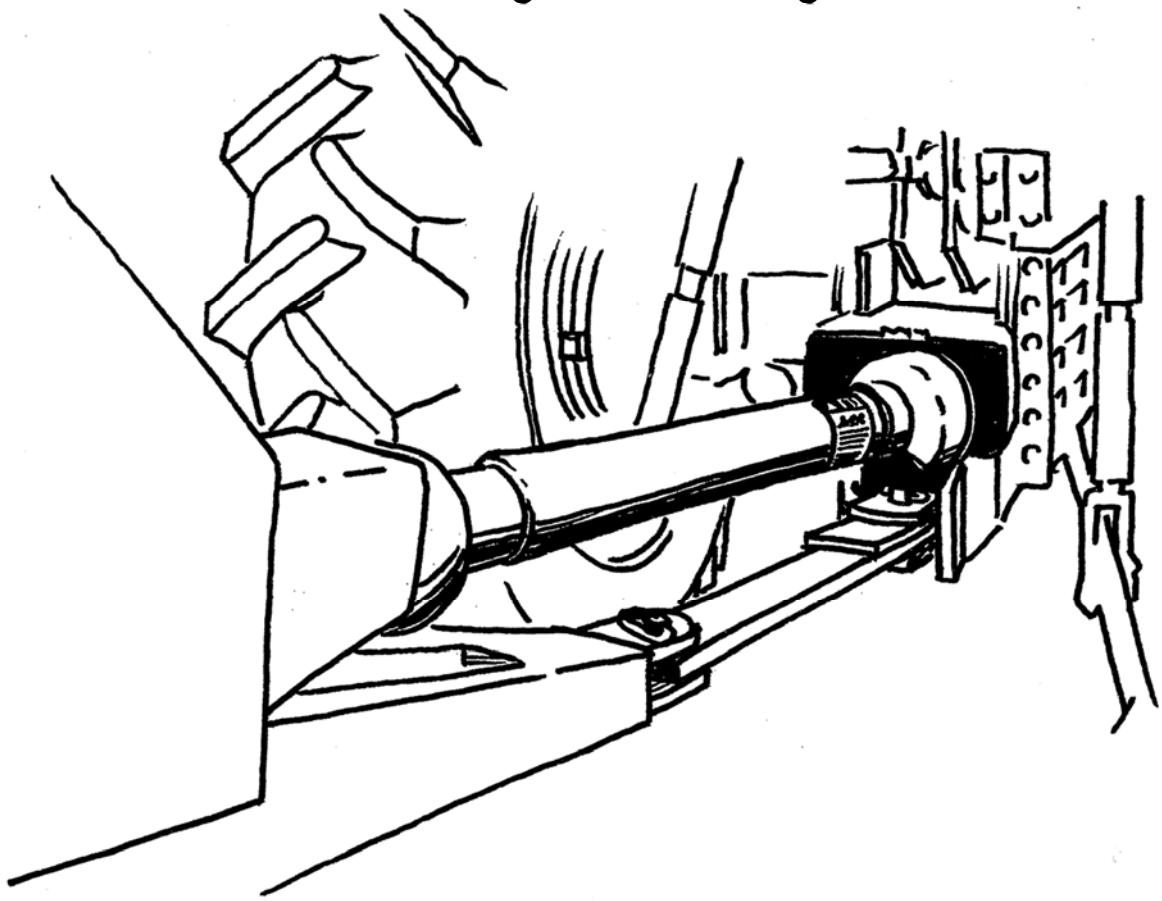
ADMA
Agricultural Driveline Manufacturers Association

Power Take-Off (PTO) Drive Shaft Design and Safety Checklist

For OEM Designers and Engineers



Agriculture is recognized as one of the more hazardous occupations. Today's farmer spends long hours in close proximity to increasingly complex and powerful machinery. In order to avoid accidents, everyone from the component suppliers, to the company who manufactures and assembles the machinery, to the dealers, and ultimately the actual user must keep safety in mind.

ADMA is concerned that PTO drive shafts be used in the safest possible manner. This checklist consists of safety information directly related to the PTO drive shafts of agricultural implements. More information may be found in general safety literature and in the relevant standards published by the American Society of Agricultural and Biological Engineers (ASABE), the Canadian Standards Association (CSA), the International Standards Organization (ISO) and the Society of Automotive Engineers (SAE).

DRIVE SHAFT SPECIFICATIONS – *The first step is to specify and test the drive shaft to operate properly under expected field conditions.*

□ Specify and test the proper size joints and telescoping members based upon the power required by the implement, speed of rotation, joint angles, joint phasing, shock loads and expected life.

□ Design the implement and PTO drive shafts to fit all three types of common PTO (1 ⅜"-6 spline at 540 rpm, 1 ⅜"-21 spline and 1 ¾"-20 spline at 1000 rpm) to eliminate the use of PTO spline adaptors.

□ Design and test the hitch geometry on primary drive shafts and check implement frame movement on secondary drive shafts to prevent the drive shaft from:

- *Extending beyond the recommended maximum length.*
- *Bottoming out.*
- *Reaching a position which would allow the joints to lock.*
- *Exceeding the maximum allowable angle for constant velocity (CV) joints.*

□ Provide a proper operational clearance zone for the drive shaft to avoid damage to the drive shaft or guard components. Some common areas of interference are:

-- Three point linkage *-- Hitch jacks* *-- Implement tongue*
-- Extended or eye loop hitch pins *-- Tractor tires* *-- Implement frame members*
-- Hydraulic hoses *-- Tractor drawbar clevis / hammerstrap hitch*

□ Follow standards recommendations and your drive shaft supplier's advice for the location of the power input connection (PIC) on implements to avoid drive shafts that are too short, too long or have improper joint angles.

□ Specify and test telescoping members considering thrust loads and expected working conditions.

□ Specify large enough telescoping members to prevent the drive shaft from reaching critical speed at the designed operating speed.

□ Where necessary, specify and test torque limiters to control shock loads and overloads.

□ Where necessary, specify and test overrunning clutches to prevent inertial loads from overpowering the tractor.

□ Provide a support location to secure the drive shaft on the implement when it is disconnected from the tractor to prevent damage during storage or transportation.

□ On stationary implements provide a means to prevent separation of the drive shaft, such as a hitch connection between the implement and tractor.

HAZARD REDUCTION – *The second step is to strive to eliminate as many hazards as possible.*

□ Minimize protrusions on drive shafts.

□ For implement connections which require bolts or set screws, select and supply hardware which minimizes any protrusions.

□ Select a locking device for the tractor PTO connection that minimizes protrusions.

□ Do not locate machine controls, gauges or other mechanisms which require or encourage operator presence in the vicinity of the drive shaft.

GUARDING / SHIELDING – *For hazards which cannot be effectively eliminated, guarding or shielding must be provided.*

□ The tractor PTO master shield, PTO drive shaft guard, and PIC guard should provide an effective interactive shielding system throughout the range of expected operating conditions.

□ Specify and test the drive shaft guard with end bell cones which overlap, but do not interfere with the tractor PTO master shield or PIC guard.

□ Specify and test guards designed to operate in the expected environmental and operational conditions.

□ Provide a PIC guard which overlaps with the drive shaft guard to provide guarding of the shaft coupling and any torque limiting device installed on the drive shaft.

□ Make sure that secondary drive shafts (drive shafts that do not attach to the tractor PTO) are fully guarded or adequately guarded by location. Secondary drive shafts with guards should also use PIC guards on both ends.

□ Check that all routine maintenance of the drive shaft can be performed without complete removal of the guards or shields.

□ If the drive shaft guards have a restraint device to prevent them from rotating with the drive shaft, provide an attachment point on the implement.

□ Make sure the drive shaft meets all local regulations and standards for the region or country where the machine will be sold.

□ Make sure that the packaging or shipping method for the drive shaft from the factory to the dealer does not damage the drive shaft guarding or deform the guard cones.

WARNINGS AND INSTRUCTIONS – *Warnings shall be provided for hazards associated with the machine. Instructions should be provided for proper operation, maintenance and repair*.

□ Provide safety signs on the implement to warn that the tractor master shield, drive shaft guard and PIC guard must be kept in place.

□ Provide safety signs on the implement to alert the user to proper hitch dimensions and normal PTO operating speed.

□ Check that proper safety signs are supplied with the drive shaft (replacements are available from your drive shaft supplier).

□ Provide easy to understand instructions for proper drive shaft operation, maintenance (including regular lubrication intervals), and repair in the operator's manual.

□ Advise against the use of PTO adaptors which may defeat the purpose of the tractor's master shield and adversely affect the performance of the drive shaft.

□ Advise the user to use only the original equipment specification replacement parts.

Further information about PTO drive shaft specifications and safety may be obtained from your ADMA PTO driveshaft supplier.

Go to **www.admausa.com** to find a list of industry standards relevant to PTO powered equipment.

Standards may be found at **www.asabe.org**.

Agricultural Driveline Manufacturers Association

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