machined surfaces of the following components and recorded:

a. Single axle vehicle (or tandem with non-driving rear axle)
1. Transmission (output yoke).
2. If present, transfer case, aux drive or retarder (input and output yoke).
3. If present, central universal joint (input and output yoke).
4. Drive Axle (input yoke).
5. Drive-shafts.

b. Tandem axle vehicle
1. Transmission (output yoke).
2. If present, transfer case, aux transmission or retarder (input or output yoke).
3. Tandem forward axle (input yoke-inclinometer flat or pump cover).
4. Tandem rear axle (drive pinion yoke).
5. Both main and inter-axle drive shafts.

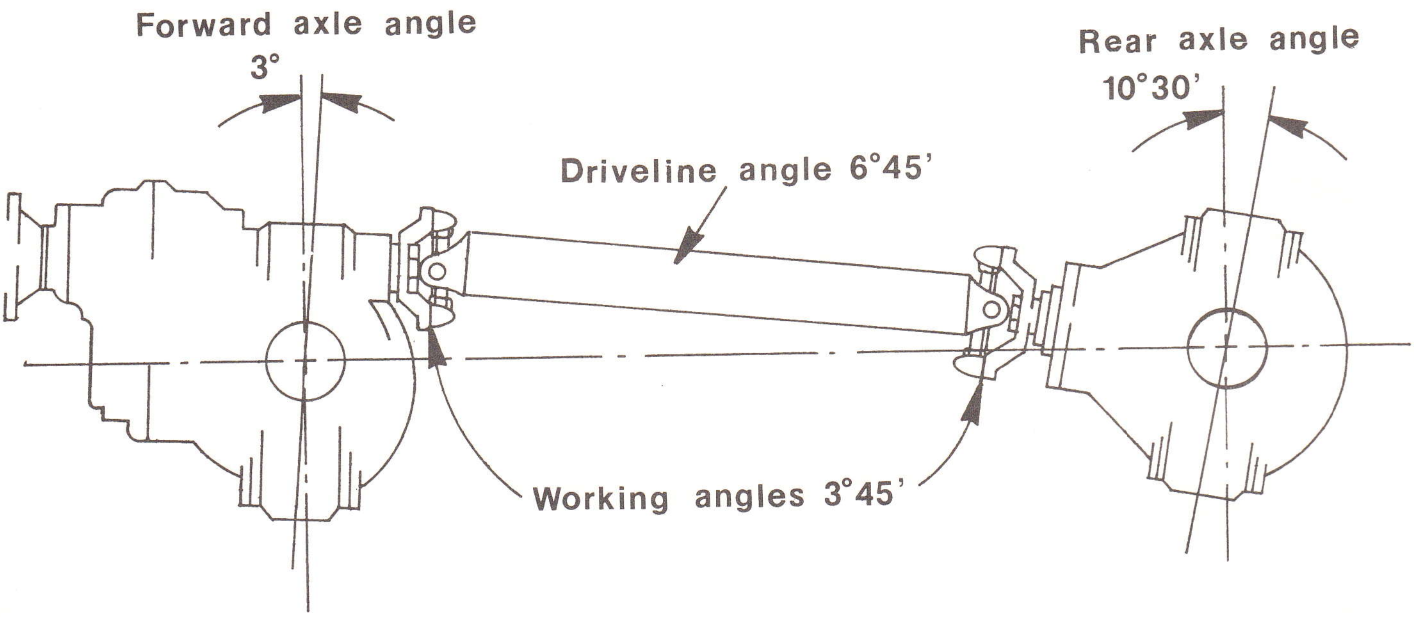
6. Computing Drive Line Angles

Once component angles have been established, universal joint working angles can be compared to allow determination of the adequacy of drive line angles.

To compute for correct angles (tandem axle)

1. The difference between the drive shaft angle and the transmission angle is the transmission joint working angle.
2. The difference between the drive shaft angle and the power divider input joint working angle is the forward axle joint working angle.
3. The difference between the inter-axle drive line angle and the forward axle angle is the output shaft joint working angle.
4. The difference between the rear axle angle and the inter-axle drive line angle is the rear axle joint working angle.

Compare the transmission and forward axle joint working angles. Compare output shaft and rear axle joint working angles. For optimum component life, the working angles in these paired joints should be within 1° 30' and not exceed the U-joint manufacturer's recommended maximum working angle. See the charts contained in this bulletin for various driveline combinations.



Working angles were computed as follows:

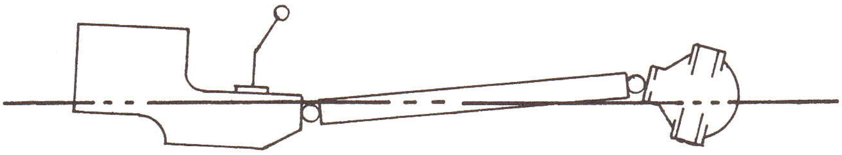
Inter-axle driveline angle:	6° 45'
Less forward axle angle:	-3°
	3° 45' joint working angle
Rear axle angle:	10° 30'
Less inter-axle driveline angle:	-6° 45'
	3° 45' joint working angle

Working angles are equal at 3° 45'.

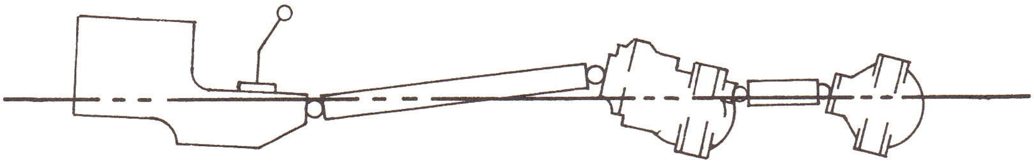
7. An "uphill" drive line exists when the engine/transmission inclination is down while the drive line inclination is up (engine CL below axle input CL: example A & B). In this configuration, working angles will tend to increase when the vehicle is loaded. Working angles must be computed by adding component angles rather than subtracting as is the case with a "downhill" drive line installation. In "downhill" drive line installation (example C & D) the joint working angles will normally decrease as the chassis is loaded.

Typical Uphill Drivelines

A.

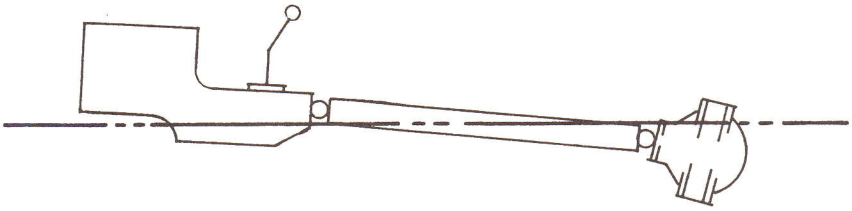


B.

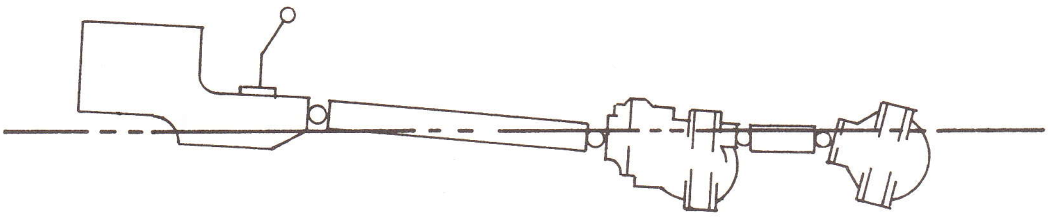


Typical Downhill Drivelines

C.



D.



8. Correcting Unequal Drive Line Angles

Follow the vehicle manufacturer's recommendations for adjustment of mounting angles in drive axles, transmissions and other components. When reassembling the drive line insure that yokes and slip joints have been phased properly. Note: Male/Female driveline members should be marked before disassembling to allow accurate reassembly of yokes and slip joints. After completing adjustments, test the vehicle in both loaded and unloaded condition. It should be free of excessive noise and vibration.

DRIVELINE ANGLE RECORDING CHART
(Single Drive Axle with Center Bearing)

1. MEASURE & RECORD COMPONENT ANGLE READINGS

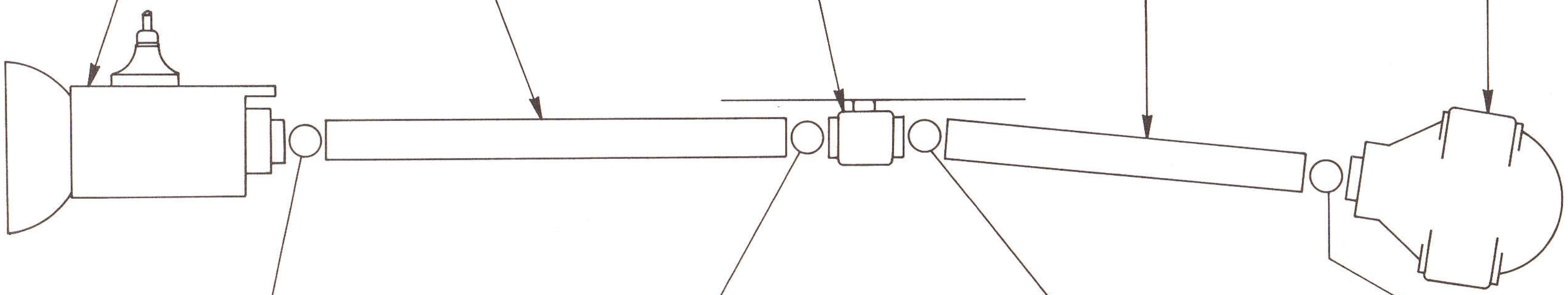
ANGLE 1. ____ Main Transmission

ANGLE 2. ____ Forward Main Driveline

ANGLE 3. ____ Center Bearing

ANGLE 4. ____ Rear Main Driveline

ANGLE 5. ____ Rear Axle



2. COMPUTE - JWA (see notes below)

Transmission	Input Center Bearing	Output Center Bearing	Rear Axle
ANGLE 1. ____	ANGLE 2. ____	ANGLE 3. ____	ANGLE 4. ____
(∓) ANGLE 2. ____	(∓) ANGLE 3. ____	(∓) ANGLE 4. ____	(∓) ANGLE 5. ____
Transmission JWA ____	Input Center Bearing JWA ____	Output Center Bearing JWA ____	Rear Axle JWA ____

3. COMPARE - JWA

____ ____ Should be equal or within 1° 30'

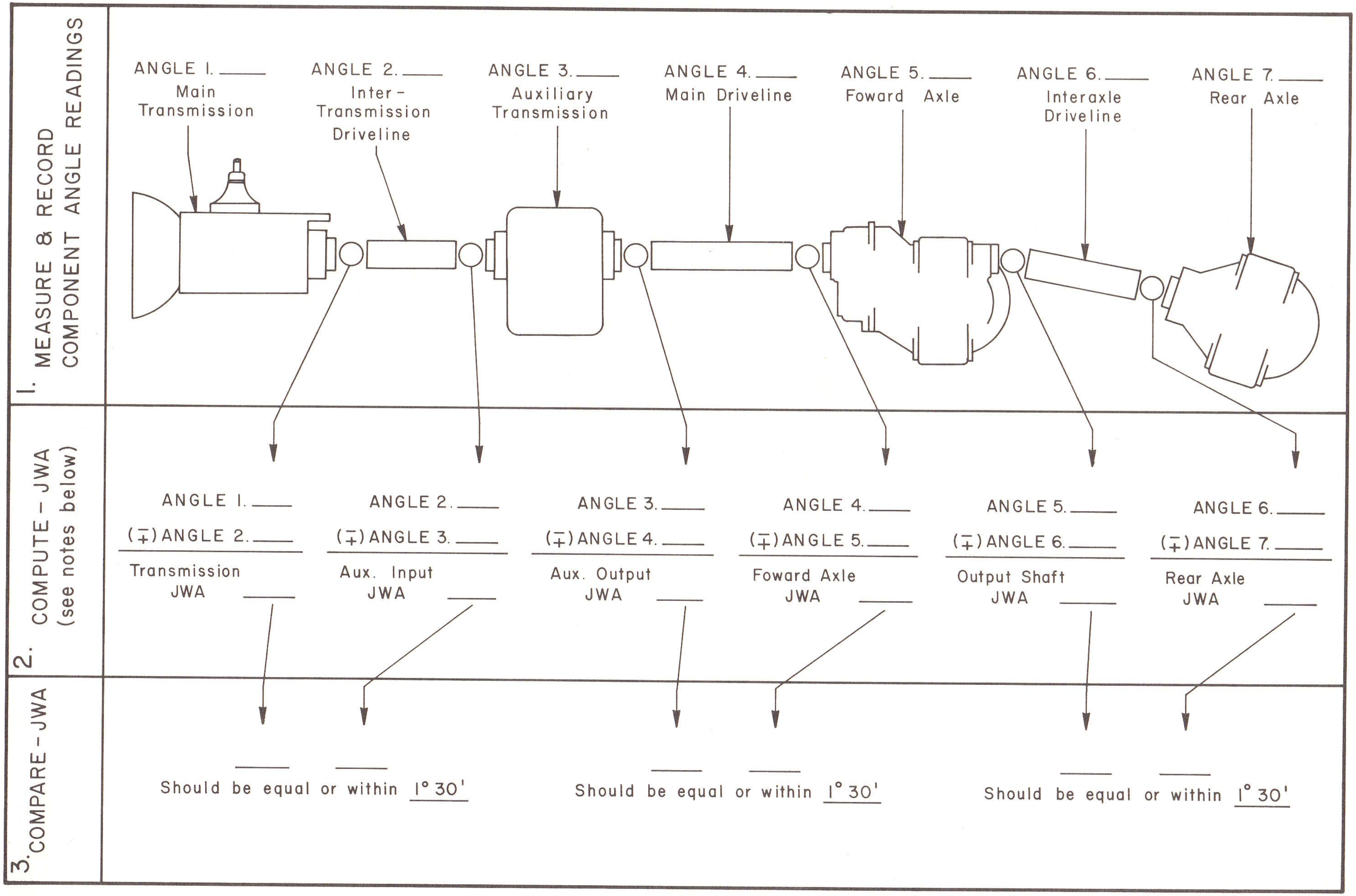
____ ____ Should be equal or within 1° 30'

NOTE: If either driveline is uphill, add angles to determine JWA.

JWA - Joint Working Angles

DRIVELINE ANGLE RECORDING CHART

(Typical Tandem with Auxillary Transmission)

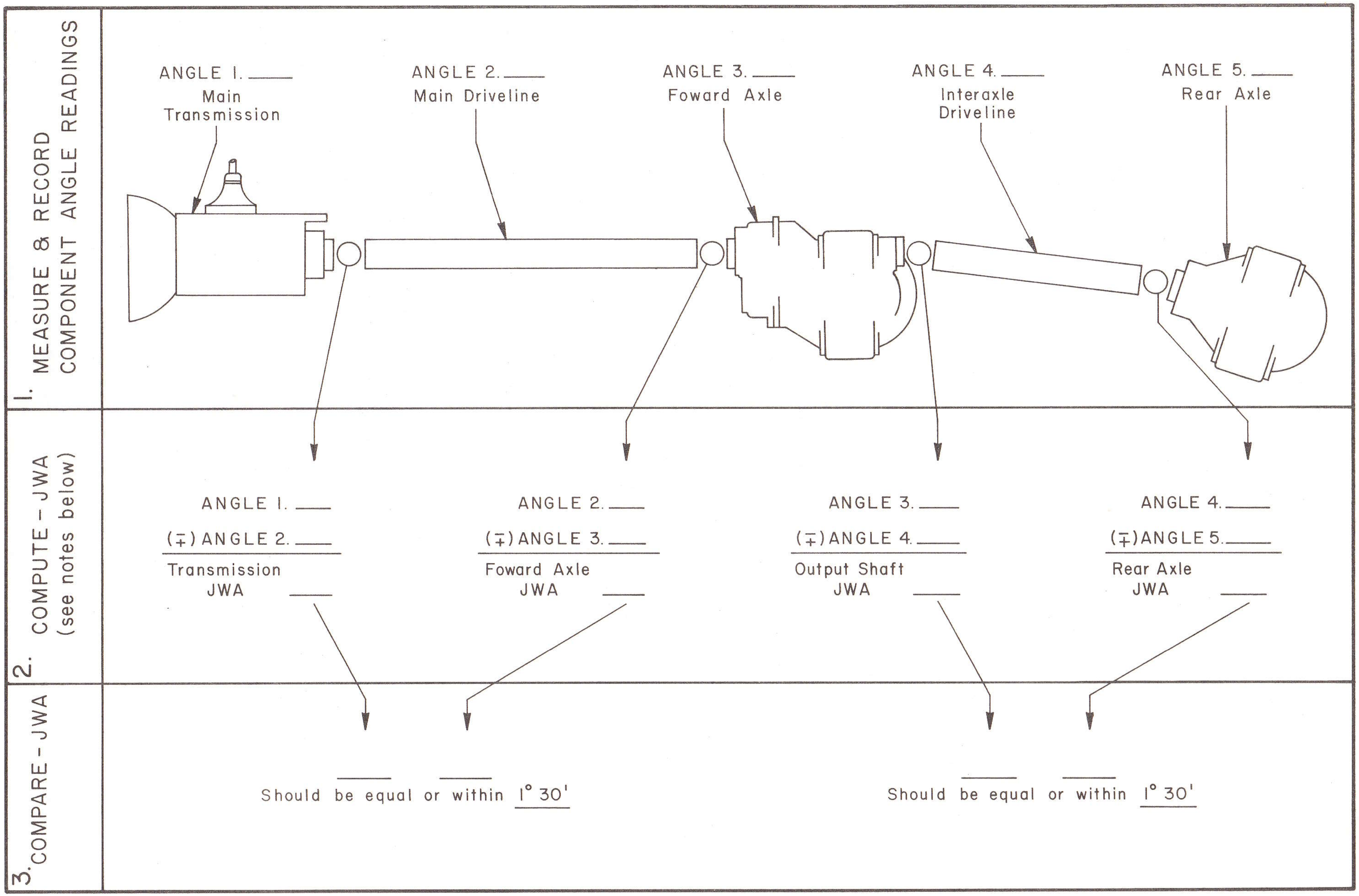


NOTE: If either driveline is uphill, add angles to determine JWA.

JWA - Joint Working Angles

DRIVELINE ANGLE RECORDING CHART

(Typical Tandem Installation)



NOTE: If either driveline is uphill, add angles to determine JWA.

JWA - Joint Working Angles