

**Test Endurance Life of WinDrive Guide Vane Adjustment System****Contents:**

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**1. Test definition**

Simulation of 20-year operation of the guide vane adjustment system of the torque converter in the WinDrive as proof of endurance life.

In order to illustrate wear features after 20 operating years at rated power, 5-fold loads and tenfold travel adjustment are applied in a shortened test period.

**2. Test execution**

In order to represent the resistant hydraulic force affecting the guide vanes, two devices act against each other in the test run. One device acts as the adjustment actuator, the other one as resistance.

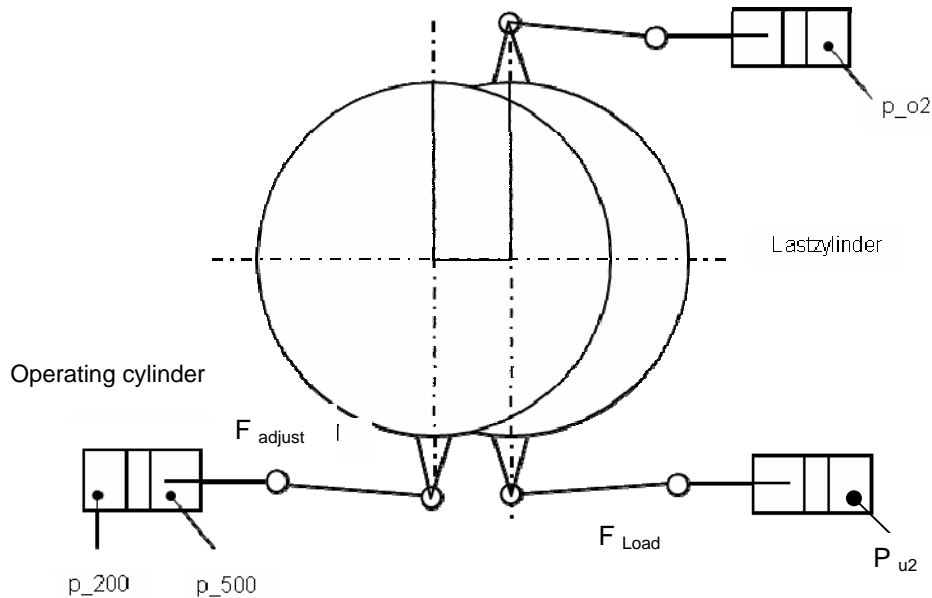
**2.1. Mechanical design and technical data of guide vane adjustment:**

The design of the mechanical guide vane adjustment corresponds with the WinDrive design. An actuating cylinder, made by H&L, is used as the guide vane actuator for the WinDrive

Operating medium:  
Oil temperature:

Mineral oil ISO VG32 and VG22  
60°C

### 2.2. Working scheme:



### 2.3. Technical test data:

Cylinder/hydraulics manufacturer: H&L  
 Operating time: 4662 h  
 Design: 2 load cylinders + 1 oper. cylinder  
 Actuating forces:  $F_{adjust}$ : 13 up to 18kN  
 Torque at guide vane:  $M_{adjust}$ : 50 Nm  
 Actuating pressure  
      $p_{working\ cylinder}$ : 15 bar  
      $p_{supply\ system}$ : 70 bar  
 Test period: 2005-11-11 through 2006-5-15  
 Positioning speed: 200 mm/s  
 Cycles of operation:  $33.2 \cdot 10^6$   
 Oil: Shell Tellus S 22  
 Load: 4-fold load for guidance and  
       5-fold load for adjustable guide vane

### 2.4. Loads used:

$F_{adjust} = 18.000N$  corresponds to torque  $ML = 50Nm$  on vane journals in the mechanical design WinDrive. In normal operation, the WinDrive vane journals experience a mere 10 Nm.

- Medium adjustment travel per operation: 30 mm
- Number of operations:  $>33 \cdot 10^6$
- Total adj. travel after 20 years of operation: 1370 km  
 (corresponds to  $> 6$  operations per minute with 4000 h operating time per year)

### 3. Result

After a total operating time of 4662 h, equating to approx.  $33 \cdot 10^6$  cycles, the endurance life test was successfully finished.  
No wear features or impairment of any other kind were found.

Actuator:



Connecting rod between cylinder and adjustment ring with bushing



Mechanism of adjustment (top view)



Mechanism of adjustment (side view)



Guide vanes with bearing shaft



Adjustment bolts