

**REPORT TO  
EZI-PRODUCTS PTY LTD**

**PERFORMANCE OF EZI-TURN FIFTH  
WHEEL BEARING**

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## **1. INTRODUCTION**

There has been increasing interest in recent years in new ways of improving the lubrication between the top plate of the prime mover fifth wheel and the skid plate of the semi-trailer. This lubrication is essential to assist the articulation of tractor-semi-trailers and affects the life of the fifth wheel and some steering characteristics of the articulated vehicle. For a number of reasons, conventional greasing of the fifth wheel is not as effective as it should be.

The EZI-TURN bearing is a plastic liner attached to the top of the fifth wheel which acts as an intermediate layer between the fifth wheel and the skid plate. It differs from other plastic liners, which are usually attached to the skid plate.

Ezi-Products Pty Ltd wish to ensure that the presence of the EZI-TURN bearing does not invalidate any regulatory requirements applying to fifth wheel couplings. These include dimensional requirements applying to the relative vertical location of the fifth wheel jaws and the kingpin, and any possible effect of the method of attachment of EZI-TURN to the fifth wheel on the strength rating of the fifth wheel.

This report reviews these regulatory requirements and analyses the effects of EZI-TURN on safe and successful coupling of tractors and semi-trailers and on the strength rating on the fifth wheels.

## **2. FIFTH WHEEL REGULATORY REQUIREMENTS**

National standards for fifth wheels are contained in Australian Design Rule (ADR) 62 (Mechanical Connection Between Vehicles). This ADR calls up the detailed requirements of the Australian Standards AS 1773-1990 (Articulated vehicles – fifth wheel assemblies) and AS 2175-1990 (Articulated vehicles – kingpins). These standards basically cover two areas of fifth wheel and kingpin performance: interchangeability and strength. Interchangeability requirements ensure that successful coupling occurs between prime movers and trailers. Strength requirements ensure that the coupling is adequately strength-rated for the weight of the articulated vehicle.

ADR 62 requires all fifth wheels and kingpins to be of a nominal 50 mm size, and therefore only 50 mm equipment is considered in this report.

## 2.1 INTERCHANGEABILITY REQUIREMENTS

Dimensions of both fifth wheel and kingpin affect the interchangeability of tractors and semi-trailers.

### Fifth Wheels

AS 1773-1990 requires, inter alia, the fifth wheel jaws to be located a certain distance below the top surface of the fifth wheel. Fig 1 shows the dimensional requirements involved. The distance to the centre-line of the jaws is specified as well as the thickness of the jaws. It is essential that the jaws are able to lock around the small diameter of the kingpin.

Not all fifth wheel jaws engage solely on the small diameter of the kingpin; some manufacturer also engage the upper diameter of the kingpin. Nevertheless, the key issue is the distance from the top plate to the upper face of the part of the jaws which engages on the small diameter of the kingpin.

With reference to Fig 1, AS1773 requires dimension B to be 25mm +0,-3 and dimension C to be 52 mm +2, -1.

### Kingpins

AS 2175-1990 requires, inter alia, the kingpin to protrude a certain distance below the lower surface of the trailer skid plate. This is illustrated in Fig 2. with reference to the insertion of a layer between the skid plate and the fifth wheel, the critical distance is dimension H (required to be 70 mm +1.5, -0).

In practice, this dimension may depend on the method of attachment of the kingpin. There are three basic types of kingpin in terms of method of attachment; flange bolt-in (Fig 3), taper bolt-in (Fig 4) and flange weld-in (Fig 5). All of these rely on the correct thickness of the skid plate to control the critical dimension H.

## 2.2 STRENGTH REQUIREMENTS

While the strength requirements of fifth wheels are of the greatest significance in terms of the effects of the installation of EZI-TURN` some consideration also needs to be given to effects on the kingpin.

### FIFTH WHEELS

AS 1773-1990 specifies two types of strength test for fifth wheels; dynamic (or fatigue) test and a static overturning moment test.

### Dynamic Test

Certain fluctuating vertical and longitudinal loads are required to be applied simultaneously through a test device simulating the skid plate and kingpin. It is interesting to note that an intervening polyamide layer is required to be placed between the fifth wheel and the simulated skid plate in this test, to reduce the influence of frictional forces.

The test loads are required to fluctuate sinusoidally with a frequency up to a certain maximum. The magnitude of the load depends on the required "D-rating" of the fifth wheel. The loads have to be applied for two million cycles. After the test, the fifth wheel is inspected for residual deformation or any breaks, cracks, separation of components, malfunction or wear.

Many fifth wheels are being rated for a D-value of 162 kN, which requires longitudinal test loads cycling between + 97 kN and – 97 kN and vertical test loads cycling between 110 kN and downwards and 165 kN downwards.

### Static Overturning Test

An upward levering action is required to be applied to the kingpin, to simulate the tendency of the kingpin to be pulled upwards out of the fifth wheel jaws during severe cornering. This is a one off static test only.

## KINGPINS

AS 2175-1990 specifies two types of strength test for kingpins; dynamic and a static test of the kingpin attachment.

### Dynamic Test

An alternating force fore-and aft load must be applied, as indicated in Fig 6, for two million cycles. The load magnitude for a kingpin D-rated at 162 kN is +/- 97 kN.

As an alternative, it is possible to rate kingpins via a material test provided the dimensional requirements are met.

### Static Test Of Attachment

A downward pull equivalent to the static fifth wheel test is required.

### **3. IMPACT OF EZI-TURN**

It is necessary to consider the impact of EZI-TURN on both the interchangeability and the strength rating of fifth wheels and kingpins.

#### **3.1 EZI-TURN INSTALLATION**

EZI-TURN places a plastic layer 6 mm thick between the fifth wheel and skid plate. It is essential that this does not affect the ability of the fifth wheel jaws to engage on the appropriate section of the kingpin.

EZI-TURN is installed by bolting the pre-cut liner to the upper face of the fifth wheel. This is done by drilling a number of 7.9 mm holes around the extremities of the fifth wheel.

#### **3.2 EFFECT ON INTERCHANGEABILITY**

##### **SURVEY OF FIFTH WHEELS AND KINGPINS**

The critical aspect of dimensional interchangeability, as potentially affected by EZI\_TURN, is the relationship between dimensions JB and H, as shown in Figs 1 & 2. In order to investigate this relationship in practice, a survey of dimension in typical Australian vehicles was undertaken. For completeness, the dimensions JA and A (Figs 1 & 2) were also measured in the survey.

##### **Survey Design**

The survey was designed to include the following important variables:

- trailer type (including flat-top, tanker, pantechicon)
- representative range of fifth wheel manufacturers
- representative range of kingpin manufacturers
- all types of kingpins (flange bolt-in, taper bolt-in and flange weld-in)
- effects on wear in both fifth wheel and kingpins.

The survey covered 29 prime movers and 26 trailers. It is considered that the survey was a reasonably representative of the mix of fifth wheel s & kingpins in service in Australia.

## Results

Full details of the survey are given in Appendix A.

Statistics for the dimensions JB, H, JA and A are given in Table 1, showing the mean and standard deviation for all dimensions.

**TABLE 1. STATISTICS FOR CRITICAL INTERCHANGEABILITY DIMENSIONS**

STATISTIC	DIMENSION JB (FIFTH WHEEL) (mm)	DIMENSION H (KINGPIN) (mm)	DIMENSION JA (FIFTH WHEEL) (mm)	DIMENSION H (KINGPIN) (mm)
mean	66.2	72.8	39.5	36
standard deviation	3.1	2.8	3.4	3.1
number outside Australian standard	1 (3%)	3 (12%)	8 (27%)	17 (65%)

The three kingpins outside the AS 2175 requirements were all weld-in kingpins.

Of the 780 possible combinations among the prime movers and trailers surveyed, a total of 24% would have mismatch of the fifth wheel and kingpin with no plastic liner fitted. With a 6mm liner fitted, the total mismatch rate reduces to 12%; if the liner is only fitted to fifth wheels meeting AS1773, the total mismatch rate is reduced to 9%. The effect of adding the liner is to reduce mismatch at the top of the fifth wheel jaws from 23% to 1% and increase mismatch at the bottom of the jaws from 1% to 11%.

It was noted in the survey that one of the trailers fitted with a plastic liner attached to the skid plate had inadequate kingpin protrusion; this was contributed to by the presence of debris which had accumulated between the liner and the skid plate in the vicinity of the kingpin, and was permitted by the fact that the liner was attached around its extremities only.

## IMPACT OF EZI-TURN ON INTERCHANGEABILITY

The results of the survey show the majority of combinations of prime movers and semi-trailers would have no difficulty with correct coupling of the kingpin and fifth wheel when EZI-TURN is fitted. In fact, the small survey undertaken indicated that, due to poor compliance with AS1773 & 2175 requirements in practice, **the presence of a liner tends to improve interchangeability.** If necessary, the possibility of mismatch caused by the presence of EZI-TURN may be reduced by restricting the fitting of EZI-TURN to fifth wheels complying with AS1773, or meeting more specific (and readily achievable) jaw dimensions.

### 3.3 EFFECT ON STRENGTH RATING

#### FIFTH WHEELS

The AS 1773 strength tests involve loads applied mainly through the jaws of the fifth wheel, as a low friction-layer is placed between the fifth wheel and the simulated skid plate. While the design of the fifth wheel jaws varies from manufacturer to manufacturer, the load path always goes through the jaws into the fifth wheel structure and through the fifth wheel structure into the mounting feet. **The location of the EZI-TURN mounting holes is well away from the load path, and it is considered extremely unlikely that they would affect the strength rating, in either the dynamic or static test in AS1773.**

#### KINGPINS

In relation to the AS 2175 dynamic test illustrated in Fig 6, the presence of EZI-TURN increases the moment arm of fore-aft load, and could be seen to slightly increase kingpin stresses. However, **the application of the fore-aft loads in service will always be within the general requirement for the AS 2175 test and the presence of EZI-TURN is not considered to have any effect on kingpin strength ratings.**

## 4. CONCLUSIONS

(i) There has been increasing interest in recent years in new ways of improving the lubrication between the top plate of the prime mover fifth wheel and the skid plate of the semi-trailer. This lubrication is essential to assist the articulation of the tractor-semi-trailers and affects the life of the fifth wheel and some steering characteristics of the articulated vehicle. **EZI-TURN is designed to assist the articulation performance of tractor-semi-trailers and its method of attachment avoids some problems associated with other types of liners.**

(ii) **The majority of combinations of prime movers and semi-trailers will have no difficulty with correct coupling of the kingpin and fifth wheel when EZI-TURN is fitted.**

(iii) The indication from the survey undertaken on behalf of EZI-TURN is that due to poor compliance with AS 1773 & 2175 requirements in practice the presence of the liner actually improves the interchangeability in general. **The dimensional incompatibility rate is reduced from 24% to 12% by the fitting of the 6mm liner.**

(iii) If necessary, the possibility of mismatch caused by the presence of EZI-TURN may be reduced by restricting the fitting of EZI-TURN to fifth wheels complying with AS 1773, or meeting more specific (and readily achievable) jaw dimensions. EZI-TURN could certify all fifth wheels fitted with the liner to appropriate jaw dimensions to ensure continuing compliance with the requirements of AS 1773.

(v) **The fitting of EZI-TURN is not considered to have any effect on the ADR strength ratings of fifth wheels or kingpins.**