

## Development test report airbus swivel valve

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**DEVELOPMENT TEST REPORT  
AIRBUS SWIVEL VALVE**

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SUMMARY

New airbus 330/340 aeroplanes will probably first fly in Oktober 1991. DAF special products has engineering responsibility of the steering actuators and Swivel Valves. The Swivel Valve is a hydraulic valve providing reversal of hydraulic pressure during steering operations.

A number of problems arised about its operation during production, assembling and acceptance testing :

- chipping of chrome from pocket edges
- completely blocking during rotation without pressure
- appearance of deep scratches during acceptance testing

Although up till now, the Swivel Valves have performed without any problems during qualification tests at the client's, DAF wants to test them to ensure the proper functioning during its complete endurance life. Alternative Swivel Valve configurations are also tested to have a fall back solution when the basic configuration fails. During the test a number of measurements are done, to build up knowledge about the mechanism that is involved in wear.

Conclusions after 50,000 flights endurance testing :

- All Swivel Valve configurations satisfied concerning wear (the ionic nitrided configuration most).
- All Swivel Valve configurations showed leakage.
- None of the seals used in the valves operated satisfactory.

Recommendations :

- The supply of basic Swivel Valve configurations can continue.
- The seal problem has to be solved.
- The ionic nitride treatment has to be investigated further.

## 1 INTRODUCTION

The Airbus 330/340 aeroplanes will first fly in October 1991. The nose landing gear of such an aeroplane consists of two actuators to provide steering during ground manoeuvring. A Swivel Valve, which is a hydraulic valve, is mounted on these actuators and provides a fluid direction change within them during rotation of the nose landing gear.

DAF Special Products has engineering responsibility of the steering actuators and the Swivel Valves of the Airbus 330/340. During mounting of several Swivel Valves and rotating just for a few times without pressure, a few blocked completely, some showed several deep marks of seal grooves and pocket edges on contact surfaces, especially in the house and chrome chipped from pocket edges of other. Hence there is anxiety about current Swivel Valve configuration proper functioning during its endurance life. Because of these doubts, it was decided to perform an endurance test and to test Swivel Valves on endurance. Not only the Swivel Valve standard configuration but also alternative configurations are being tested. The purpose of this test is to get certainty about the configuration, that will satisfy not only functional requirements, but also will perform over its lifetime. Further important aspects for executing this test are:

- getting a better view of factors that are involved in wear
- getting a better view of mechanism that is involved
- building up own general knowledge
- coming up with solutions in case the Swivel Valve doesn't survive the endurance tests executed at Messier Buggatti, a French landing gear manufacturer and designer of the Airbus 330/340 nose landing gear, and principal contractor.

## 2 Problem Definition

### 2.1 The Swivel Valve

The Swivel Valve is mounted on both steering actuators of the nose landing gear and provides reversal in flow direction of the hydraulic fluid used in these actuators. In this way the steering actuator changes from push to pull or visa versa. The Swivel Valve consists of two parts, a house and a core (see figure 2.1.1), that rotate in relation to each other. Further detailed information about the Swivel Valve operation are shown in enclosure A.

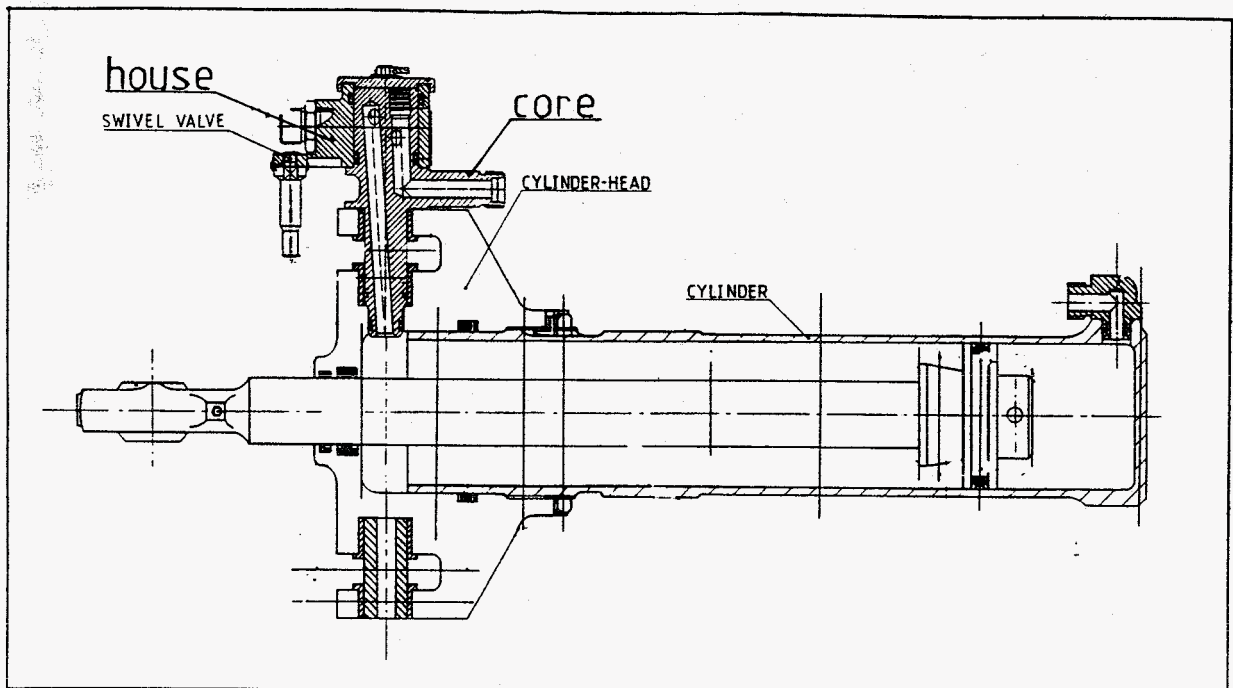


Figure 2.1.1 : Drawing of the Swivel Valve mounted on the actuator.



## 2.2 Configuration Development of the Swivel Valve

During the design of the Swivel Valve, the basic material used for core and house was changed from a basic carbon-steel (4340) to stainless steel. The first design did not provide any surface treatment for the contact area between core and house. This caused galling of the assembly during acceptance testing. Therefore the core of the Swivel Valve was partially chrome-plated. The not chrome-plated area over the seal groove was reduced in diameter to prevent galling in this area.

At first the chrome-plating seemed to solve the problem, but a number of valves still blocked during acceptance testing.

During the design, a special seal for rotary applications was proposed by DAF, but the principal contractor Messier disagreed on this selection and ordered o-seals to be used. These are not preferred for rotary applications, but the selection was made on the experience with similar valves and from the standpoint of economy and logistics.

## 2.3 Current Swivel Valve Configuration

The current material of the Swivel Valve house is Z15CN17-03 without further treatment and the core is made out of 15-5PH (see table 2.3.1 for chemical structure).

The surface of the core is chrome plated till 1.5 mm from the seal groove and it has a nominal thickness of 100 um (see figure 2.3.1).

	house	core
material	Z15CN17-03	15-5PH H1025
C	0.12-0.20	< 0.05
Si	< 1.00	0.05-0.60
Mn	< 1.00	< 0.6
P	< 0.025	< 0.03
S	< 0.025	< 0.03
Cr	15.0-18.0	14.5-15.5
Ni	2.0-3.0	4.2-5.0
Cu	-	2.8-3.5
Nb+T	-	0.15-0.30
N	-	< 0.05
tensile strength N/mm <sup>2</sup>	880-1080	1125-1320
hardness HB	262-326	
hardness HRC		35-42
hardness HV	275-340	350-410

Table 2.3.1 : Chemical structure of house and core.

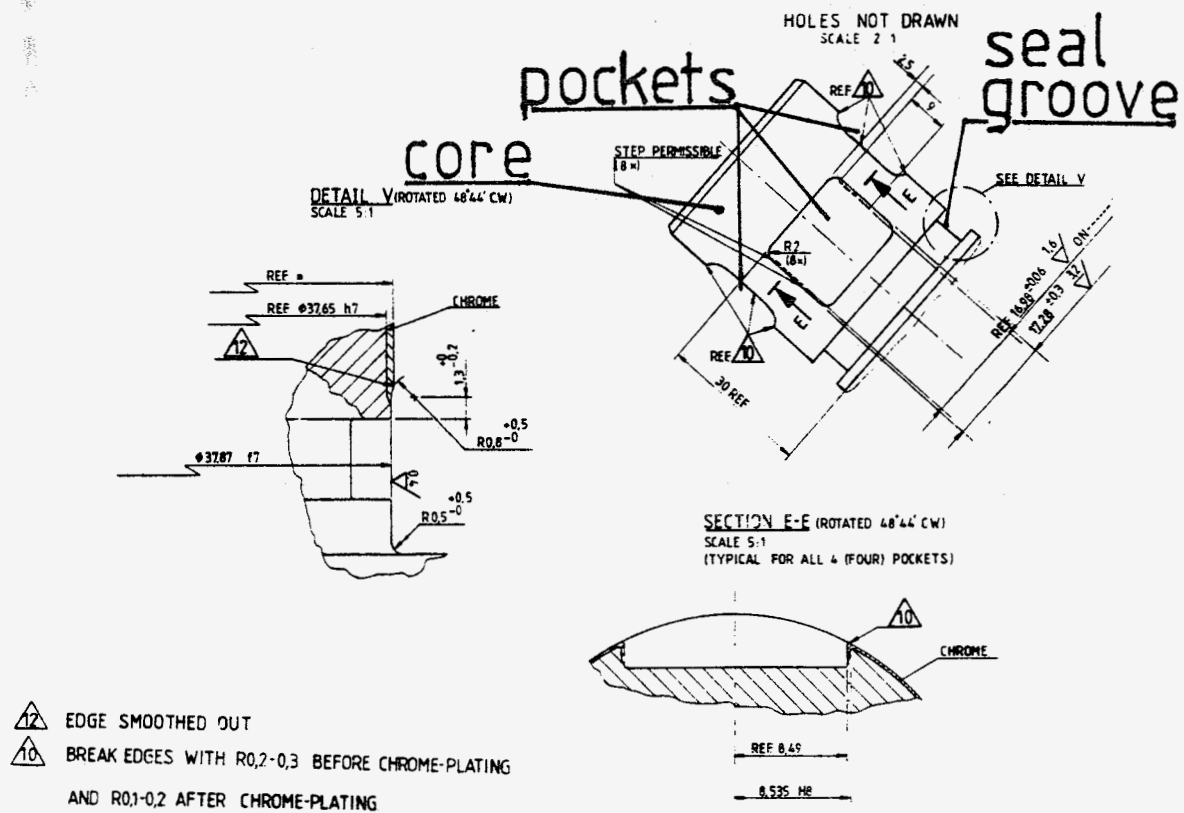


Figure 2.3.1 : The current core configuration with a harchrome surface.

The manufacturing method for the surface treatment of the core is : there is put about 250 um chrome on the surface of the core and then the pocket (4 rectangle shaped pits within the running surface of the core ) edges are grinded. After this the diameter of the core is grinded cylindric to about 100 um . Finally the core is matched on the house with a nominal play of 8 to 12 um on the diameter.

#### **2.4 Problem Diagnose**

The actual problems that remained after the design had been progressed to this stage (as described in section 2.3) are listed below.

- A number of valves still blocked during non-pressure turning at acceptance testing.
- At the sharp edges of the pockets, that are crucial to the switching characteristics of the Swivel Valve, chrome chips break away during final grinding. This causes a quality problem for production and can cause critical failure if chips are caught between core and house.
- Deep scratches appear in the house and on the core after non-pressure rotating of the assembly.

Because of these problems there was concern, whether the Swivel Valve could operate properly over its service life. Therefore it was decided that an endurance test would be performed, including a number of alternative designs to develop an optimal configuration for the Swivel Valve.

#### **2.5 REM-analysis of a Swivel Valve Core**

One core which blocked completely during acceptance testing due to binding and which had scratches on the outside has been analysed by DAF's Cental Laboratory.

The core has been analysed with a REM for visual damage at Philips PMF-CMTI.

2.5.1 Results of the analysis

The running surface of the core has been analysed. It shows a number of deep scratches in rotation direction and chipped chrome particles at the edge of the pockets.

Figure 2.5.1.1 shows a macrophotograph of the chipped chrome particles in the left upper edge of one of the two pockets, which is nearest to the seal groove of the core. In this same pocket chipping of the chrome is also found at its right side.

The side of the seal groove and near the pocket shows a rather deep scratch in rotation direction. The scratches in axial direction are probably the result of demounting of the core and the house of the Swivel Valve.

The figure shows that the chrome stops somewhere between the pocket edge and the seal groove and not 1.5 mm from the seal groove as specified in the drawing of the core.

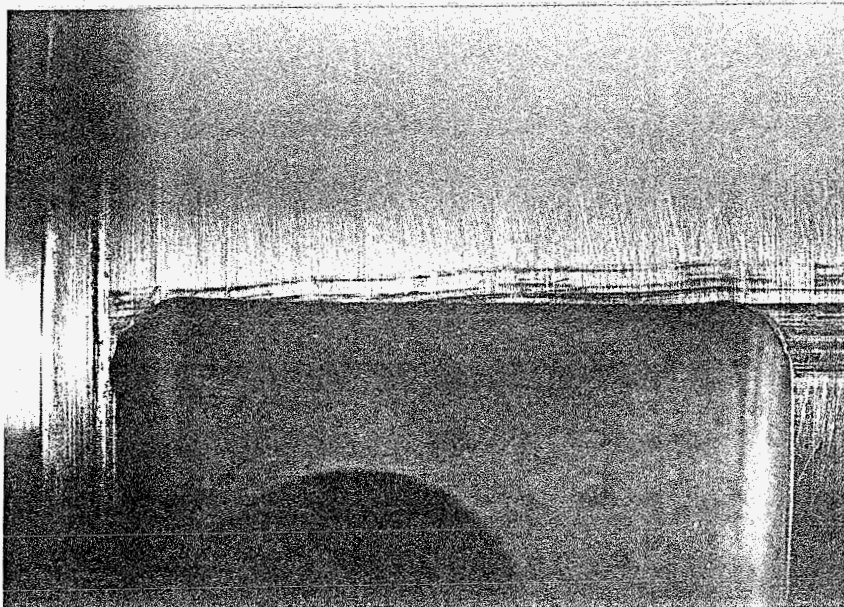


figure 2.5.1.1 : Macrophotograph of chipping particles at the upper left edge of one of the two pockets nearest to the seal groove.

Figure 2.5.1.2 shows a REM-photograph of the edge of the pocket shown in figure 2.5.1.1 with the chipping chrome. It shows scratches in the chrome surface and chrome in the pockets. The chipping has taken place in the chrome surface and not in the base material. This has been verified by a EDX-analysation (a qualitative analysation of the chemical composition). This means that the firmness between the chrome and the base material has been good.

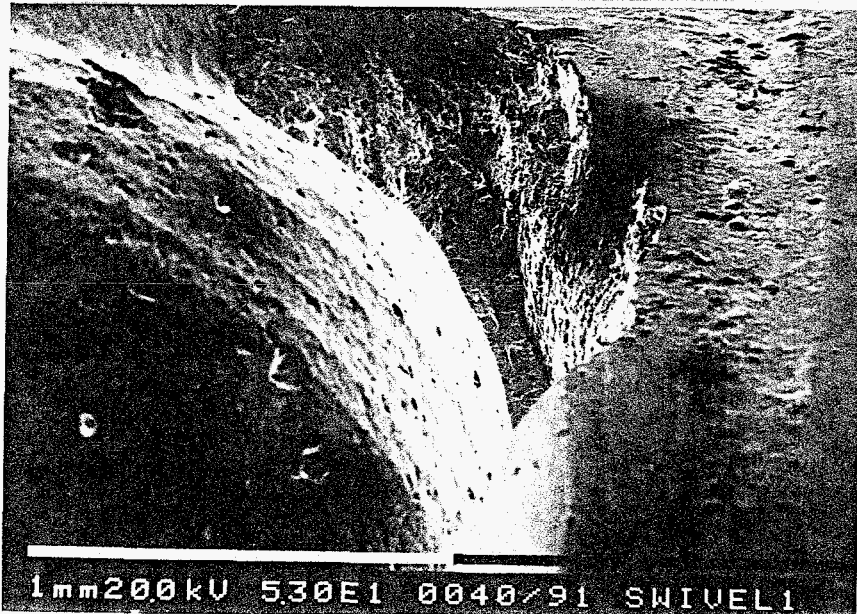


Figure 2.5.1.2 : REM-photograph of the edge of the pocket.

Figure 2.5.1.3 shows a REM-photograph near figure 2.5.1.2 at the running surface. In the lower right corner the chipping chrome can be seen. The pollution of the chrome in axial direction contains Fe and is probably from the damaged house.

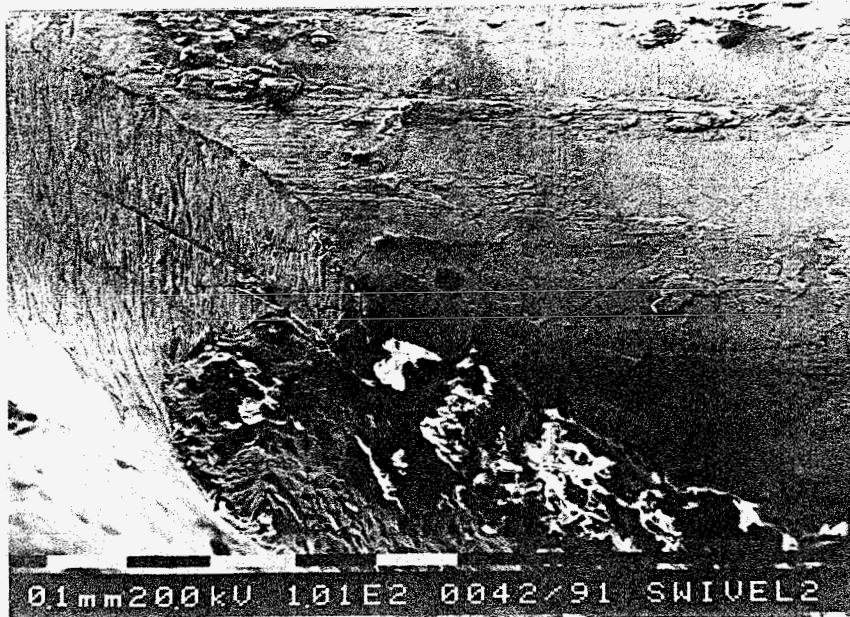


Figure 2.5.1.3 : REM-photograph near figure 2.5.1.2 on the running surface.

Figure 2.5.1.4 shows a REM-photograph which is a detail of figure 2.5.1.3 just above the chipped edge of the pocket. It shows hair cracks in the chrome surface.

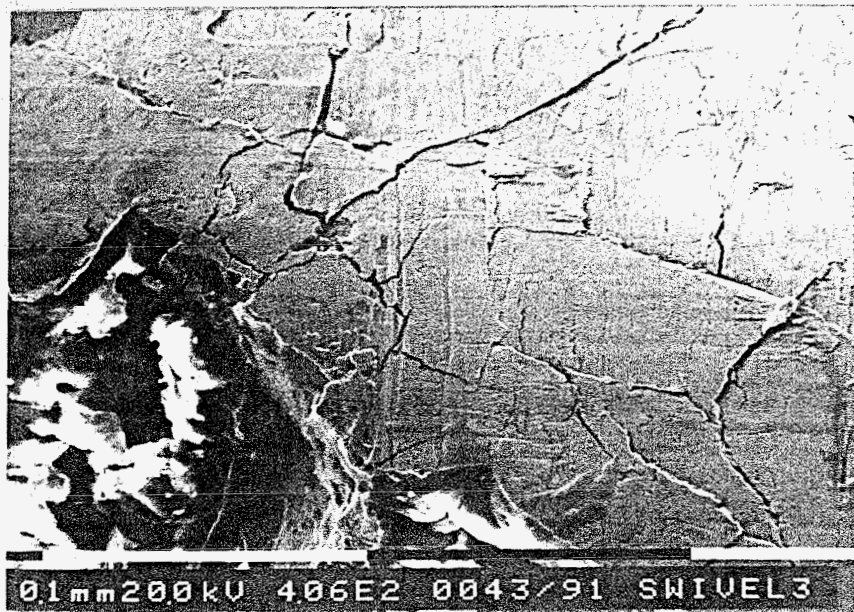


Figure 2.5.1.4 : REM-photograph above the chipped edge of the pocket.

Figure 2.5.1.5 shows a detail of the deep scratch shown in figure 2.5.1.1. Left and right of the groove Fe can be found on the chrome surface probably because of material transfer from the house to the core. The groove itself contains chrome, so the damage has not been penetrated through the chrome surface.

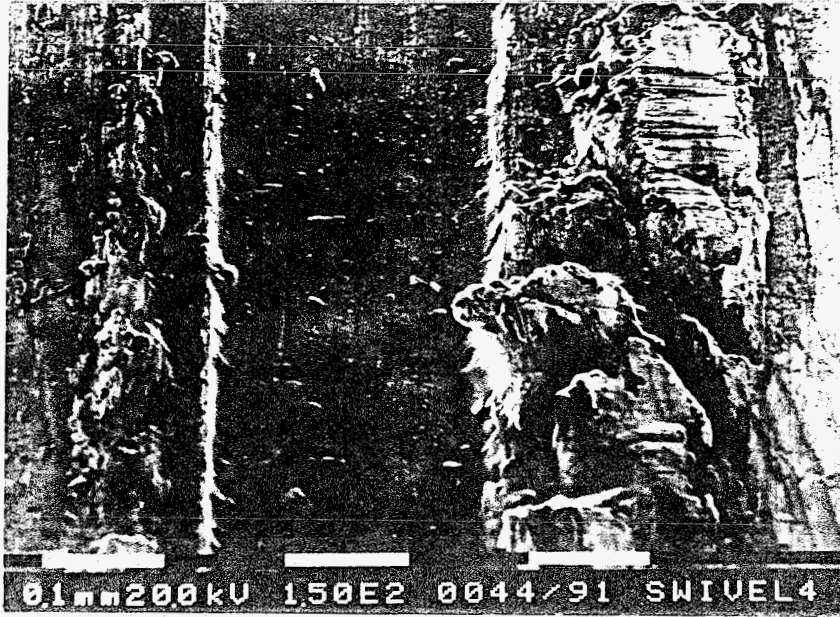


Figure 2.5.1.5 : Detail of the deep scratch in figure 2.5.1.5.

Figure 2.5.1.6 shows a macrophotograph of a groove where grating has taken place. This groove is located at the crossing chrome/base material at the seal groove side diametrical of the pocket from figure 2.5.1.6.

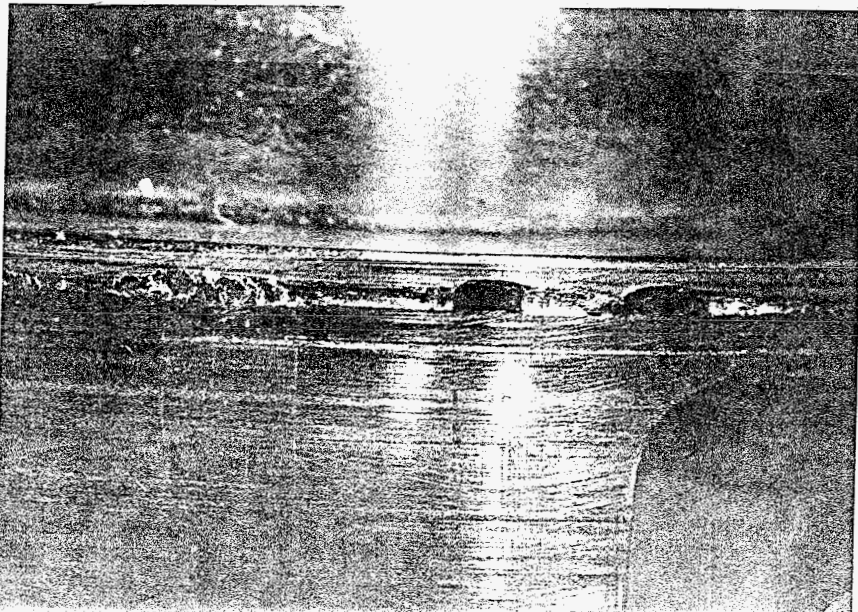


Figure 2.5.1.6 : Macro photograph of a groove consequent on grating.

Figure 2.5.1.7 shows a detail photograph.

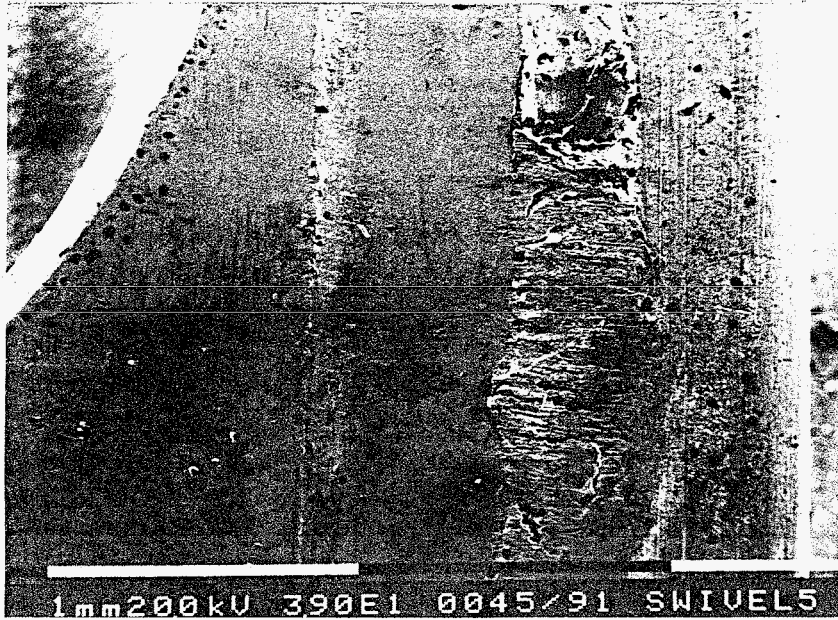


Figure 2.5.1.7 : Detail photograph of the groove consequent on grating.

On the other side of the running surface of the core, in axial direction, 2 grooves are located as high as the seal groove of the house (figure 2.5.1.8).

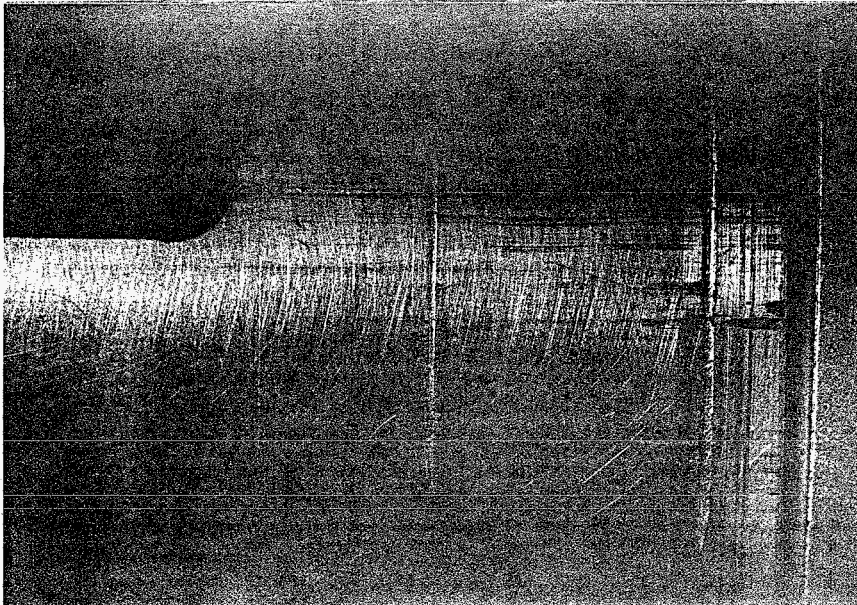


Figure 2.5.1.8 : The other side of the running surface of the core, in axial direction.



### 2.5.2 Discussing the Results

The grooves in the chrome in rotation direction are probably caused by hard particles, which are embedded in the rather soft material of the house and then cutted in the core. Because of the wear these particles have caused in the core the house is damaged and material transfer from house to core has taken place. Because the house wasn't analysed Central Laboratory couldn't tell where the particles came from, but they are probably chrome particles or corund abrasive particles. Remarkable are also the grooves as high as the seal groove of the house.

Chipping of the chrome from one pocket is caused by violence, secondary cracks are also found. It is not sure whether the chrome is chipped during grinding, testing or dissambling. The chrome is not chipped from the base material, but in the chrome surface itself. This means that the firmness of the chrome with the base material is good. Because of the thick chrome (250 um) during grinding to a size of 100 um, chipping takes place. Because of the extra surface build up at the edges the surface will be there probably between 300 and 400 um thick.

At the crossing chrome/base material at the side of the seal groove of the core grating has taken place. The cause is probably the running out of the chrome.

The axial scratches are probably caused by demounting.

### 2.5.3 Recommendations

- Use a chrome thickness of 50-75 um and grinding as little as possible.
- Use a chrome surface on the complete running surface.
- Round the edges of the pockets, so less thickness build up of the chrome.
- Keep your hydraulic system as clean as possible.

### 3 TESTCONFIGURATIONS

One problem concerning the standard configuration of the Swivel Valves is possible chipping of chrome from the pocket edges during rotation. If these chrome particles are big enough, they can cause blocking between the core and the house.

Because the test for the Swivel Valve starts in a rather late stage (some Swivel Valves have already been send to Messier), the changes concerning the Swivel Valve can not be drastic. That is why only minor modifications can be allowed for the Swivel Valve design and the form, fit and function has to remain unchanged.

The standard configuration for the Swivel Valve can be changed in the following way :

- changes in surface treatment
- geometric changes
- using other basic material

#### 3.1 Surface Treatment

The Swivel Valve can be changed in choosing another surface treatment.

The treatments that have been investigated are listed below :

- Electroless Nickel Plating
- Hardening
- Induction Hardening
- Reduction
- Nitriding
- Ionic Nitriding
- Chrome Plating
- Hard Anodizing
- Chemical Vapour Deposition

- Physical Vapour Deposition
- Ceramic
- Plasma

These treatments have been discussed with the Central Laboratory, Plating Department and Production Engineering and their recommendations are listed below (these recommendations refer to surface treating the core, because according to them surface treating the core would be easier than surface treating the house ) :

- Chrome Plating : possible if executed correctly
- Electroless Nickel Plating : possible if executed correctly
- Hardening : product is already hardened  
Just hardening is not enough  
In that case the material combination still remains stainless steel versus stainless steel.
- Induction Hardenening : same comment as hardening
- Reduction : same comment as hardening
- Nitriding : This is not possible because of the needed temperature of 515°C. Stainless steel loses its resistance to corrosion.
- Ionic Nitriding : This is possible and can be done by Mamesto, a company in Arcen Holland. This treatment will cause no loss of resistance to corrosion.
- Chromating : This isn't useful, because of the already presents of Chrome in the basic material.
- Hard Anodizing : Only possible when using Aluminum as basic material.
- Chemical Vapour Deposition : This isn't possible because of the high working temperature 850-1000°C.

- Physical Vapour Deposition : This is possible but not yet used in aeronautics.
- Ceramic : The same comment as for PVD/CVD.
- Plasma : This is possible with only Molybdenum.

Regarding this the cores during the first test will be treated as follows :

- Chrome Plating
- Ionic Nitride

and during an eventual second test :

- Physical Vapour Deposition
- Molybdenum Plasma

### 3.2 Geometric Changes

The geometric changes will be changes especially in the pocket size and shape on the core.

The size of the pockets can be decreased to create a larger bearing surface and reduce wear. To decrease the size of the pockets, their positions have to change. The position of the pockets has to be lined up, as can be seen in figure 3.2.1.

The shape of the pockets is also important regarding wear aspects.

A large radius on the pocket corners reduces the possibility of cutting of the pockets in the house (see figure 3.2.2).

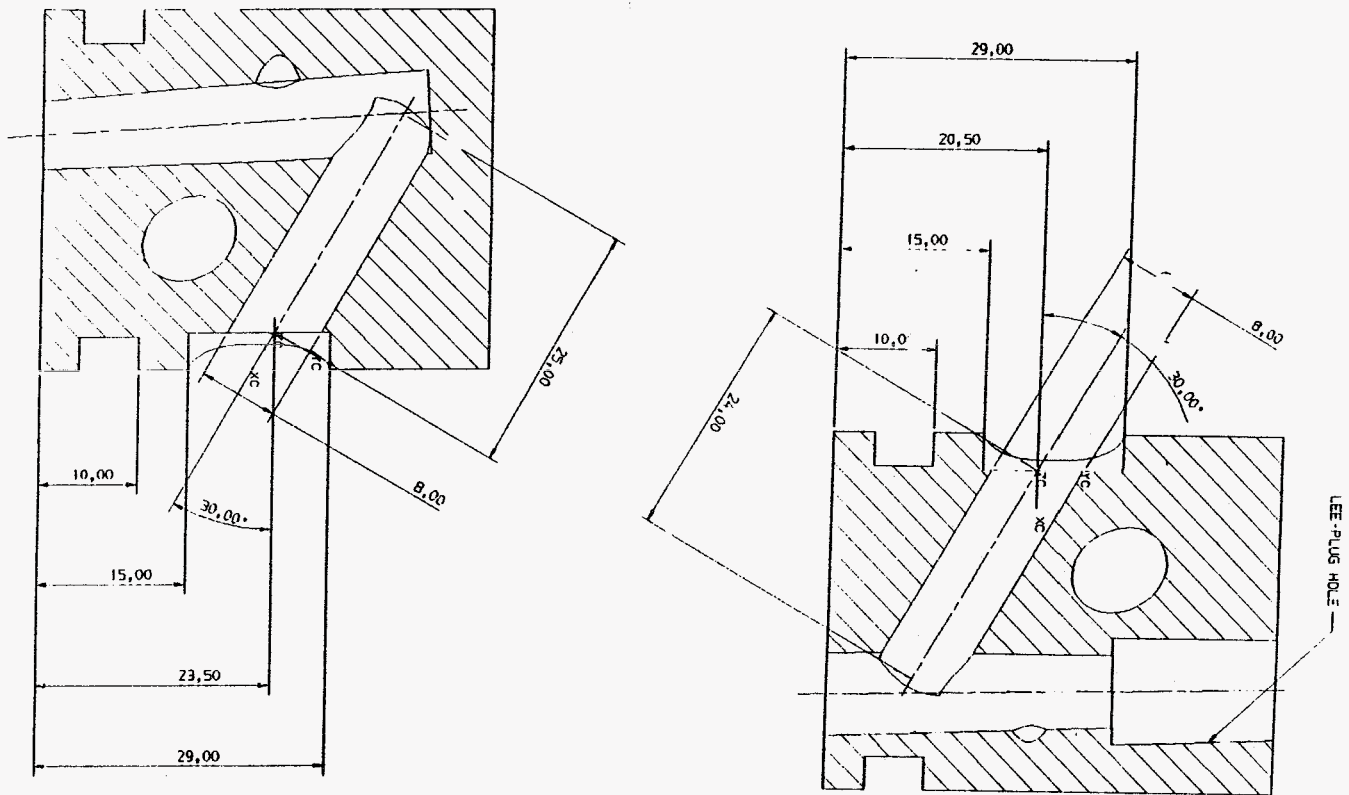


Figure 3.2.1 : Pockets lined up in the core.

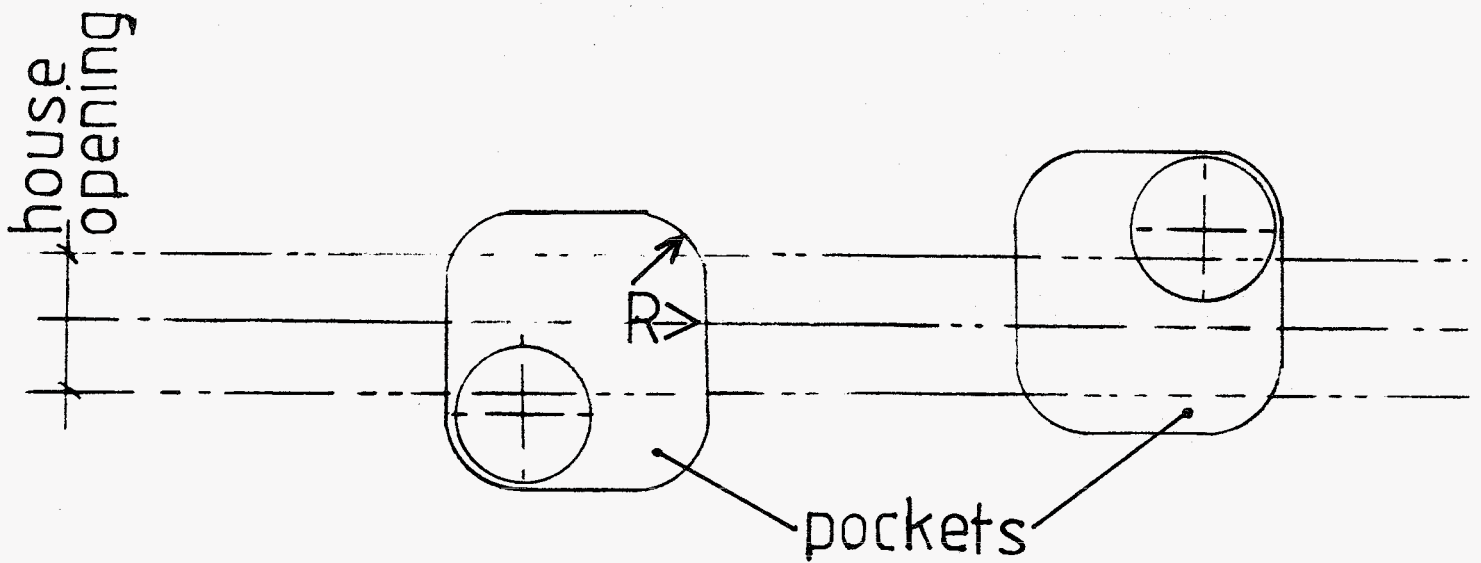


Figure 3.2.2 : Increasing radius of pocket corners.

The limitation for increasing the radius of the pockets edges is the switching moment of the Swivel Valve. Therefore the pocket edges must be as sharp as possible. The limitation in decreasing the bore holes within the pockets, is the pressure drop over the Swivel Valve, which may not be too large.

Regarding this the Swivel valve core will be changed for the first test round in :

- increasing radius of pocket corners
- decreasing bore holes within pockets

### 3.3 Material Changes

Besides the stainless steels as selected for the current Swivel Valve configuration it is allowed to change back to previously envisaged carbon-steel. However it must be guaranteed that parts will be properly protected against corrosion.

The corrosion protection is a specified demand from Messier, because of earlier corrosion problems on similar valves.

For the first test round it was decided to stay with the basic material as selected for the current design.

### 3.4 Seal Change

The use of an o-seal in rotary applications is not the most preferred solution. Therefore it was expected that the o-seal would fail during the test. To provide a backup solution, an alternative seal was selected, specially designed for rotary applications.

From the seal manufacturer Geene Tweed, the ENER-CAP seal was selected.

From the catalogue, the glas-filled cap was selected for chrome plated surfaces, but the manufacturer recommended carbon filled caps for our applications.

### 3.5 Selected Test Configurations

The 4 chosen test configurations of the Swivel Valve for the first test round are :

- |                           |                                 |
|---------------------------|---------------------------------|
| type 1) Basic Design      | Standard unit                   |
| type 2) Improved Design   | - Pocket corner with radius 3mm |
| Chrome                    | - Completely chromed core       |
|                           | - Reduced chrome layer (50um)   |
| type 3) Improved Geometry | - Pockets in line, cross        |
| Chrome                    | drillings under angle           |
|                           | - Pocket corner with radius 3mm |
|                           | - Completely chromed core       |
|                           | - Reduced chrome layer (50um)   |
|                           | - Alternative seal, Greene      |
|                           | Tweed type : enercap            |
| type 4) Improved Geometry | - Pockets in line, cross        |
| Ionic Nitriding           | drilling under angle            |
|                           | - Pocket corners 4mm radius     |
|                           | - flange flash-chromed          |
|                           | - Completely ionic nitrided     |
|                           | core                            |
|                           | - Alternative seal, Greene      |
|                           | Tweed type : enercap            |

The drawings of the cores used for the endurance test are shown in enclosure II drawingno :

- SP10288
- SP10289
- SP10290
- SP10291

The pocket edges and seal groove of the test configurations are not completely representative for the production units, because the order of machining of the outside diameter and the pockets was reversed. First the pockets should have been grinded to size, to allow small chips on the edge to

be machined away during final matching of the outside diameter.

A lot of attention has been put into the breaking of the pocket edges, done under a microscope with a lapping stone. This will remain a critical operation during series production, crucial to the characteristics of the valve.

The requirement for chroming of cores type 2 and 3 were a maximum chrome layer of 75um. After chroming, the minimum layer thickness was 60um and the maximum around 100um. Chrome plating was done up to the edge of the pocket. The final grinding sequence was first the pockets and then the outer diameter. This caused chipping of the chrome, because of the fact that both the chrome and the base material were grinded. Therefore it was decided to machine the pockets slightly oversize and allow the core to be chromed over the pocket edge.

After stripping and chrome plating, the grinding sequence was reversed by accident. Therefore, small chrome chips that broke off during grinding could not be grinded away during final matching. Therefore the quality of the pocket edges is not completely representative for normal production.

Because the cores of type 2 and 3 are chromed over the seal groove, the seal groove has to be grinded after chroming. After examination of the cores after the testing, it appeared that the final grinding of the seal groove had not been done.

The core of type 4 has been ionic nitrided by Mamesta in Lomm. After return to DAF the core is black on the running surface and blue everywhere else. A dummy core which has also been ionic nitrided has been analysed by Central Laboratory. The hardness of the pocket edges and in the pockets is 1100 HV and the hardness of the running surface



is 400 HV, which is the same hardness as the base material of 15-5 PH. The bearing surface of the core has no nitride surface at all. The ionic nitride process has failed. Measuring the diameter of the bearing surface of the core before ionic nitriding results in 37.877 mm and after ionic nitriding results in 37.871 mm and so it appeared to have shrunk 6 um. The temperature of this ionic process was just below 500°C.

The same core of type 4 has been nitrided for a second time at a higher temperature (570°C), but this temperature is above the PH-temperature of the material (550°C). Because of the advice of Mamesta Central Laboratory to ionic nitride the core better a higher temperature is used. A dummy core which has also been ionic nitrided has again been analysed by the Central Laboratory. The hardness on the core is about 1100 HV on the whole bearing surface including the pockets, which is satisfying. After measuring the core, its cylindricity is not satisfying (see table 3.5.1).

Cylindricity of the ionic nitrided core (mm)		
measured	allowed	difference
0.0204	0.0050	0.0154

Table 3.5.1 : Cylindricity of the bearing surface of core type 4 before testing.

The core again has shrunk to a diameter of 37.842 mm. Because of the shrunk core a new house is matched on the diameter of the core.

**4 TEST SPECTRUM**

The lifetime of an Airbus 330/340 aeroplane is 50,000 flights. Every 20,000 flights the landing gear is completely overhauled. During this overhaul a Swivel Valve which fails to meet the requirements can be replaced by a new one. Therefore the operational life of a Swivel Valve is required to be 50,000 flights with an absolute safety minimum of 20,000 flights.

**4.1 Nose Landing Gear Endurance Spectrum**

The endurance spectrum of the nose landing is as follows :

**a) Manoeuvre A**

**Controlled Manoeuvre**

rotation :  $\pm 50^\circ$   
rotation speed : 0.145 rad/s  
frequency : 2 per flight

**b) Manoeuvre B**

**Oscillating Manoeuvre**

rotation :  $\pm 3^\circ$   
rotation speed : 0.209 rad/s  
frequency : 15 per flight

And all these manoeuvres are carried out with 3 different pressures, namely :

- 1) 20.6 MPa
- 2) 14.1 MPa
- 3) 6.7 MPa

These pressures are in the proportion of

(1) : (2) : (3) = 1 : 99 : 900

4.2 Relation between Nose Landing Gear and Swivel Valve

The schematic mechanism between nose landing gear and Swivel Valve is shown in figure 4.2.1. AC rotates around A and represents the rotation of the nose landing gear. BC rotates around B and represents the rotation of the actuator and so also of the Swivel Valve which is mounted on the actuator. At point C the actuator is attached to the nose landing gear. BC is variable in length.

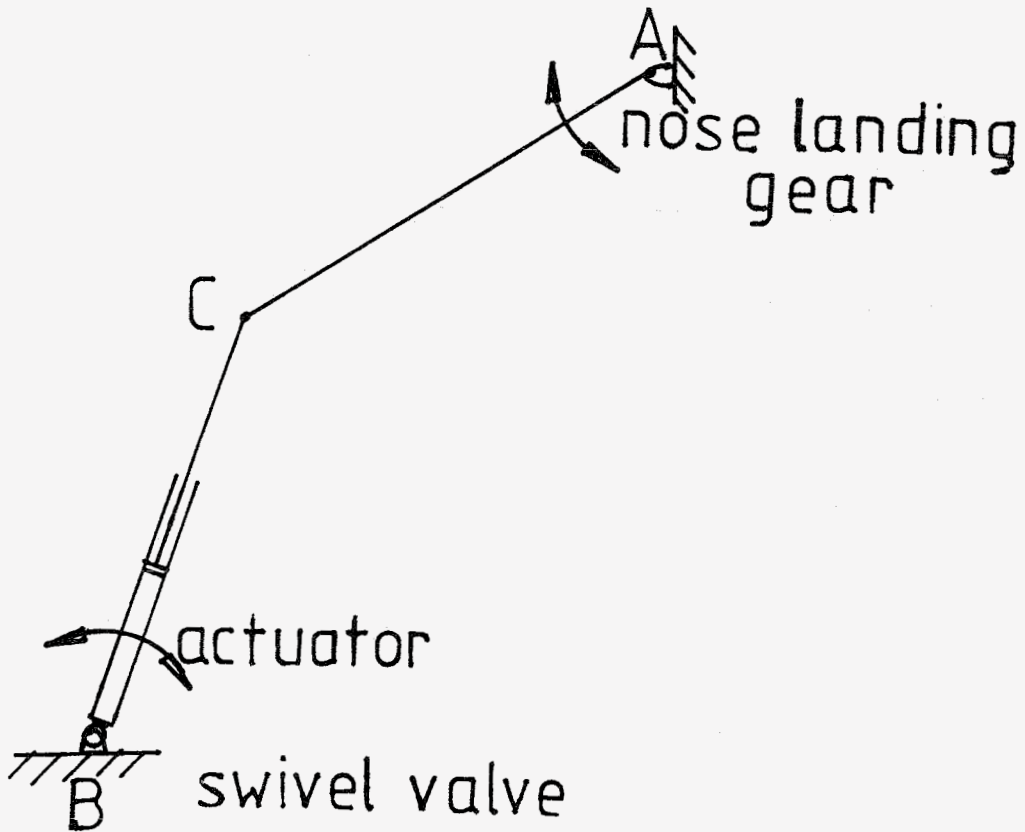


Figure 4.2.1 : Schematic mechanism of the nose landing gear.

The Swivel Valve rotation versus nose landing gear rotation during manoeuvre A and B are shown in figure 4.2.2 and 4.2.3.

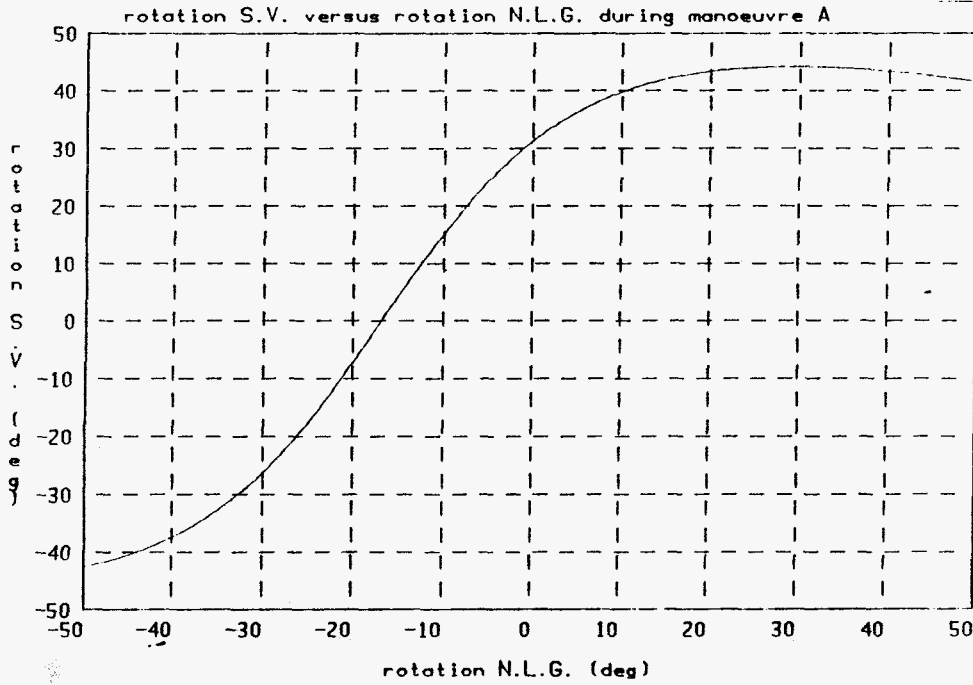


Figure 4.2.2 : Swivel Valve rotation versus nose landing gear rotation during manoeuvre A.

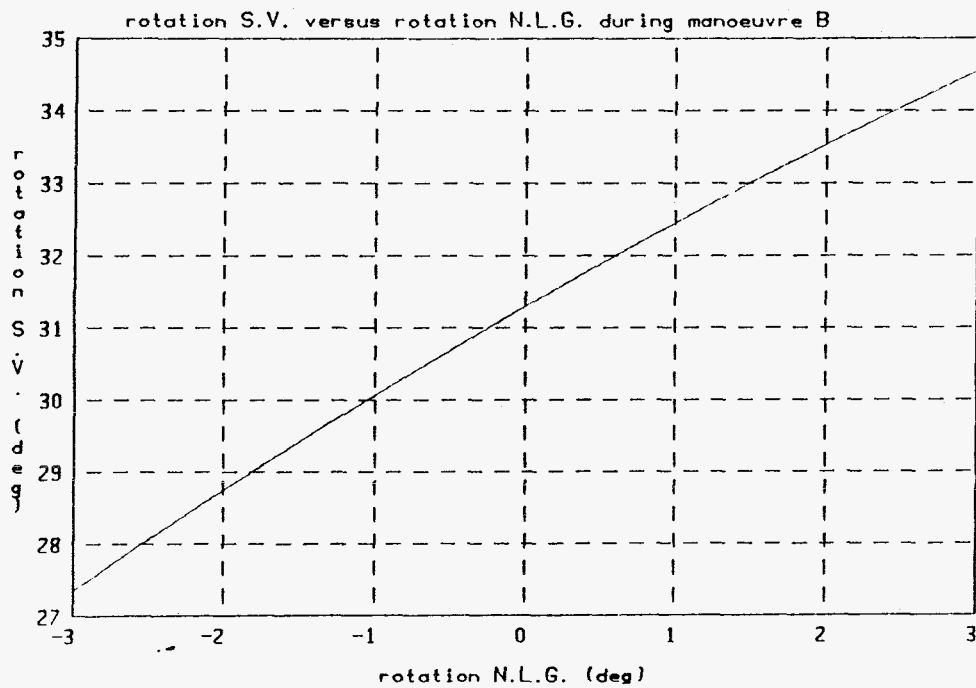


Figure 4.2.3 : Swivel Valve rotation versus nose landing gear rotation during manoeuvre B.

The Swivel Valve angular velocity versus the nose landing gear rotation during manoeuvre A and B is shown in figure 4.2.4 and 4.2.5.

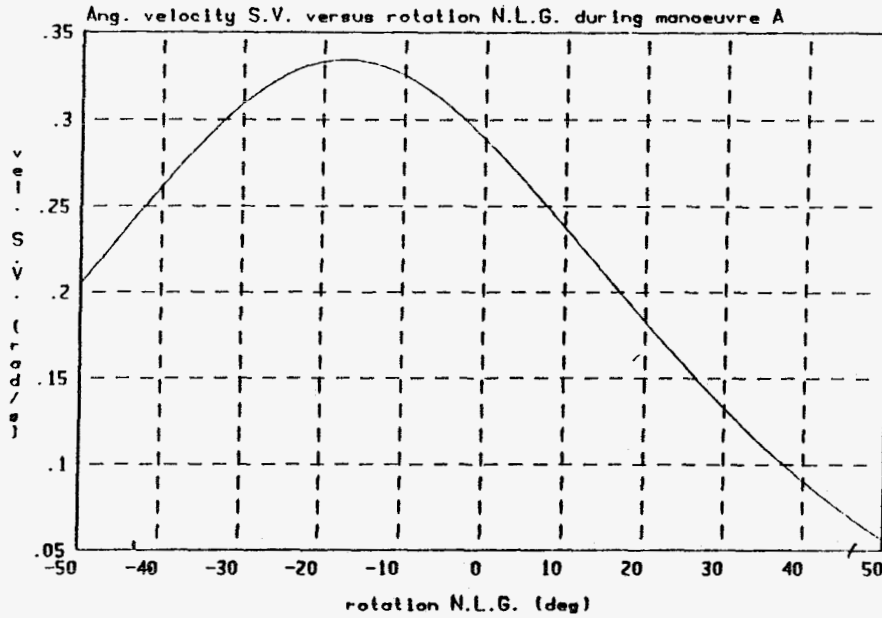


Figure 4.2.4 : Swivel Valve angular velocity versus nose landing gear rotation during manoeuvre A.

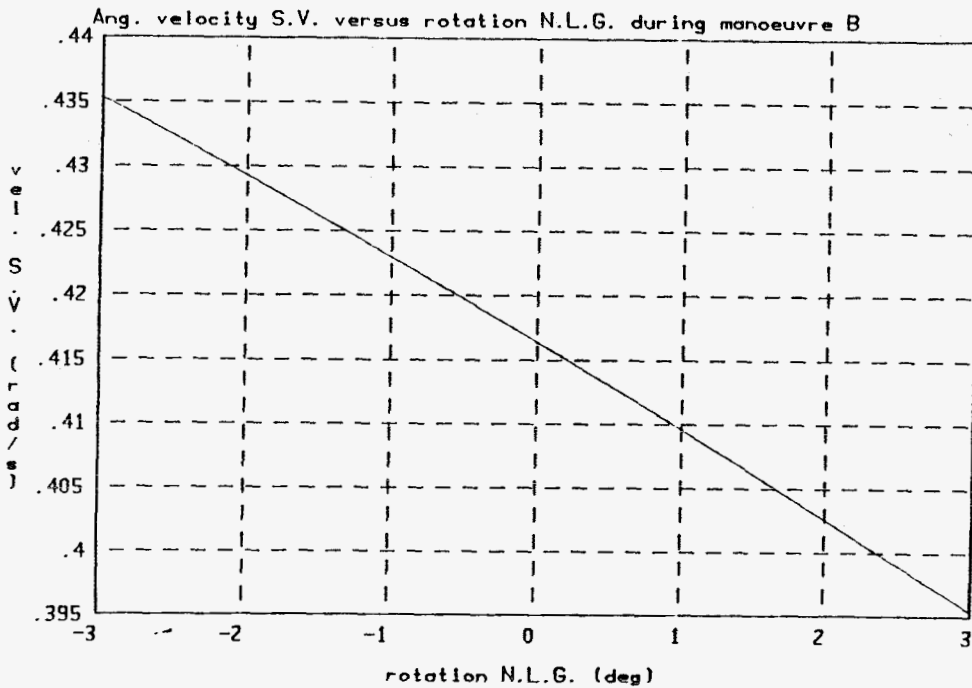


Figure 4.2.5 : Swivel Valve angular velocity versus nose landing gear rotation during manoeuvre B.

### 4.3 Swivel Valve Endurance Spectrum

The Swivel Valve endurance spectrum is shown below :

- It is required that the Swivel Valve operates correctly during 50,000 flights.

From figures 4.2.2,4.2.3,4.2.4 and 4.2.5 it is clear that the Swivel Valve manoeuvres are :

a) **Manoeuvre A**

**Controlled Manoeuvre**

rotation range : -42.41° -> 43.30°  
maximum angular velocity : 0.33 rad/s  
frequency : 2 per flight

b) **Manoeuvre B**

**Oscillating Manoeuvre**

rotation range : 27.33° -> 34.50°  
maximum angular velocity : 0.44 rad/s  
frequency : 15 per flight

with 3 different pressures, namely :

- 1) 20.6 MPa
- 2) 14.1 MPa
- 3) 6.7 MPa

in the proportion of

(1) : (2) : (3) = 1 : 99 : 900

### 4.4 Test Programme

Every selected Swivel Valve configuration will undergo a test programme doing different manoeuvres with different pressures as specified in its endurance spectrum (see section 4.3).

The required time between overhaul of the Swivel Valve is 20,000 flights. To ensure proper functioning and to eliminate the statistical probability of having an occasional good product the test will be performed over 50,000 flights.

When we assume the valves' endurance lives to be distributed Gaussian and the standard deviation equal to 10,000 flights, the probability for one configuration surviving its test and not surviving 20,000 flights is 0,13 per cent.

One cycle, which will be further used in this report, represents one relative harmonic rotation of the Swivel Valve.

To limit the number of different loadings within a test block, the number of cycles at the lowest pressure (6.7 MPa) are added to the number of cycles at the middle pressure (14.1 MPa). This will increase deformation of the house and hence increase wear over lifetime .

To speed up the test, higher angular velocities are selected for the specified manoeuvres of the Swivel Valve. The values choosen are guided by design constrains of the electric motor and the transmission pulleys (see enclosure IV). The values for angular velocities and rotation range during the test are compared to the one in reality and shown in table 4.4.1 and plotted in figure 4.4.1 and 4.4.2.

	test	reality
max. rotation range (deg)	-44.93°-44.99°	-42.41-43.30
min. rotation range (deg)	24.38°-38.73°	27.33-34.50
max. angular velocity		
at max. rotation (rad/s)	2.04	0.33
max. angular velocity		
at min. rotation (rad/s)	1.17	0.44

Table 4.4.1 : Comparison between test and reality.

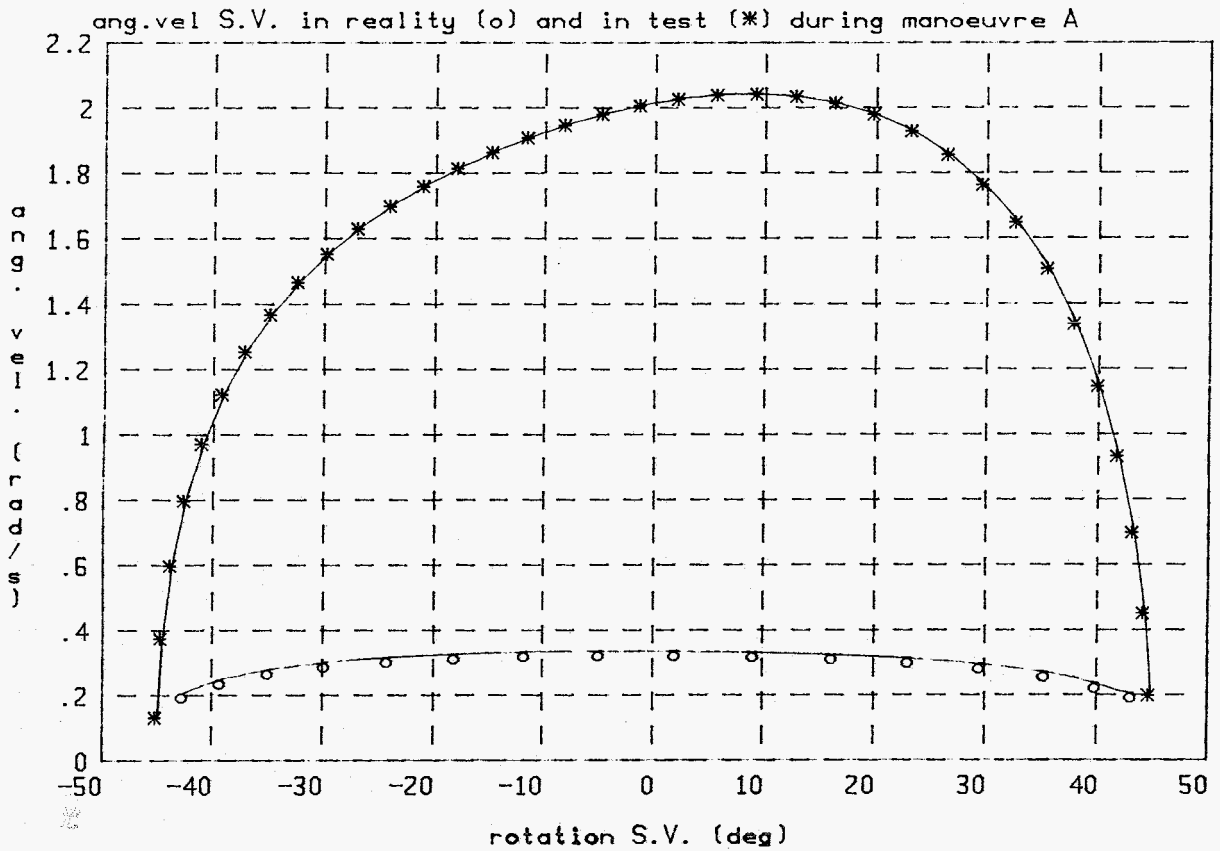


Figure 4.4.1 : Comparison the angular velocities and rotations during manoeuvre A.

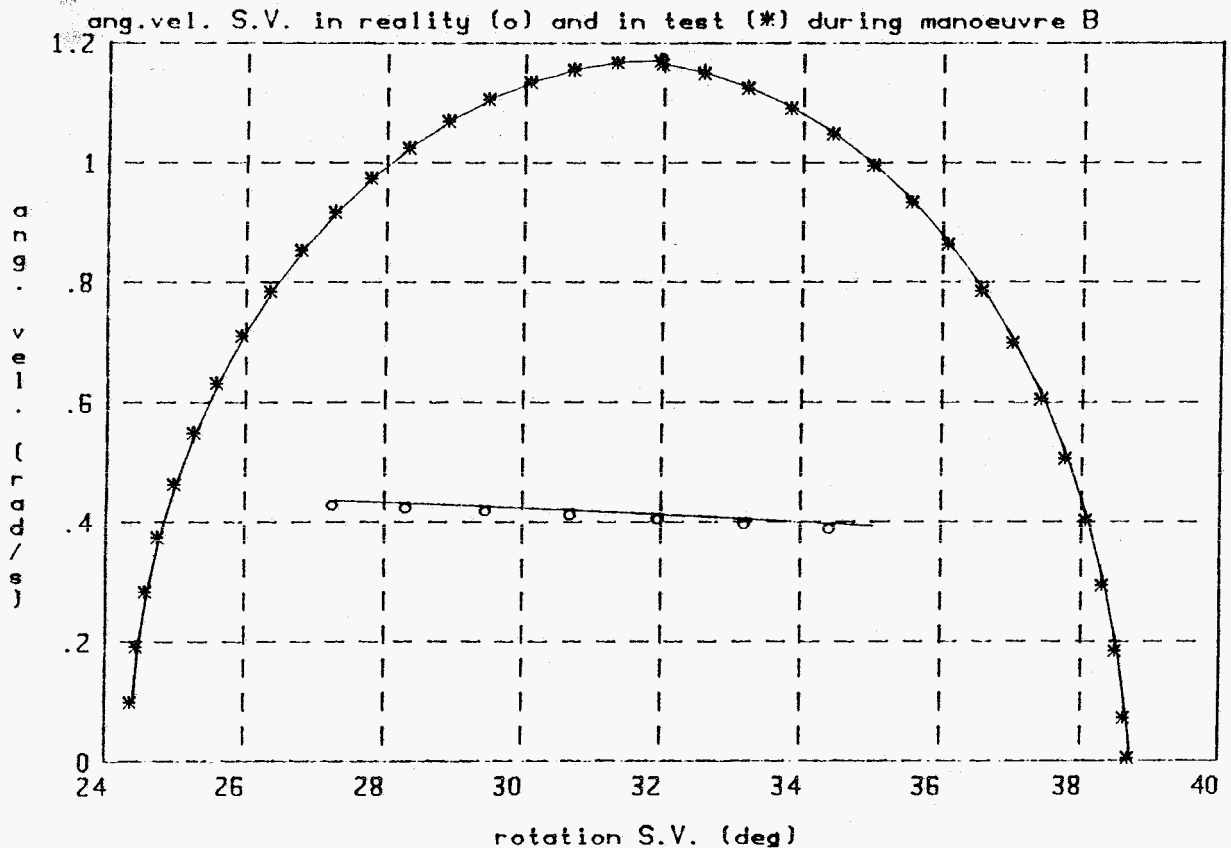


Figure 4.4.2 : Comparison the angular velocities and rotations during manoeuvre B.



The tests will be carried out in blocks with a block representing a part of the Swivel Valve life (10,000 flights). Between the blocks, measurements will be taken and judgements will be made concerning the status of the Swivel Valve.

The total number of cycles during the endurance test, covering 50,000 flights for every valve is shown in table 4.4.2.

rotation(deg)/pressure(Mpa)	20.6	14.1	total
-44.93 -> 44.90 (A)	100	99,900	100,000
24.38 -> 38.73 (B)	750	749,250	750,000
total	850	849,150	850,000

Table 4.4.2 : Number of cycles for the endurance test of a Swivel Valve configuration with different pressures and rotation angles.

The total number of cycles will be divided into 5 equal sized blocks (10,000 flights). The total number of cycles one Swivel Valve configuration has to make during one block is shown in table 4.4.3.

number of cycles per block			
rotation(deg)/pressure(Mpa)	20.6	14.1	total
-44.93 -> 44.99 (A)	20	19,980	20,000
24.38 -> 38.73 (B)	150	149,850	150,000
total	170	169,830	170,000

Table 4.4.3 : Number of cycles for a Swivel Valve configuration during one block with different pressures and different rotation angles.

Knowing the angular velocity of the driving disc 0.58 rotations per second for the range of -44.93° -> 44.99° and 1.5 rotations per second for the range 24.38° -> 38.73° (enclosure III), the time scheduling can be calculated and is shown in table 4.4.4.

time in hours :			
rotation(deg)/pressure(Mpa)	20.6	14.1	total
-44.93 -> 44.99	0.06	55.5	55.56
24.38 -> 38.73	0.14	138.75	138.89
total	0.20	194.25	194.45

Table 4.4.4 : Time table for the test using different pressures and rotation angles.

**4.5 Measurements**

Measurements that will be taken of all configurations before testing :

- Torque between house and core
- Leakage (acceptance test)
- Draw sample of the fluid
- Roundness           ⌋
- Diameter            + profile measurement
- Cylindriness       ⌋
- Dimensional control

Measurements between the blocks and after the test :

- Torque between house and core
- Leakage (acceptance test)
- Draw sample of the fluid
- Roundness           ⌋
- Diameter            + profile measurement
- Cylindriness       ⌋

Measurements after the test :

- Drop test (type 3 or 4)
- Dimensional Control

Measurements after failing the test :

- Draw sample of the fluid
- Roundness           ┌
- Diameter           ├— profile measurement
- Cylindriness       └
- REM-analysis

Discussing the measurements :

- **Dimensional Control** : This is a measurement of a few dimensions of core and house (see figure V.1,V.2 and V.3).
  
- **Profile Measurement** :  
A profile measurement of the house consists of 2 straightness measurements between port A and B on both sides, 2 roundness measurements with one between the ports and the seal groove and one on the other side of the ports and one cylindricity measurement on the inside of the house. The profile measurement of the core consist of 4 straightness measurements between the 4 pockets, 2 roundness measurements with one between the seal groove and the pockets and one on the other side of the pockets.
  
- **Surface Observation** :  
On an unfold the inside of the house and the outside of the core surfaces are drawn.
  
- **Draw Sample of the Fluid** :  
A sample of the fluid is taken at the non-pressure side of the house to let it analyse by a laboratory. Chipped particles coming from the inside of the Swivel valve can be spotted.
  
- **Torque Measurement**  
The maximum torque between house and core is measured.
  
- **Leakage Test:**  
The internal leakage of the Swivel Valve will be measured for a number of different relative angles between core and house mounted. A Pressure of 206 bars is put on one port and leakage during one minute is measured at another port (see enclosure V) .
  
- **Drop Test** :  
The pressure drop through the valve is measured for Swivel Valve configurations type 3 or 4 is measured, because they are changed geometric (see V.3.11).

The measurements are numbered counting from 0 to 5. Measurement 0 represents the measurements done before the endurance test starts and measurement number 5 represents the measurements done after the endurance test. Measurement numbers 1,2,3 and 4 are measurements between the blocks.

**NOTE :** Because performing the leakage test and a profile measurement at the same day would take too much time, these measurements are split. Leakage will be measured during measurement 0,1,3 and 5 and profile will be measured during measurement 0,2,4 and 5.

**5 TEST FRAME**

To achieve the Swivel Valve to do a reciprocating rotation the following mechanism was used as shown in figure 5.1.

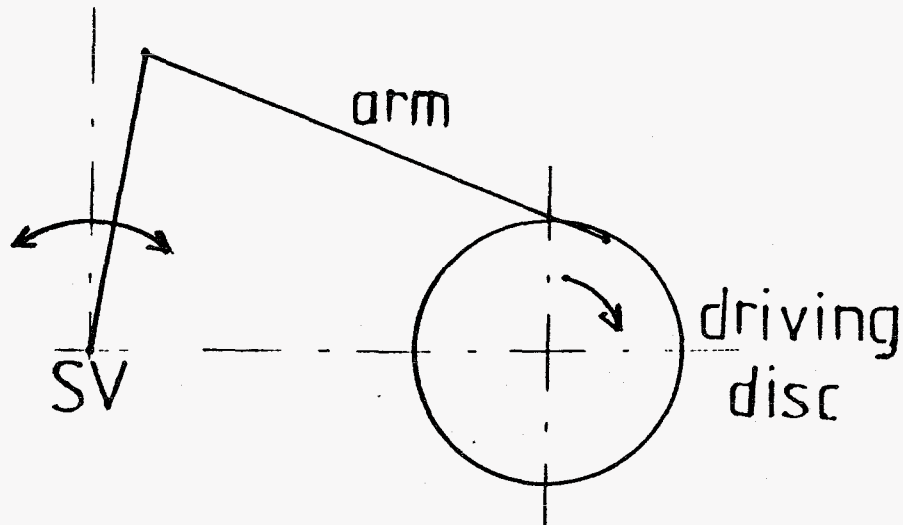


Figure 5.1 : Mechanism to achieve a reciprocating rotation of one Swivel Valve.

The driving disc rotates with a constant angular velocity in one direction and so the Swivel Valve rotates around and back because of its longer arm.

To save time 4 Swivel Valves are tested at the same time under the same circumstances. The driving motion is provided by an electric motor (see enclosure III for the electric motor calculation). To use the power of the electric motor optimal the Swivel Valves are positioned in a square and the driving disc is located in the middle (see drawing SP10263 enclosure II).

The 2 different rotation ranges of the Swivel Valve during testing will be achieved by using 2 arms with different length and 2 and plugging in on 2 different diameters of the driving disc. The 2 different angular velocities will be achieved by using 2 pairs of pulleys and 1 drive belt. (for angular velocity graph and rotation graphs see enclosure IV).

**6 RESULTS**

See also enclosure V for test results (axis definitions in figures V.4 and V.5, port and angle definitions in figure V.6)

**Dimensional control :**

- The diameter clearances between core and house of all 4 types don't satisfy their drawing demands (8-12um diameter clearance) before and also after testing (see figure 6.1).
- The diameter clearance for type 4 is the highest (at the end of the test 41um and at the beginning not measured, but probably also not according to drawing demands).
- The diameter clearance growth between type 1 and 2 is exactly the same (17-14=3um growth) and is larger than for type 3 (19-18=1um).

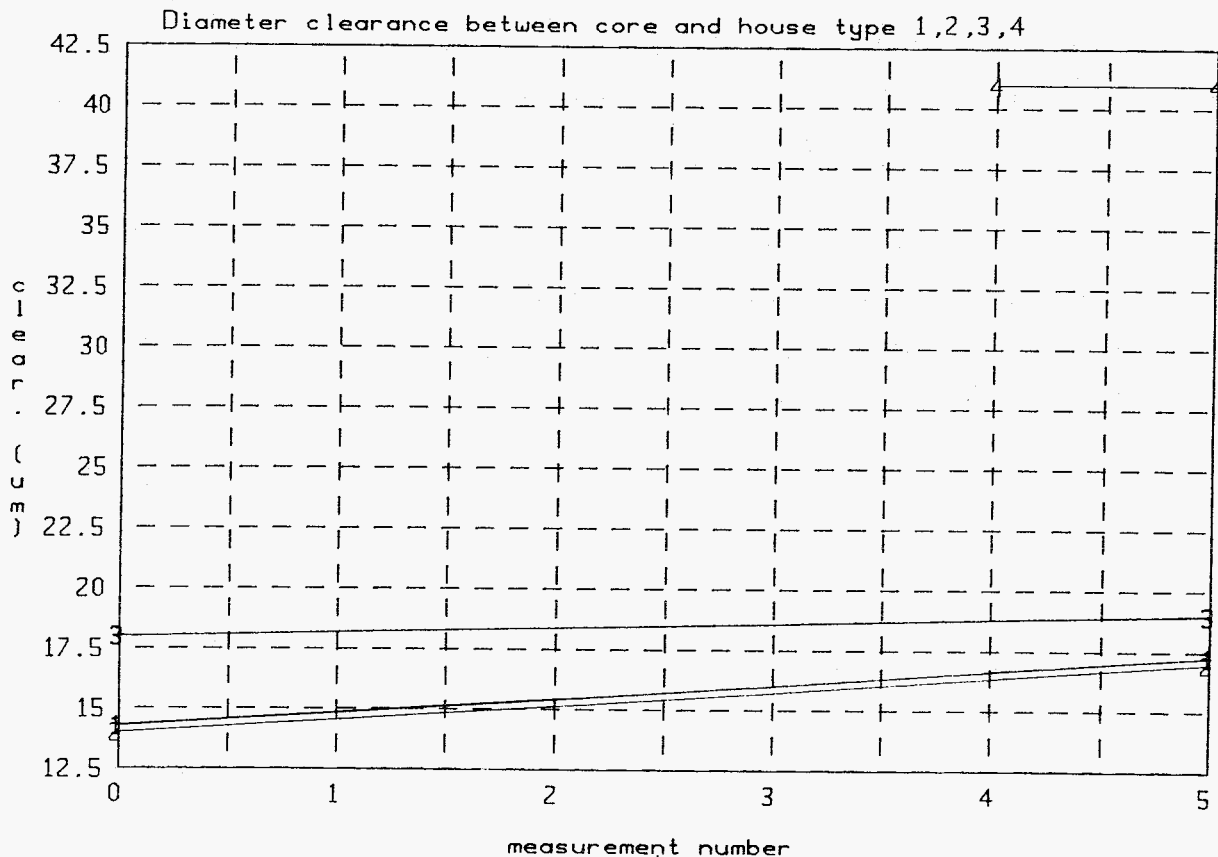


Figure 6.1 : Diameter clearance between core and house of type 1,2,3 and 4 during the test.

**profile measurement :**

- The cylindricities of all houses (figure 6.2) are are not according to drawing demands (0.002mm).
- At the end of the test, the cylindricity values are larger than at the beginning.
- The cylindricities for type 1 and 2 show a simular behavior: growth between 0 and 2, drop between 2 and 4 and enormous growth between measurement 4 and 5.
- Type 4 shows a sligth cylindricity drop between measurement 4 and 5.
- The cylindricity growth for type 3 and 4 between measurement 2 and 5 (type 3 : 0.0037mm and type 4 : 0.0045mm) is less than for type 1 and 2 (type 1 : 0.0090mm and type 2 : 0.0115).

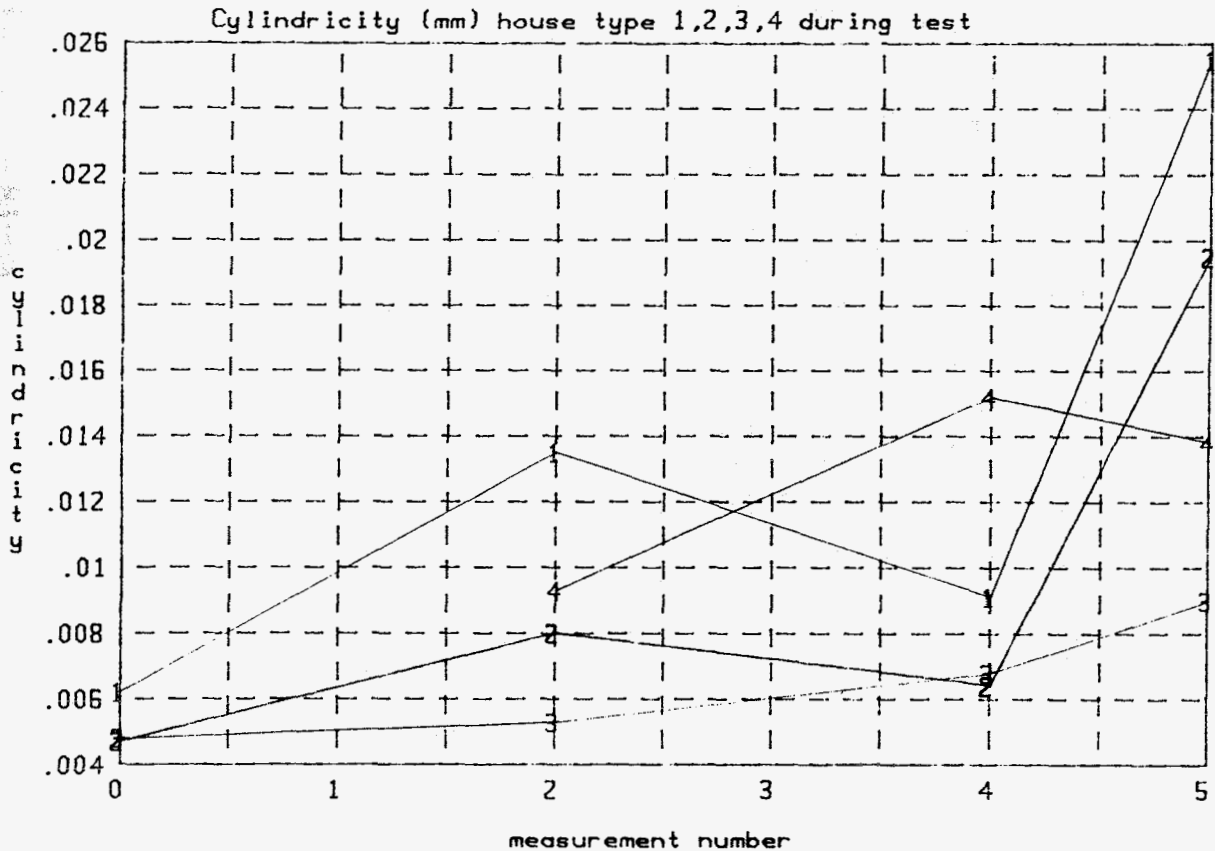


Figure 6.2 : Inside house cylindricity curve of type 1,2,3 and 4.



Figure 6.3 shows house roundness curves ( $z=-17.00\text{mm}$ ) for all 4 types.

- The roundness of type 2 and 3 are in the beginning according to drawing demands (0.0050mm) and of type 1 nearly (0.0051mm).
- The curves of type 1 and 2 show a similar behavior : growth between 0 and 2, drop between 2 and 4 and growth between measurement 4 and 5.
- The curve of type 4 shows a remarkable drop between begin and end.

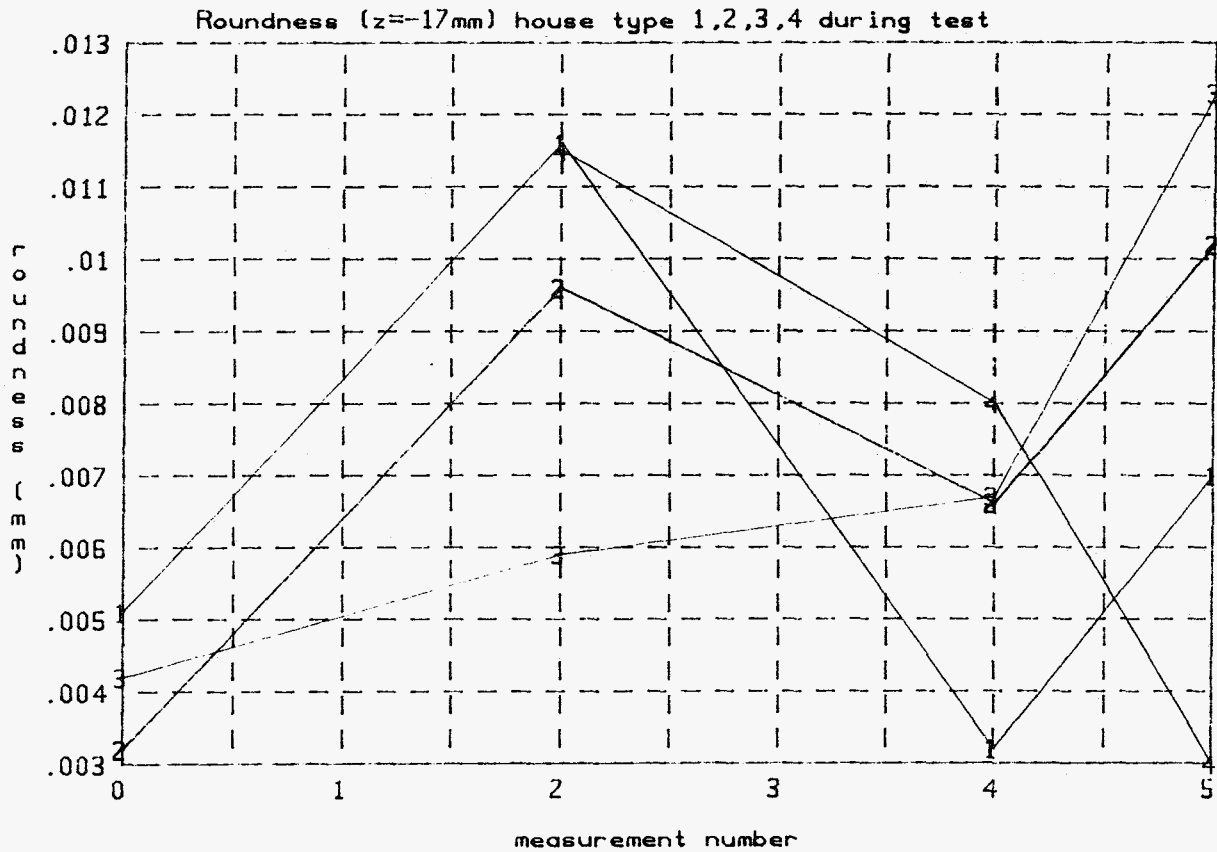


Figure 6.3 : House roundness ( $z=-17.00\text{mm}$ ) of all 4 types.

The inside roundness ( $z=-32.00\text{mm}$ ) curves for all 4 types are shown in figure 6.4.

- Type 1 and 2 are at the beginning according to drawing demands.
- The curves of type 1 and 2 show a similar behavior : growth between 0 and 2, drop between 2 and 4 and growth between measurement 4 and 5.
- The curve of type 3 is rather stable.

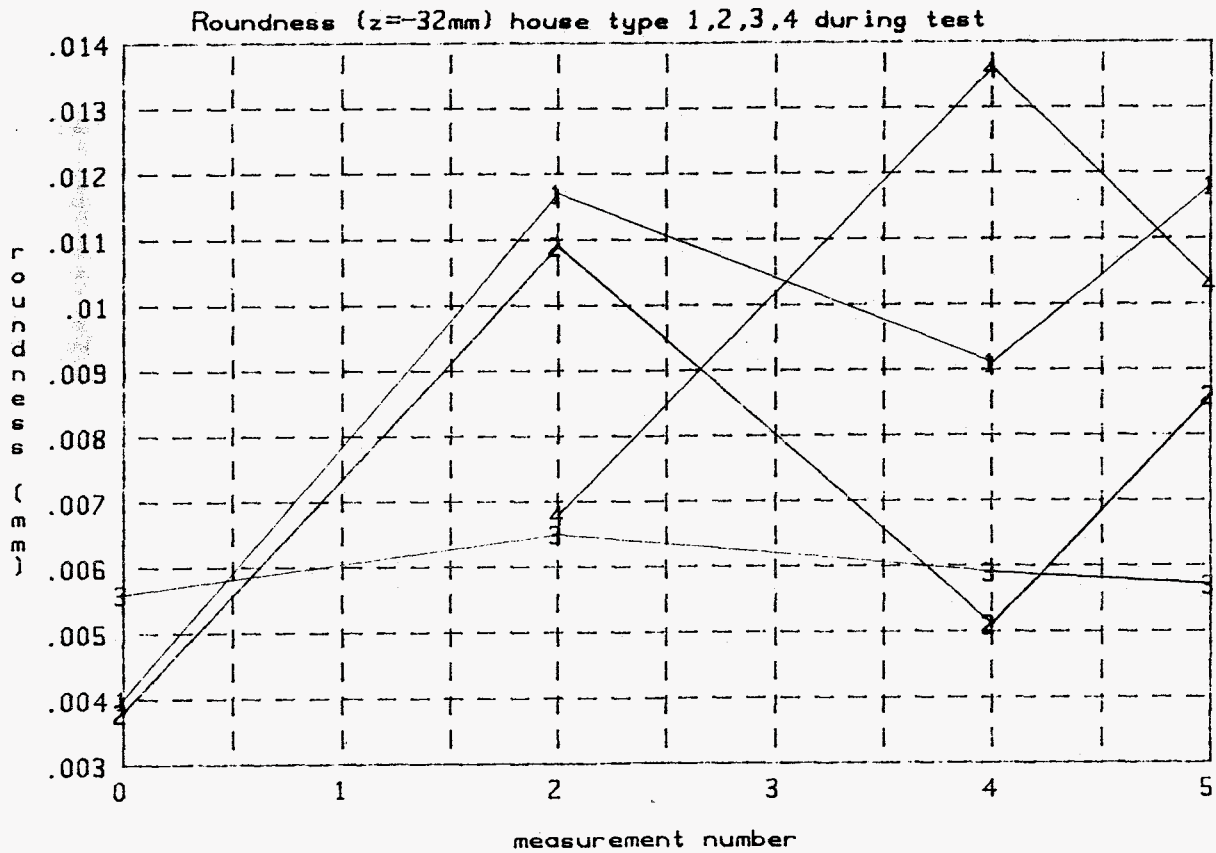


Figure 6.4 : House roundness ( $z=-32.00\text{mm}$ ) curves of type 1,2,3 and 4.

The core cylindricity curves of all 4 type are shown in figure 6.5.

- None of the cylindricities are according to drawing demands (0.005mm).
- The cylindricity of core type 4 is the highest.
- The cylindricity curve for type 4 shows an enormous growth between measurement 0 and 2 followed by an enormous drop between measurement 2 and 4.
- The cylindricity curves for core type 1 and 2 show a similar behavior : between 2 and 4 drop and between measurement 4 and 5 growth.
- The cylindricity curves for core type 3 and 4 also show a similar behavior : between 0 and 2 growth, between 2 and 4 drop and between measurement 4 and 5 sligth drop.
- The cylindricity growth between begin and end is not much and for type 3 even a sligth drop (-0.001mm).

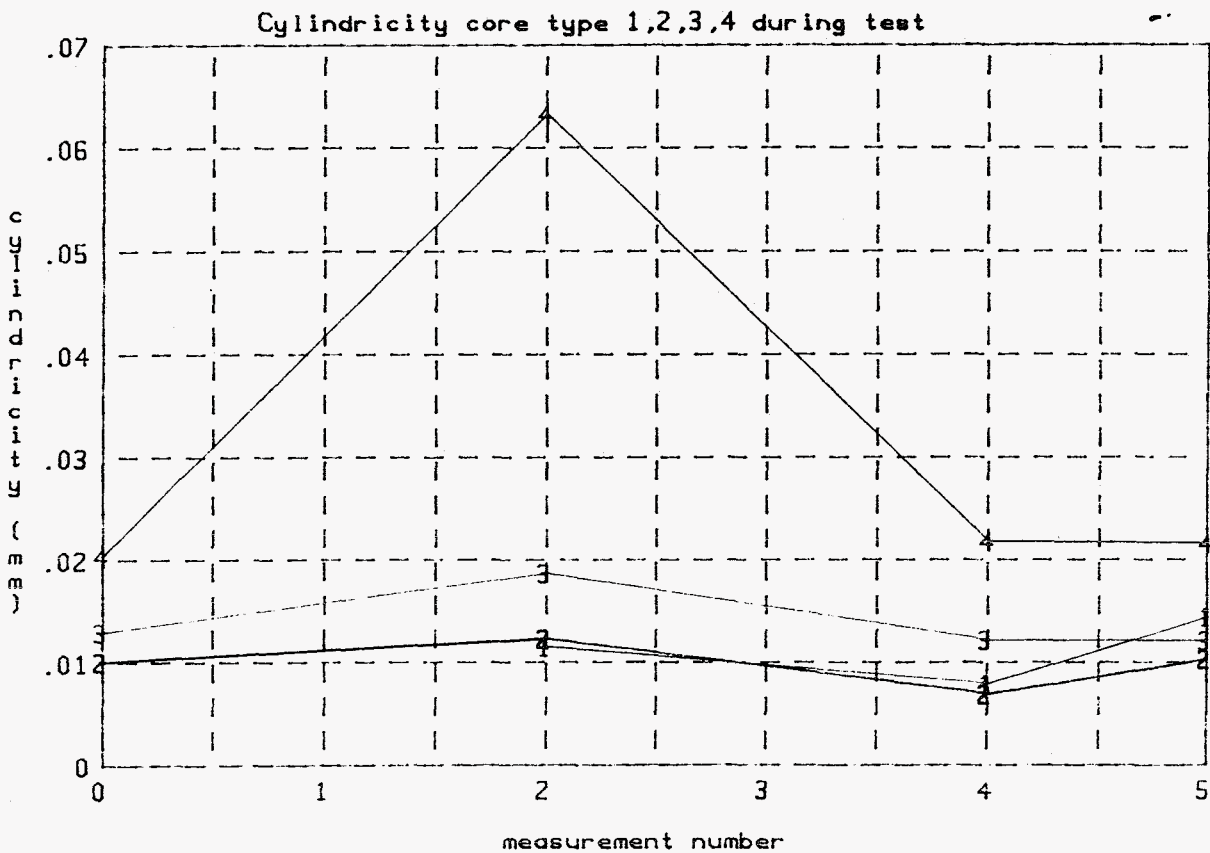


Figure 6.5 : Core cylindricity curves of type 1,2,3 and 4.

Figure 6.6 shows core roundness ( $z=-10.00\text{mm}$ ) curves of type 1,2,3 and 4.

- Only type 2 is according to drawing demands ( $0.005\text{mm}$ ) at the beginning of the test.
- Type 4 has the highest roundness.
- The last measured value is for all types equal or a little bit less than the first measured.
- The variation is the highest for type 2.

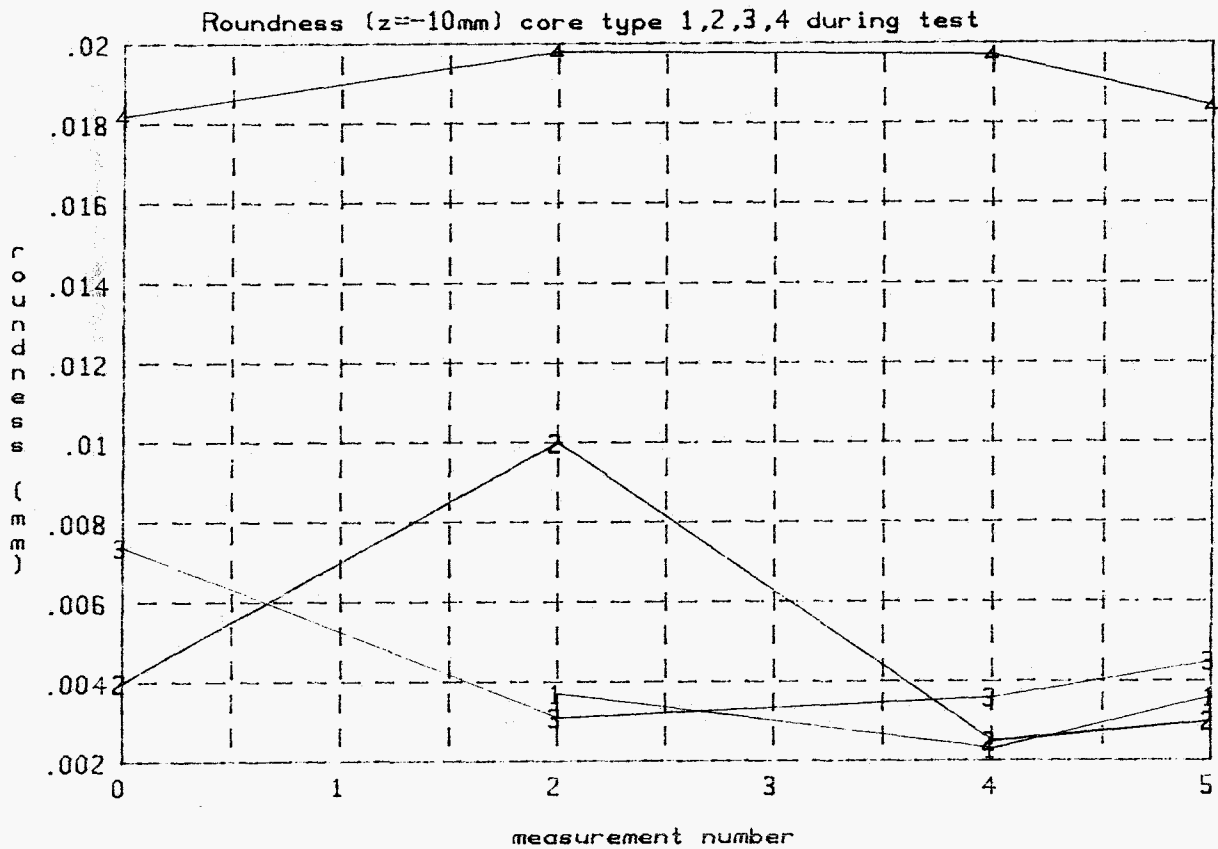


Figure 6.6 :Core roundness ( $z=-10.00\text{mm}$ ) curves of type 1,2,3 and 4.

Figure 6.7 shows core roundness ( $z=-34.00\text{mm}$ ) curves of type 1,2,3 and 4.

- Only type 2 is according to drawing demands ( $0.005\text{mm}$ ).
- Type 4 shows the highest roundness and is continuously dropping during the test.
- The curves of type 2 and 3 are rather stable.

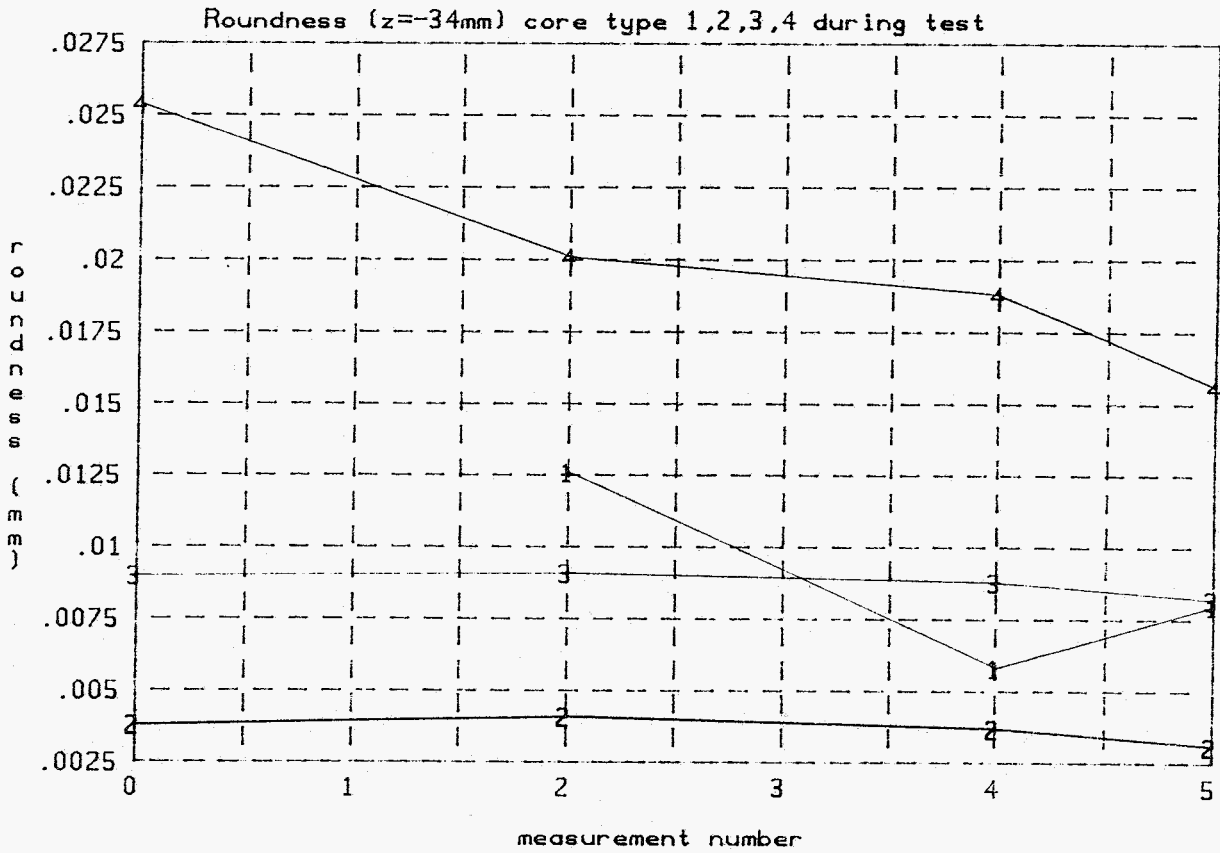


Figure 6.7 : Core roundness ( $z=-34.00\text{mm}$ ) curves of type 1,2,3 and 4.

**Surface observation :**

- Before the test starts core type 1,2 and 3 shows a few little chipped chrome particles at the pocket metering edges.
- During the test nearly no chrome particles have been chipped from the pocket edges of type 1,2 and 3.
- Type 1,2 and 3 show marks of seal grooves in house and core.
- House of type 4 shows mark of seal groove.
- Core of type 4 shows less damage at the surface of all 4 types.
- House of type 4 shows a few, but rather deep statches in vertical direction.
- All 4 houses show a black mark within the seal groove mark.

**Leakage test :**

Figures 6.8,6.9,1.10,6.11 and 6.12 shows the internal leakage of type 1,2,3 and 4.

- Type 4 shows the highest leakage.
- If the leakage is high, then the leakage mostly increases. If the leakage is not high sometimes the leakage decreases.

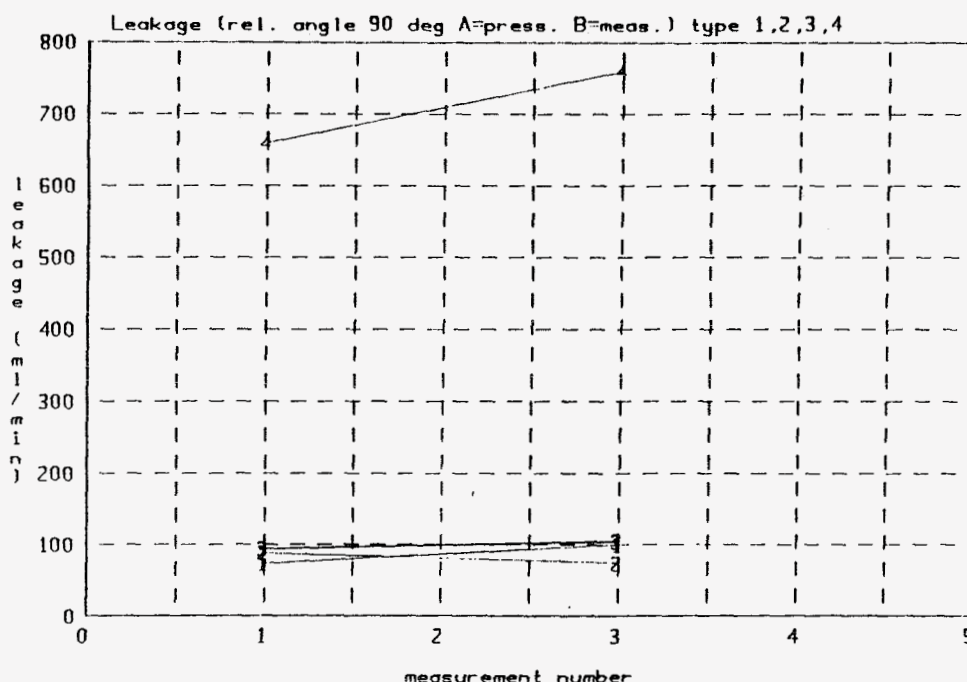


Figure 6.8 : Leakage test (rel. angle 90°, A=pressure and B=measure port).

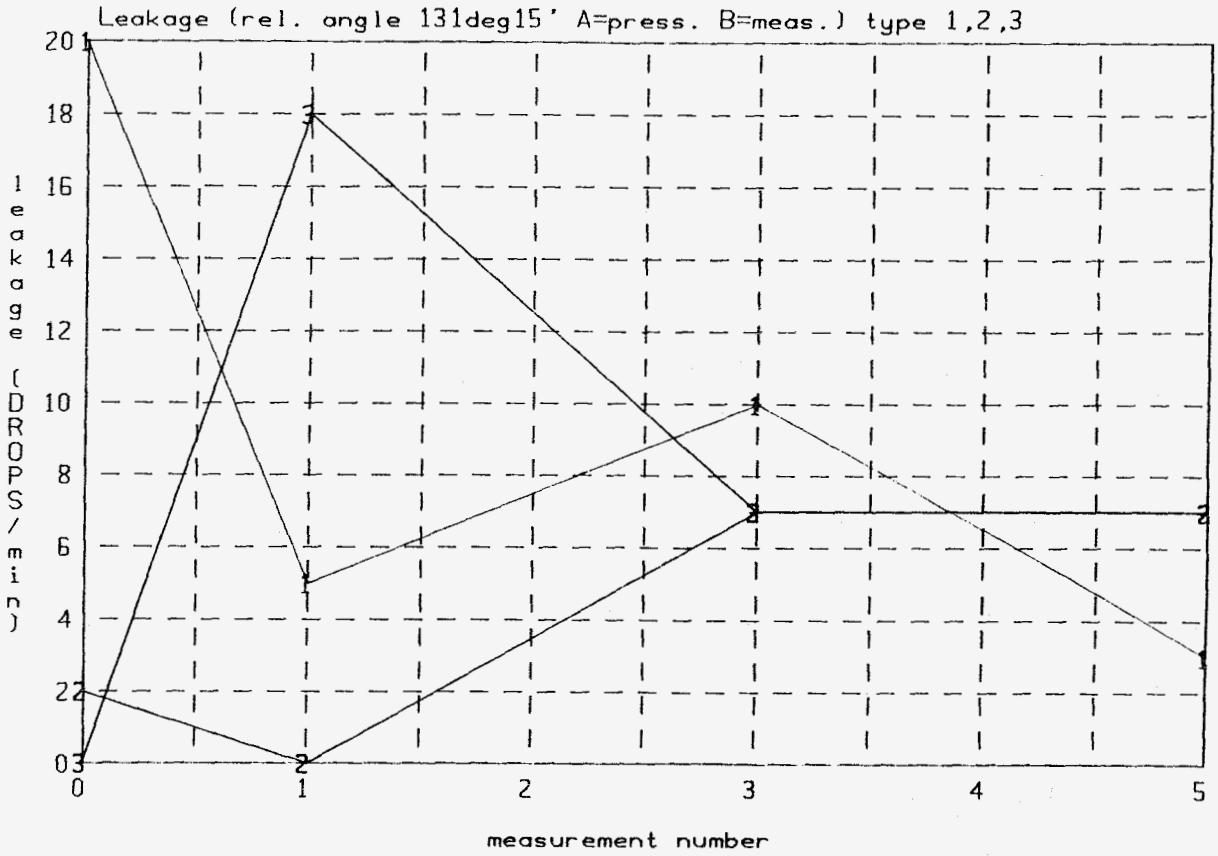


Figure 6.9 : Leakage test of type 1,2 and 3 (rel. angle 131°15' and A=pressure and B=measure port).

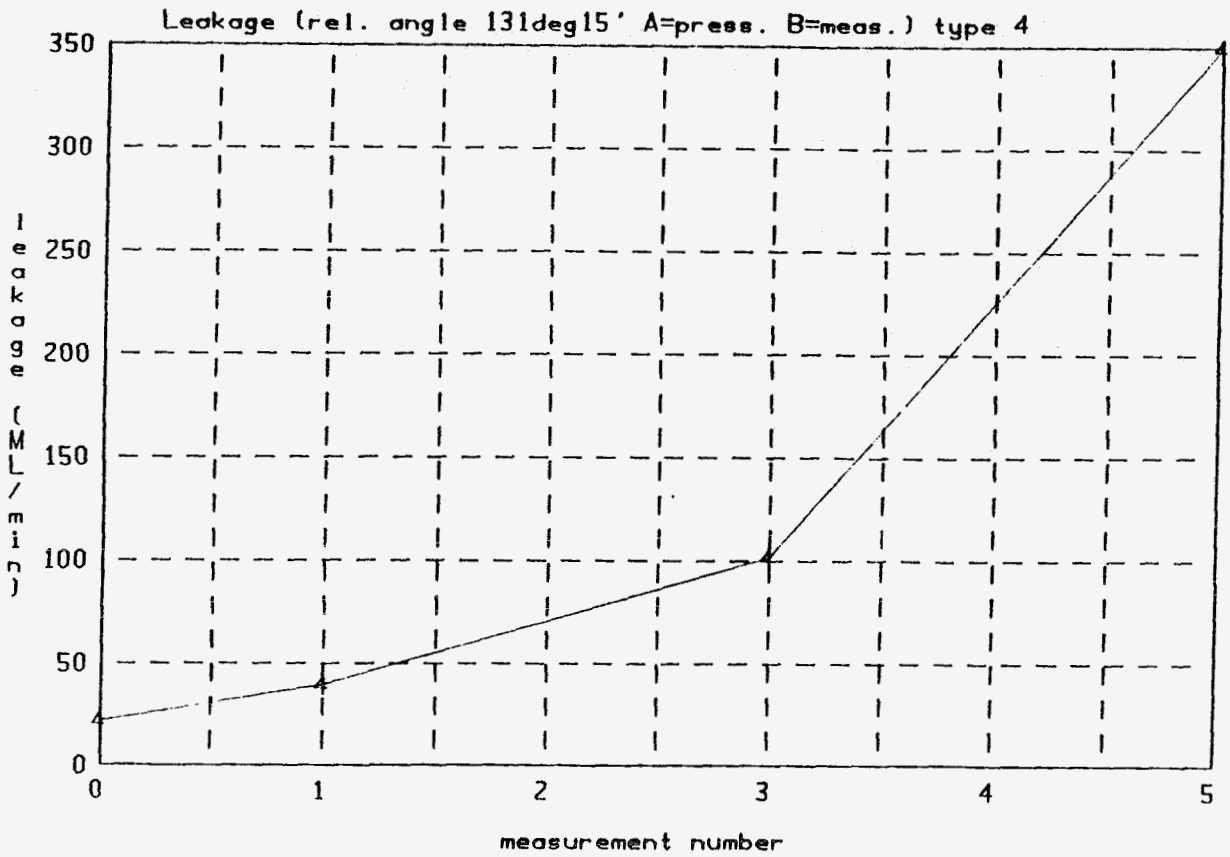


Figure 6.10 : Leakage test of type 4 (rel angle 131°15', A=pressure port and B=measure port).

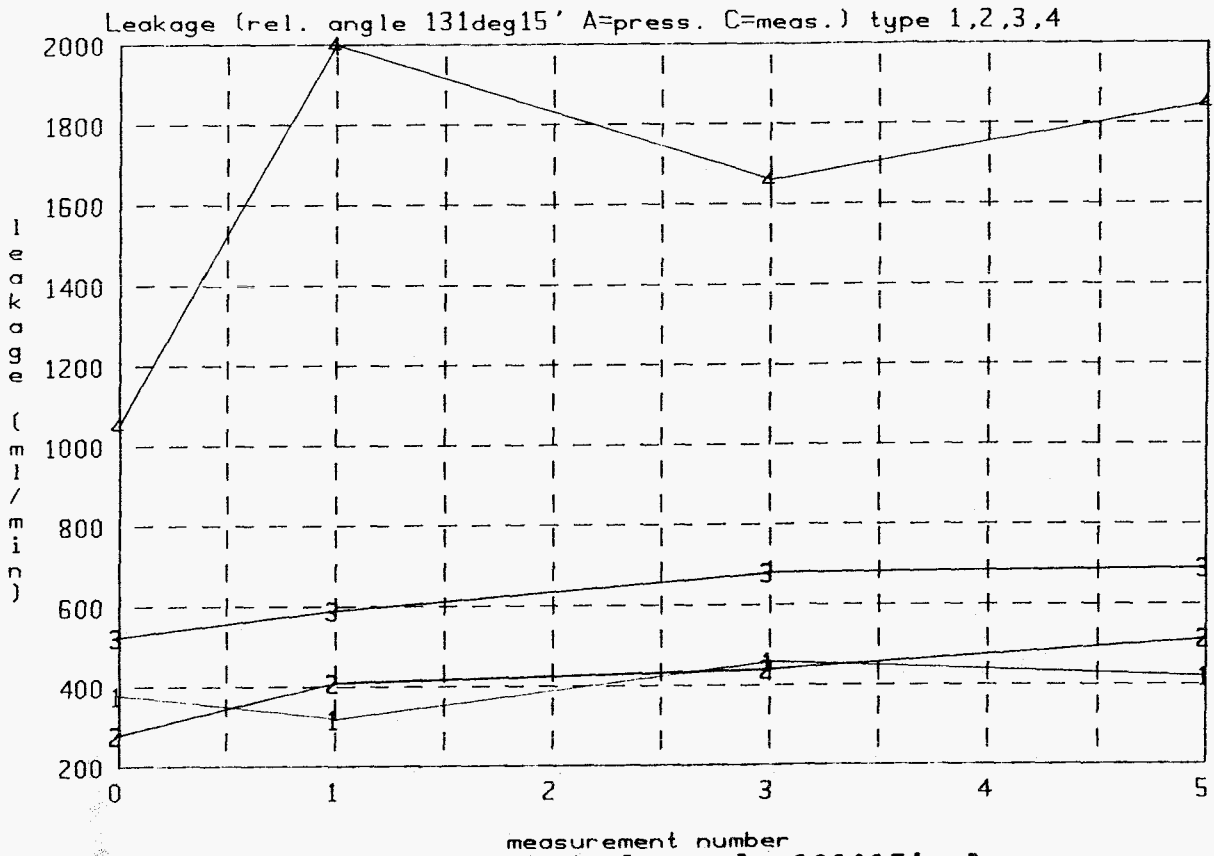


Figure 6.11 : Leakage test (rel. angle 131°15', A=pressure

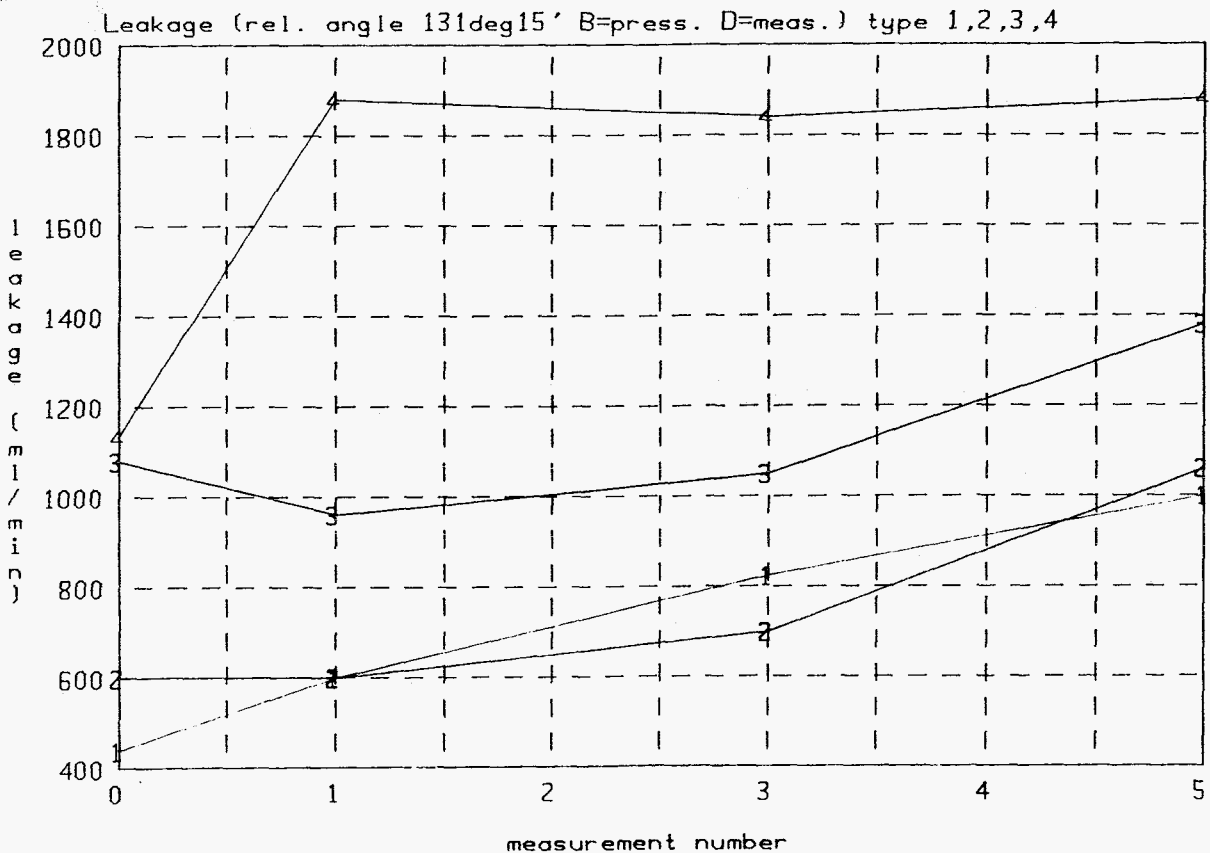


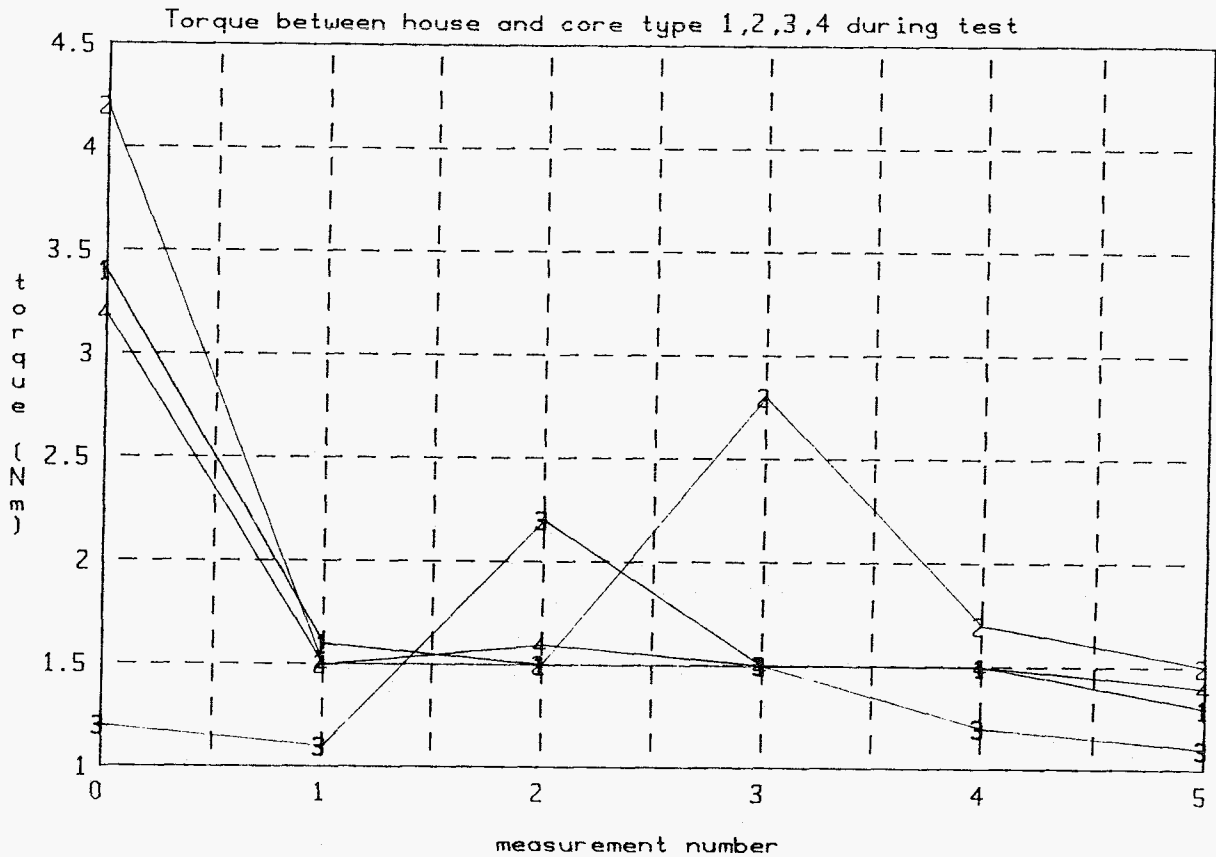
Figure 6.12 : Leakage test (rel. angle 131°15', B=pressure and D=measure port).



**Torque measurement :**

Figure 6.13 shows torque curves of type 1,2,3 and 4.

- The torque at the beginning is higher than at the end.
- Type 1,2 and 4 show a high torque at the beginning comparing to the end.



**Figure 6.13 : Torque between house and core.**

**Observations during blocks :**

The temperature curves for all types and the room temperature are plotted in figure 6.14.

- The temperature of type 4 is a few degrees higher than the rest.
- All types show leakage during the blocks.
- Particles of seal and backup ring (if used) appear at the outside.

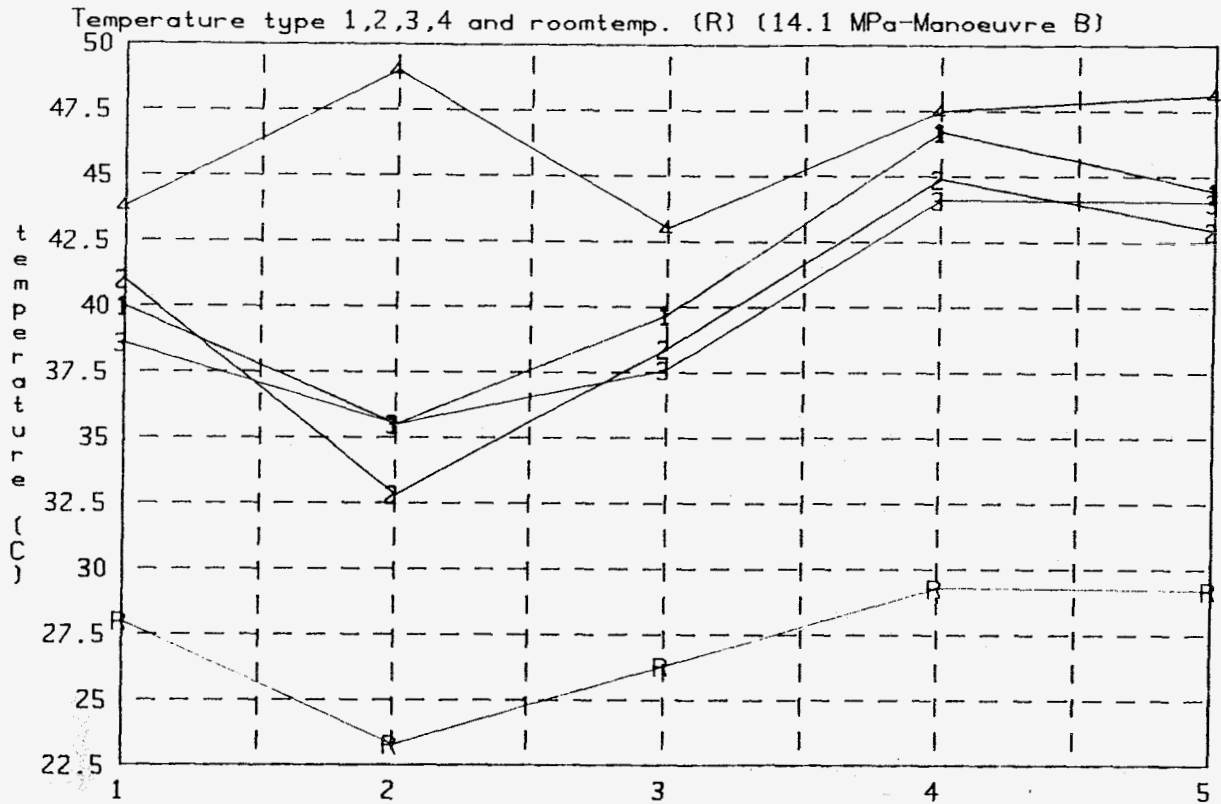


Figure 6.14 : Temperature curves.

**Pressure drop :**

Because type 3 is better according to drawing demands than type 3, a pressure drop test is done only to type 3.

The pressure drop Pd has to be  $Pd \leq 2.5$  bars.

- All measured pressure drops satisfy this demand (see table 6.1).

Rel.angle	DAF	press.-ret.	plugged	pressure drop(bars)
252°33'	162°33'	A-C	B-D	1.103
252°33'	162°33'	B-D	A-C	0.828
178°45'	88°45'	B-C	A-D	0.965
178°45'	88°45'	A-D	B-C	0.828

Table 6.1 : Pressure drop to Swivel Valve type 3.

7 CONCLUSIONS

- The basic Swivel Valve configuration type 1 satisfies regarding wear.
- The other configurations also satisfy regarding wear especially the ionic nitrided configuration.
- The geometric changes concerning pockets are acceptable (pressure drop  $\leq 2.5$  bars).
- All 4 configurations show leakage (the ionic nitrided configuration the most).
- The seals used don't satisfy.

**8 RECOMMENDATIONS**

- The supply of basic Swivel Valve configurations can continue.
- The inspection of the Swivel Valves has to be improved.
- The seal problem has to be solved.
- The ionic nitride treatment has to be investigated further.

REFERENCE LIST (person)

NAME	ACTIVITY	DEPARTMENT
Beijk, D.J.H	:chrome plating cores	:Serv.Treatm.Oper.
Cuypers, J.B.A.	:Furniture, test room	:Werkv.Niet Versp SP
Didden, C.J.	:Prod. test frame	:Ger. Beh.&Onderh.
Dielissen, C.H.	:S.V. production	:Leid.Ger.Makerij
Haans, P	:Electrical part	:Onderhoud SP
Hendriks,R.H.A.	:Incoming products	:Mat.Beh.&Ont.kontr.
Honig, J.J.	:S.V. conf. selection	:CL Chemie&Corrosie
Huberts, P.T.J.M.	:Hydraulic unit	:Manuf. Technology
Jannis, L.M.	:S.V. conf. selection	:Manuf. Technology
Kirkels, G.M.C.	:S.V. production	:Werkvoorbereiding
Kruijff, R. de	:Ion nitriding treatm.	:CL Warmtebeh.&Verm.
Martens, J.H.M.	:S.V. conf. selection	:CL Metaalkunde
Mierlo van	:Ion ntriding treatm.	:Mamesta
Nelissen, J.W.A.	:S.V. conf. selection	:Serv. Treatm. Oper.
Slippens, R.H.	:Purchasing	:Inkoop SP
Valentijn, G.N.	:Prod. test frame	:Onderhoud SP
Verboven, P.A.W.J:	Prod. test frame	:Onderhoud SP
Verhoeven, H.T.J.:	Measurement S.V.	:Fabricage Aerospace
Zalm, J. van de	:Different activities	:Werkv.Niet versp.SP
Zon, A.J.C. van	:F-16 assemblage room	:Planning Versp. SP

I SWIVEL VALVE OPERATION

The Swivel Valve takes care of a fluid reversal within the actuator. This reversal is important for the rotation of the nose landing gear, when one of the actuators passes through its dead point position (figure I.1 position 2). If the nose landing gear rotates from position 1 to 2, the actuator has to pull and when it rotates from 2 to 3 the actuator has to push. So when the nose landing gear makes a rotation movement in one direction through the dead point of the actuator, the movement of the actuator has to reverse.

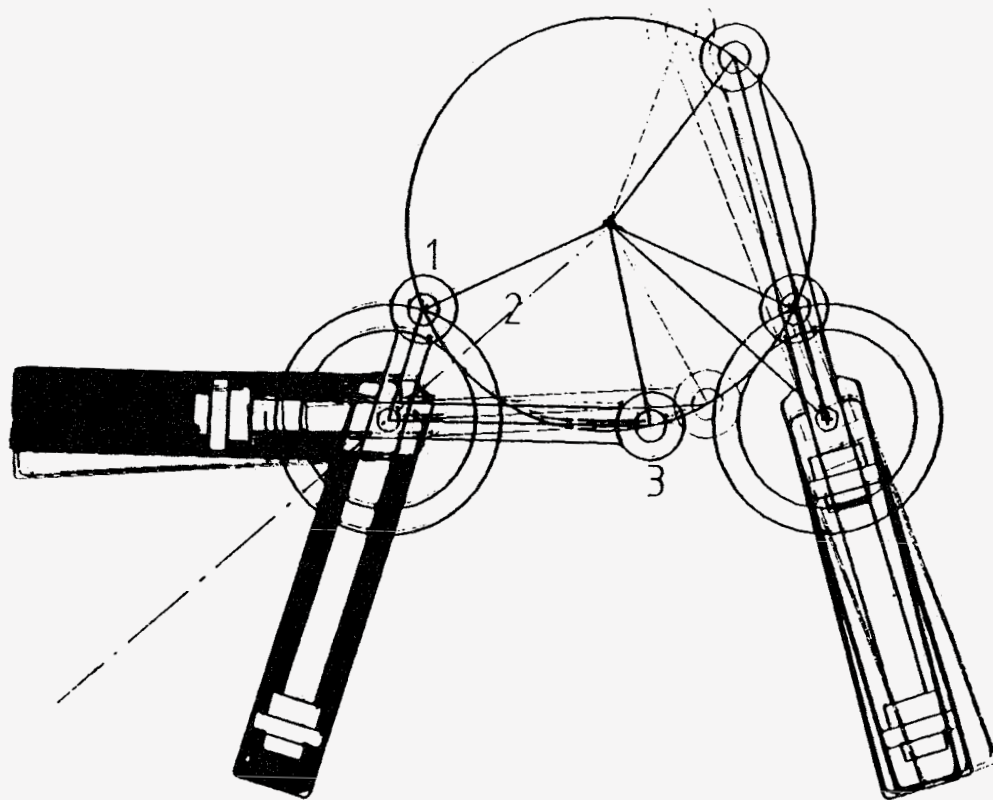


Figure I.1 : Actuator motion in combination with the nose landing gear.

The Swivel Valve takes care of the pressure supply to the actuator, reversing the direction of the actuator movement, so the nose landing gear can proceed rotating in one direction.

The house is mounted on the nose landing gear and stands still. The core is mounted on the actuator and rotates in the house. Depending on the position of the actuator relative to the gear the flow is reversed.

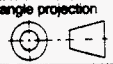
II DRAWINGS

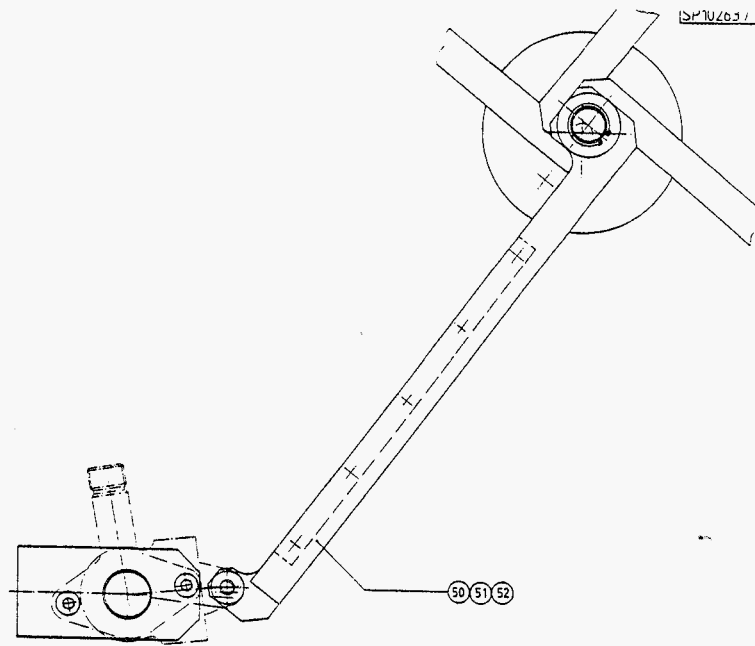
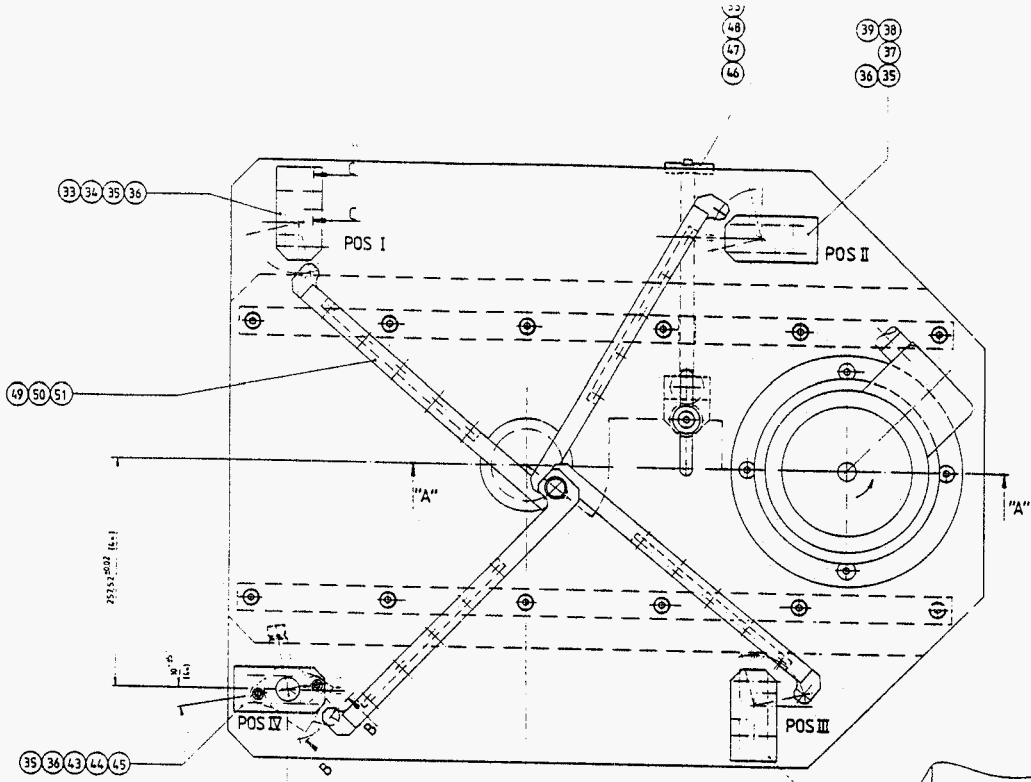
Drawing List	
no.	title
SP10263	: Assembly Testing Tool (Swivel Valve)
SP10264	: Base Plate
SP10265	: Positioning Block (Swivel Valve)
SP10266	: Positioning Arm
SP10267	: Plate
SP10268	: Bracket
SP10269	: Bracket, Motor
SP10270	: Shaft, Tension Pulley
SP10271	: Consolidation Strap
SP10272	: Plate
SP10275	: Shaft
SP10276	: Rotor
SP10277	: Rotor Pin
SP10278	: Positioning Pin
SP10279	: Bush, Tension Pulley
SP10280	: Block, Tension Pulley
SP10281	: Strap, Tension Pulley
SP10283	: Pin Tension Pulley
SP10284	: Pin
SP10285	: Snaarschijf
SP10287	: Coupling, Flexible
SP10288	: Core Experimental type 1
SP10289	: Core Experimental type 2
SP10290	: Core Experimental type 3
SP10291	: Core Experimental type 4
SP10292	: Base Plate Torque Tool
SP10293	: Positioning Strap
SP10294	: Torque Tool Assembly
SP10295	: Positioning Ring for Ionic Nitriding S.V.
SP10296	: Positioning Plate for Ionic Nitriding S.V.
SP10297	: Frame Testing Tool Swivel Valve Messier



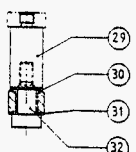
40	SP10273	1	zie SP10272	50x25x100	PLATE	
39		2	8.8	M8x40	CIL.KOPSCHR.m.b.z.	
38	DIN7979	2	ST.	ø8m6x50	PASPEN	
37	A3 SP 10272	1	AlMgSi1	50x12,5x100	PLATE	
36		8	8.8	M8x16	CIL.KOPSCHR.m.b.z.	
35	A2 SP10265	4	AlMgSi1	100x50x100	POSITIONINGBLOCK S.V.	
34		2	8.8	M8x30	CIL.KOPSCHR.m.b.z.	
33	DIN 7979	2	ST.	ø8m6x40	PASPEN	
32	ISO 7379	4	12.9	M8x10f9x16	PASBOUT UNBRAKOJEVEKA	
31	WC 08 DU	4	PTFE	ø10/ø20	THRUST WASHER GLACIER	
30	FMB 1012 DU	4	PTFE	ø10/ø12 12	GLACIER METAL NED. BUSH	
29	A3 SP10278	4	35NCD16 / S99	ø18x41,7	POSITIONING PIN	
28	A 20	1	ST.	ø20 AS	SEEGERRING	
27	WC 18 DU	1	PTFE	ø20/ø36	THRUST WASHER GLACIER	
26	FMB 2011,5 DU	4	PTFE	ø20/ø23 11,5	GLACIER METAL NED. BUSH	
25	A3 SP10277	1	C60/04011	ø30x79,5	ROTOR PIN	
24		1	NiCr st 45H	M5x10	STELSCHROEF DIN916GL	
23	A3 SP 10276	1	C60/04011	ø110x64,4	ROTOR	
22		6	SPIEËN ST.	8x7 L=25	VLAKKE SPIE (NEN 2430)	
21	A3 SP10275	2	C60/04011	ø35x148	SHAFT	
20	WC22 DU	2	PTFE	ø25/ø40 (ø24)	THRUST WASHER GLACIER	
19	SP 10286	2	zie SP10285	DW 180 SPA	SNAARSCHIJF v.d.heijden	
18	A3 SP 10285	2	Al.	DW 112 SPA	SNAARSCHIJF v.d.heijden	
17	SPA 1207	1		L=1207	STEMIN (v.d heijden)V-SNAAR	
16		1	8.8	M12x50	CIL.KOPSCHR.m.b.z.	
15	A3 SP 10280	1	C60/04011	50x25x50	BLOCK,TENSION PULLEY-	
14	A3 SP10281	2	C60/04011	50x10x60	STRAP,TENSION PULLEY-	
13	A3 SP10270	1	C60/04011	ø25h6x66	SHAFT,TENSION PULLEY-	
12	FMB 2521,5DU	6	PTFE	ø25/ø28/21,5	GLACIER METAL NED. BUSH	
11	A3 SP. 10279	1	C60/04011	ø36x47	BUSH,TENSION PULLEY-	
10		5	ST.	ø13	SLUITRING	
9	SKG90S4/RT2/63	1		1:25/56/min	ELEKTRO MOTOR / KOLMER	
8		4	8.8	M12x30	CIL.KOPSCHR.m.b.z.	
7	A3 SP 10287	1	HYFLEX : T. 80	ø90x84	COUPLING FLEXIBEL-	
6	A2 SP 10269	1	AlMgSi 1	ø250x120	BRACKET, MOTOR-	
5	A1 SP 10264	1	Alcoaplaat	650x20x825	PLATE, BASE-	
4		4	8.8	M12x50	LAGE CIL.KOPSCHR.m.b.z.	
3		24	8.8	M10x30	CIL.KOPSCHR.m.b.z.	
2	A2 SP 10268	2	AlMg3	70x30x780	BRACKET	
1	A2 SP 10267	1	Alcoaplaat	400x20x825	PLATE	
Pos.	Bl.	Code / werkst.nr.	aan- tal	Materiaal	Afmetingen	Benaming omschrijving

60					
59					
58					
57					
56					
55					
54		2	NiCr st. 45H	M6x10	STELSCHROEF DIN916 GL
53		1		AS ø16	VEER, DRUK-
52	SP10282	4	zie SP10266	45x12x351	POSITIONING ARM (3°)
51		40	8.8	M6x15	CIL.KOPSCHR.m.b.z.
50	A3 SP 10271	8	C60/04011	ø12x220	CONSOLIDATION STRAP
49	A2 SP 10266	4	C60/04011	45x12x380	POSITIONING ARM (45°)
48		1	8.8	M6x20	CIL.KOPSCHR.m.b.z.
47	A3 SP 10284	1	C60/04011	ø12x55	PIN
46	A3 SP 10283	1	ST37	ø16x210	PIN,TENSION PULLEY-
45		2	8.8	M8x65	CIL.KOPSCHR.m.b.z.
44	DIN 7979	2	ST.	ø8m6x70	PASPEN
43	SP10274	1	zie SP10272	50x37,5x100	PLATE
42		2	8.8	M8x50	CIL.KOPSCHR.m.b.z.
41	DIN 7979	2	ST	ø8m6x60	PASPEN

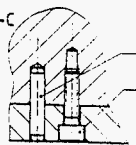
		POS 54 toegevoegd		91-05-24	P.v.B			1
micro	c to s	mac	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	tolerance principle	refer to DAF-std.	title	<b>ASSEMBLY TESTING TOOL SWIVEL VALVE (messier) parts list</b>				
dimensions in mm	checked to standards	date	for drawing interpretation third angle projection					
								
material sign off	date	material	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.	sheet	<b>DAF</b>			
authorised by	date	heat/surface treatment	regulated items	scale	model number			
drawn by	date	paint spec.	product spec.	size	drawing/issue number			
PvBerlo	91-05-24			<b>A3</b>	<b>SP10263/1</b>			
similar to	supersedes		superseded by					



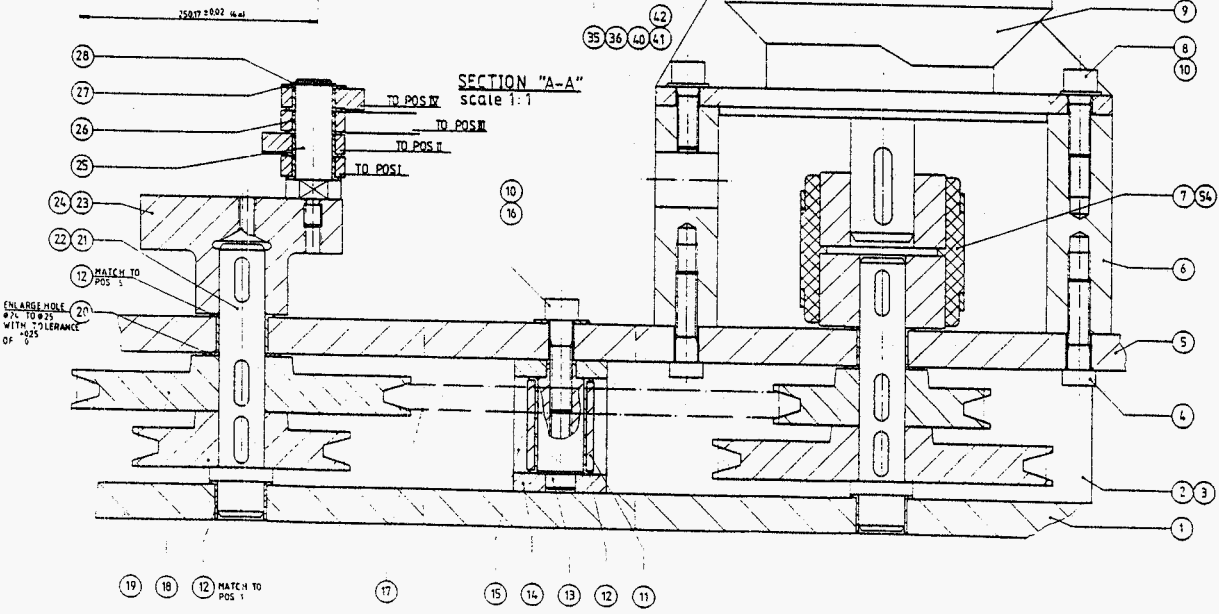
SECTION B-B scale 1:1



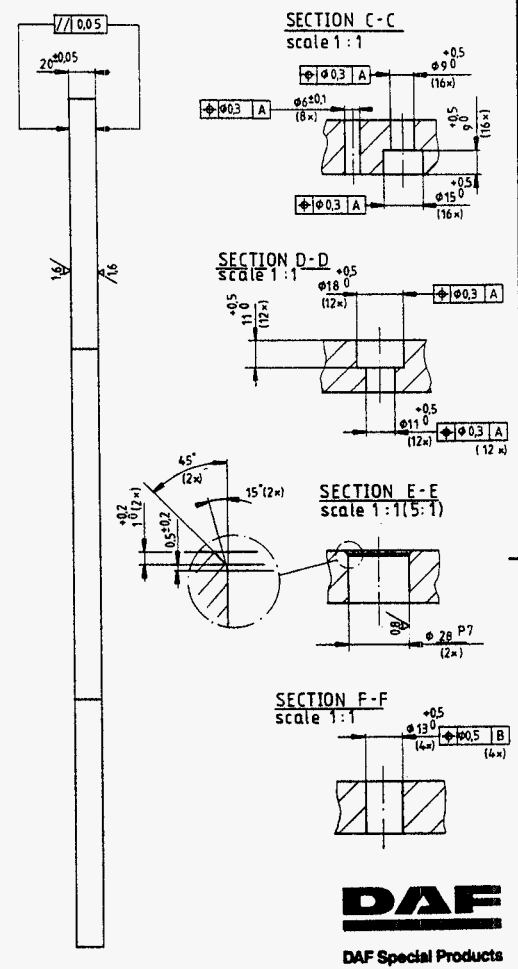
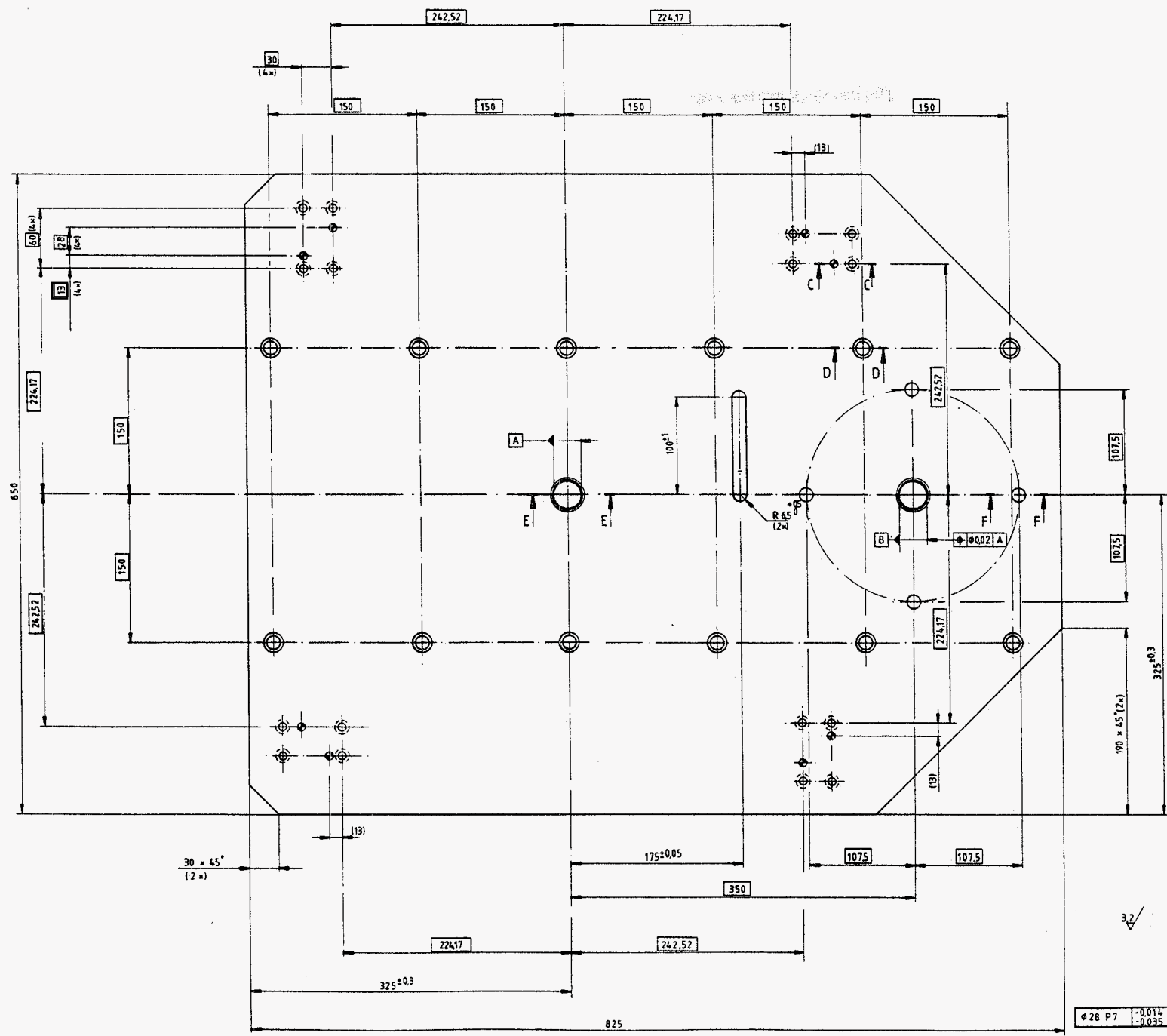
SECTION C-C scale 1:1



TAKE OVER HOLES FROM SP10264 AFTER POSITIONING ACCORDING TO MEASUREMENT ON ASSEMBLY



ASSEMBLY TESTING TOOL		SWIVEL VALVE (messier)	
SP 10263/	101-05-24	AO	SP 10263/

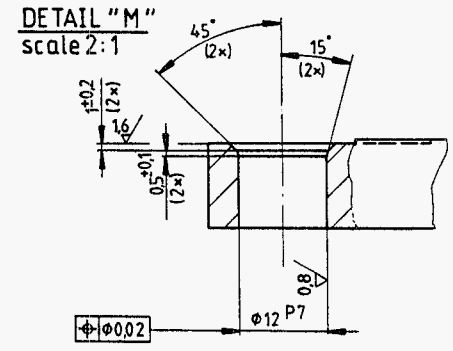
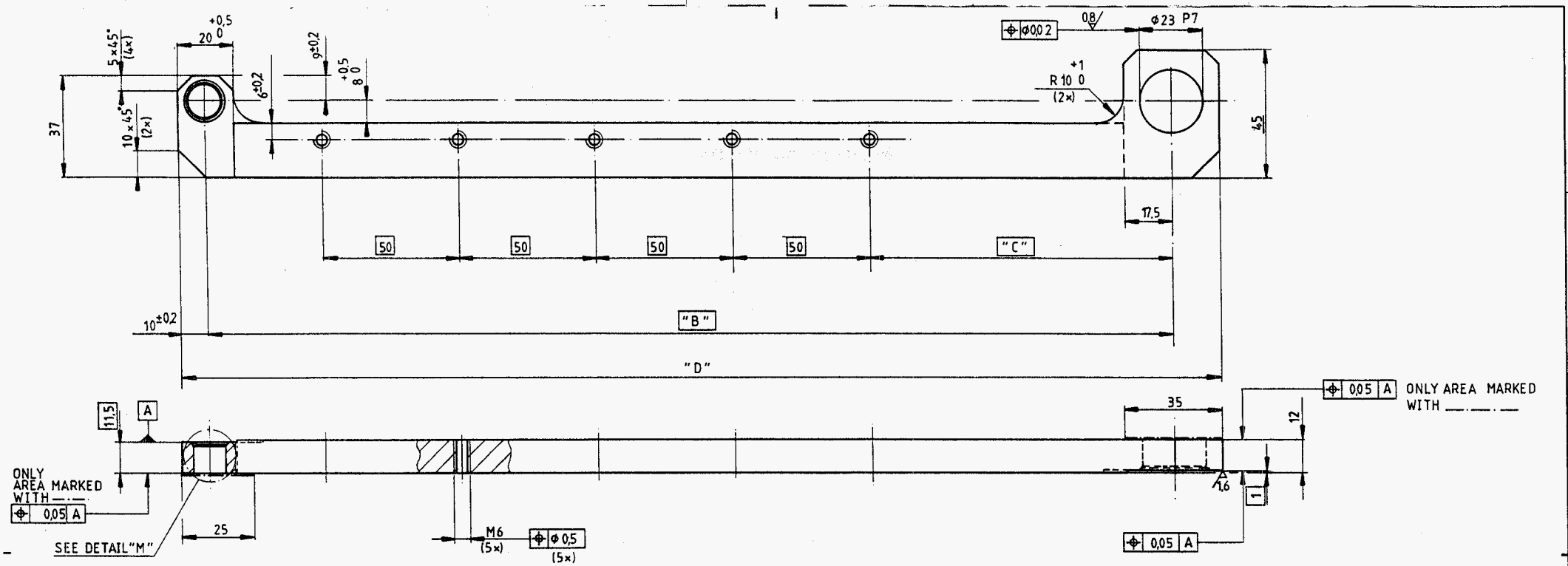


**DAF**  
DAF Special Products

3/2  
Ø 28 P7 -0.014  
-0.035

242,52 was 235,17 / 224,17 was 231,52		91-05-22	Pv B	1
material	alcoptaa	alt.mat AlMg3	1 of 1	DAF
number	91-05-14	A1	SP10264/1	



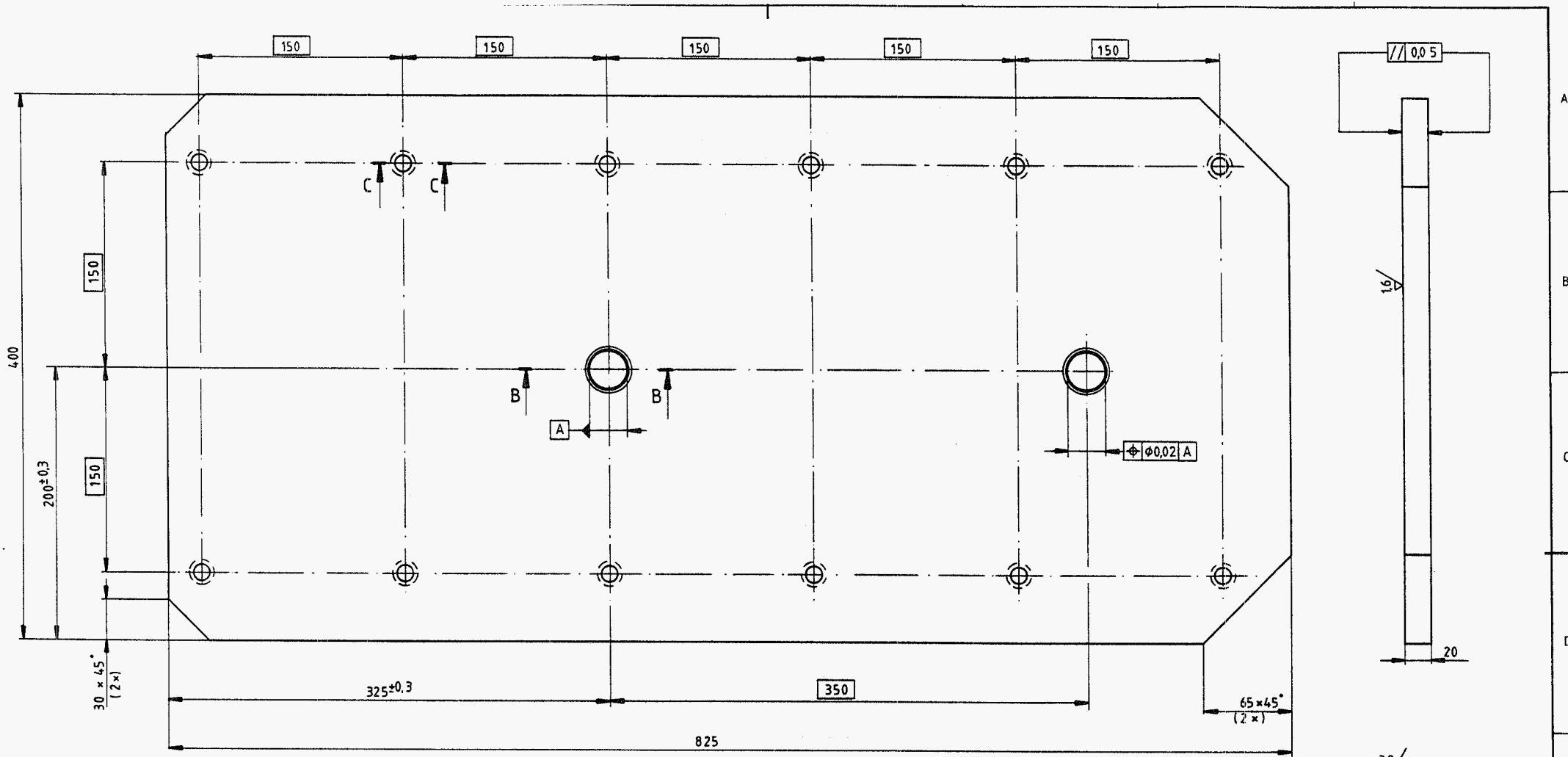


PRODUCT No.	"B"	"C"	"D"
SP 10266	352,44	110	380
SP 10282	323,12	80,8	351

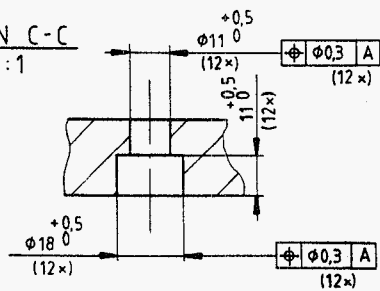
∅ 23 P7	-0.014 -0.035
∅ 12 P7	-0.011 -0.029

**DAF**  
DAF Special Products.

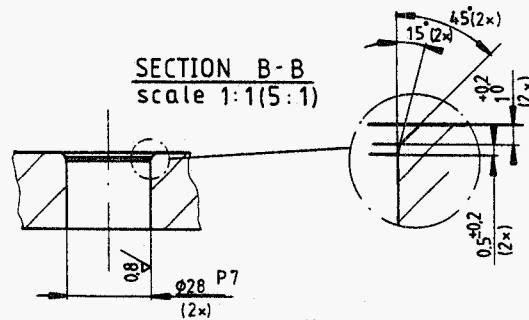
		323,12 was 323,21	91-05-23	PvB			3	
		32321/80,8/351 was resp 37997/13754075	91-05-22	PvB			2	
		COMPLETE MODIF.	91-05-22	PvB			1	
micro	c to s	micro	modification description	date	drawn by	auth. by	mod. no	issue
general tolerance	±0,5	±30'	refer to DAF-etc.	POSITIONING ARM				
dimensions in mm			for drawing interpretation					
checked to standards	date	third angle projection						
material sign off	date	material	C60	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.				
authorized by	date	heat/surface treatment	W.st. no. 04011	regulated items	scale	1:1 ; 2:1	sheet	1 of 1
drawn by	date	part spec.	P.v.Berlo	product spec.	size	A2	drawing/issue number	SP 10266/3
similar to	supersedes		superseded by					



SECTION C-C  
scale 1:1



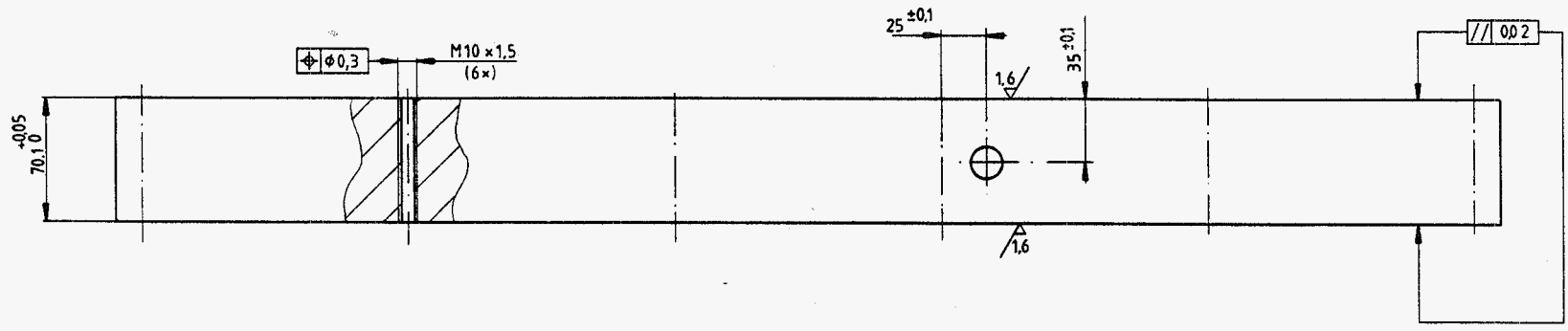
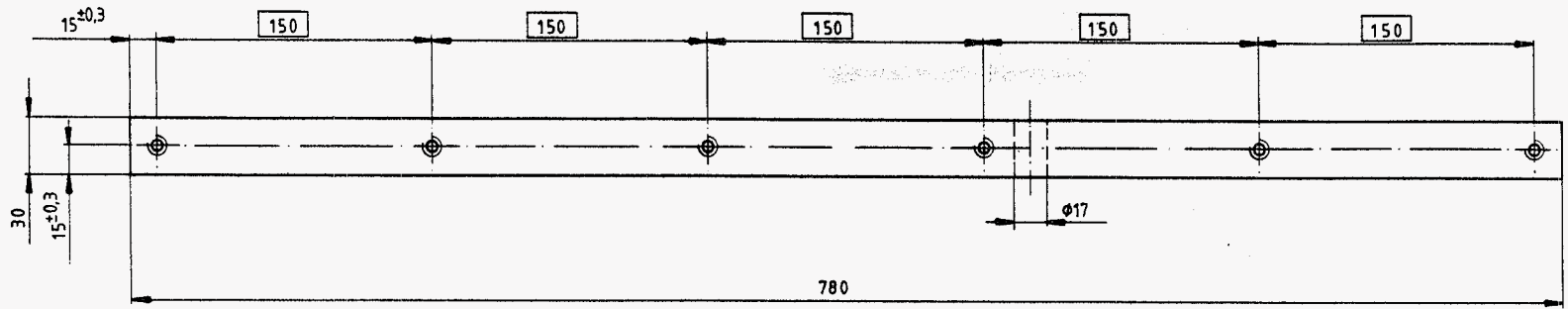
SECTION B-B  
scale 1:1 (5:1)



**DAF**  
DAF Special Products

28 P 7 -0.14  
-0.035

micro	c. to s	mm	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	+0.5 +30'		tolerance principle	refer to DAF-act	PLATE		sheet 1 of 1	
checked to standards	dimensions in mm		for drawing interpretation	date	third angle projection		material	
material sign of	date		material	Alcoa plaat alt.mat. Al Mg 3		This drawing is the property of DAF NV Enschede in the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		model number
authorised by	date		heat/surface treatment	regulated items		scale 2:1 : 1:1 5:1		drawing/issue number
drawn by	date		part spec.	product spec.		size A2		SP10267/
similar to	date		part spec.	product spec.		size		drawing/issue number
supersedes	date		part spec.	product spec.		size		drawing/issue number

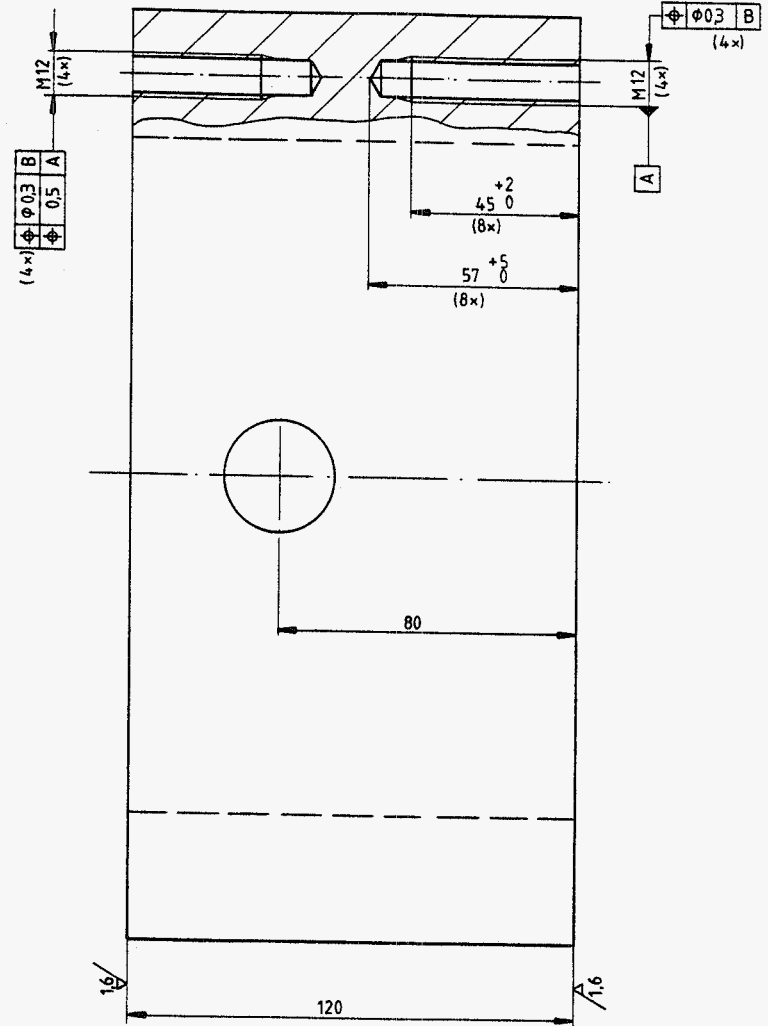
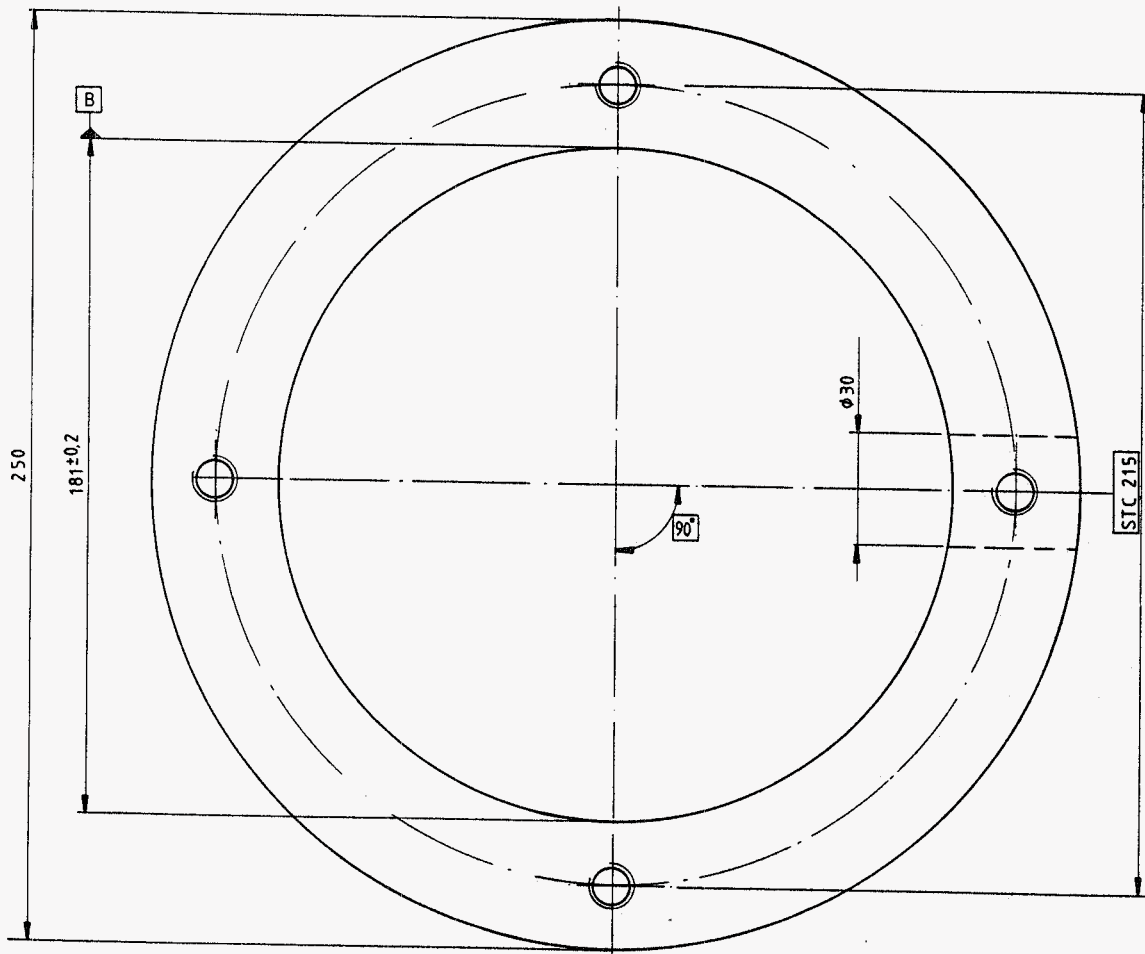


32/

**DAF**  
DAF Special Products

micro	c	s	mac	modification description	date	drawn by	auth. by	mod. no	issue
general tolerance	± 0.5	tolerance principle	refer to DAF-act.	title	BRACKET				
dimensions in mm		checked to standards	date	for drawing interpretation	third angle projection				
material sign of		date		material	AlMg 3	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet	1 of 1
authorised by		date		heat/surface treatment	/	regulated terms	scale	1 : 2	model number
drawn by	P.v. Berlo	date	91-05-14	paint spec.		product spec.	size	A2	drawing/issue number
similar to		supersedes		superseded by		SP10268/			

A  
B  
C  
D  
E  
F

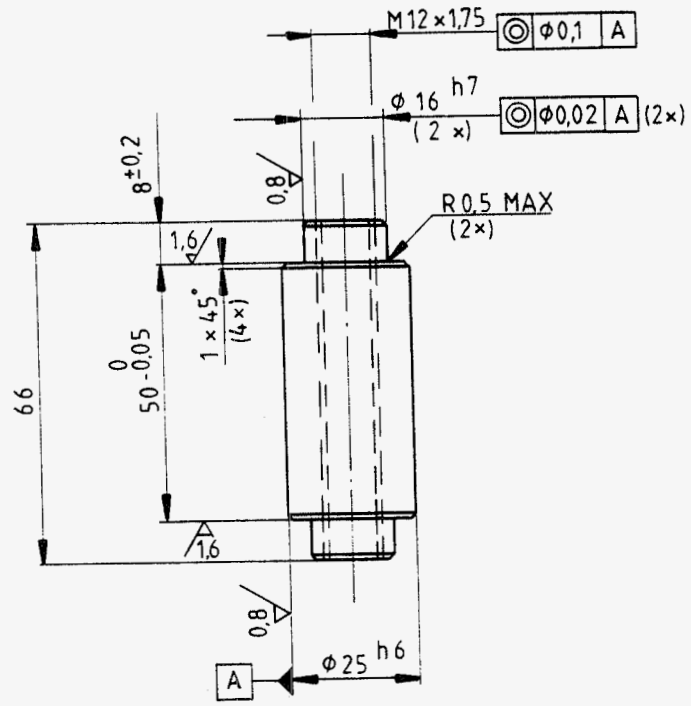


3,2/

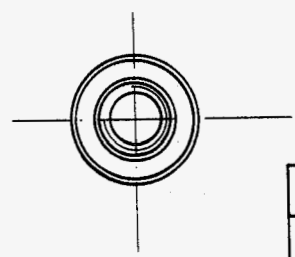
**DAF**  
DAF Special Products

micro	c to s	macro	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	±0,5	tolerance principle	refer to DAF-std.					
dimensions in mm		for drawing interpretation						
checked to standards:		third angle projection						
material sign off		material	AlMgSi1					
authorized by		heat/surface treatment	/					
drawn by	P.v. Berlo	date	91-05-15					
similar to		supersedes						
				BRACKET, MOTOR-				
				This drawing is the property of DAF NV. Enrolled in the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet 1 of 1		<b>DAF</b>
				regulated items		scale 1 : 1		model number
				product spec.		size A2		drawing/issue number SP10269 /
				superseded by				





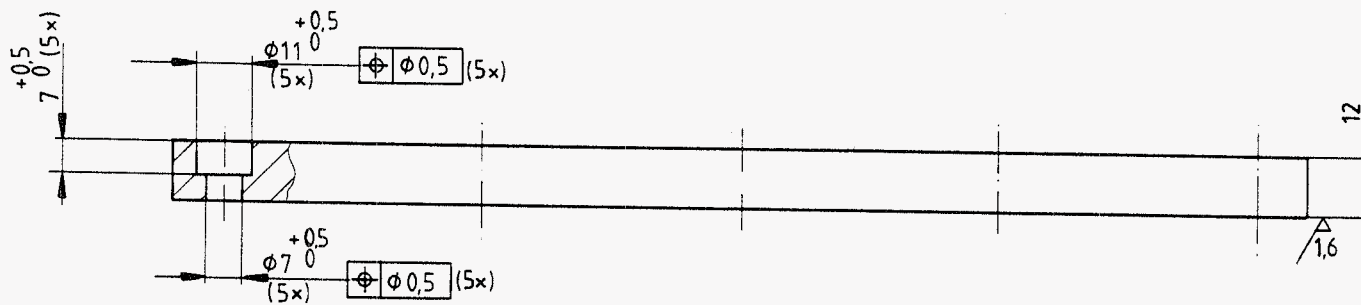
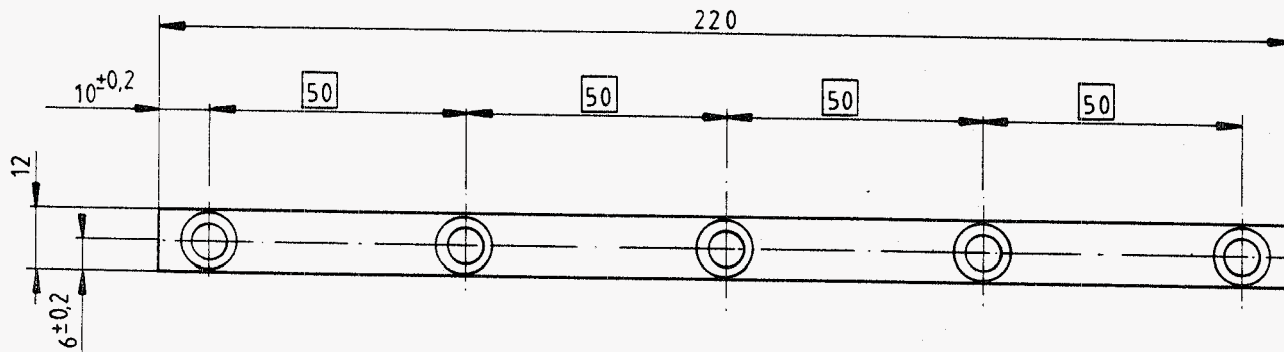
**DAF**  
 DAF Special Products



$\phi 16\ h7$	0,000 -0,021
$\phi 25\ h6$	0,000 -0,013

3,2/

micro	c to s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	tolerance principle		refer to DAF-etc.	SHAFT, TENSION PULLEY-				
$\pm 0,5 \pm 1^\circ$			for drawing interpretation					
dimensions in mm			third angle projection					
checked to standards	date							
material sign off	date		material: C 60 Wst.no. 04011	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.			sheet 1 of 1	<b>DAF</b>
authorised by	date		heat/surface treatment /	regulated items	scale 1 : 1	model number		
drawn by P.v.Berlo	date 91-05-15		paint spec.	product spec.	size A3	drawing/issue number SP10270 /		
similar to			supersedes	superseded by				

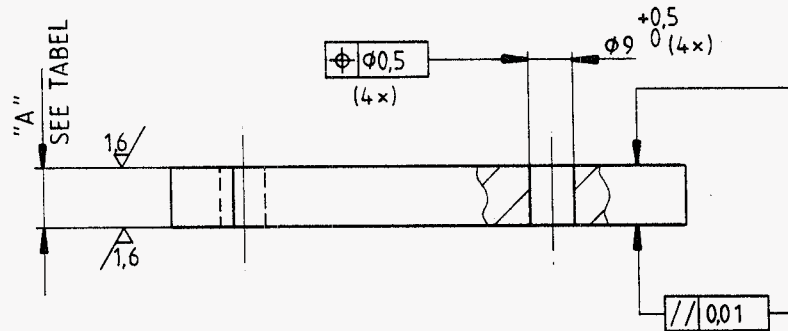
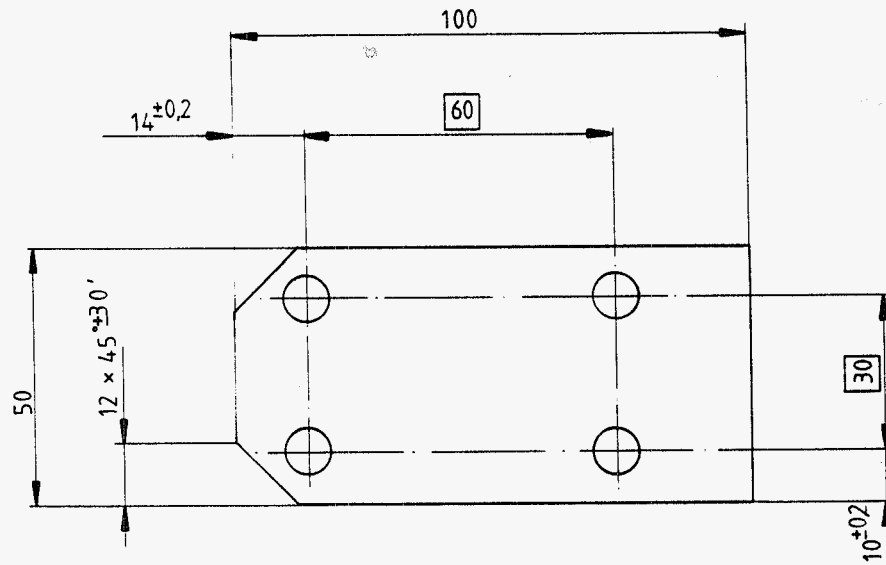


**DAF**

DAF Special Products

3.2 ✓

micro	c to s	mso	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance			tolerance principle	refer to DAF-std.	title				
± 0,5					CONSOLIDATION STRAP				
dimensions in mm				for drawing interpretation					
checked to standards			date	third angle projection					
material sign off			date	material	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet		
				C 60			1 of 1		
authorised by			date	heat/surface treatment	regulated items	scale	model number		
				/		1 : 1			
drawn by			date	paint spec.	product spec.	size	drawing/issue number		
P.v.Berlo			91-05-07			A3	SP102711/		
similar to			supersedes		superseded by				



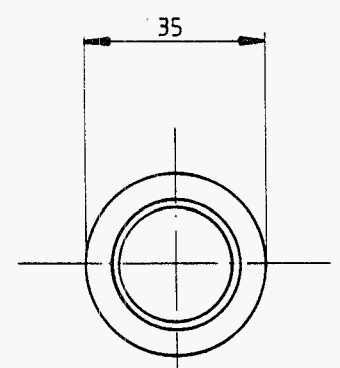
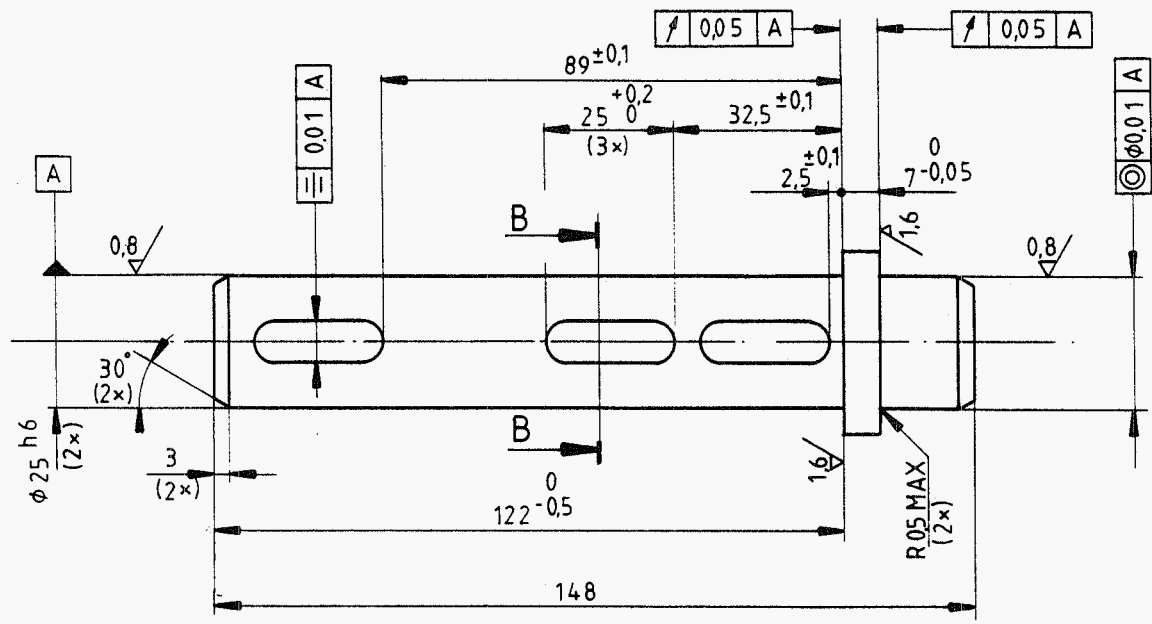
PRODUCT No	"A"
SP10272	12,5 ± 0,05
SP10273	25 ± 0,05
SP10274	37,5 ± 0,05

3.2

# DAF

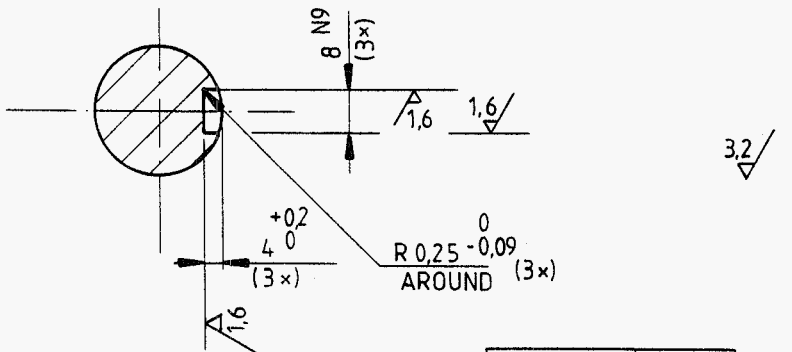
DAF Special Products

micro	c to s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
± 0,5			general tolerance principle refer to DAF-std.					
dimensions in mm			for drawing interpretation					
checked to standards			third angle projection					
material sign off			material AlMgSi1					
			This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.					
authorised by			heat/surface treatment					
			/					
drawn by			paint spec.					
P.v.Berlo			91-05-06					
similar to			supersedes					
			superseded by					
title				PLATE				
sheet				1 of 1				
regulated items				scale 1 : 1				
product spec.				size A3				
drawing/issue number				SP10272 /				



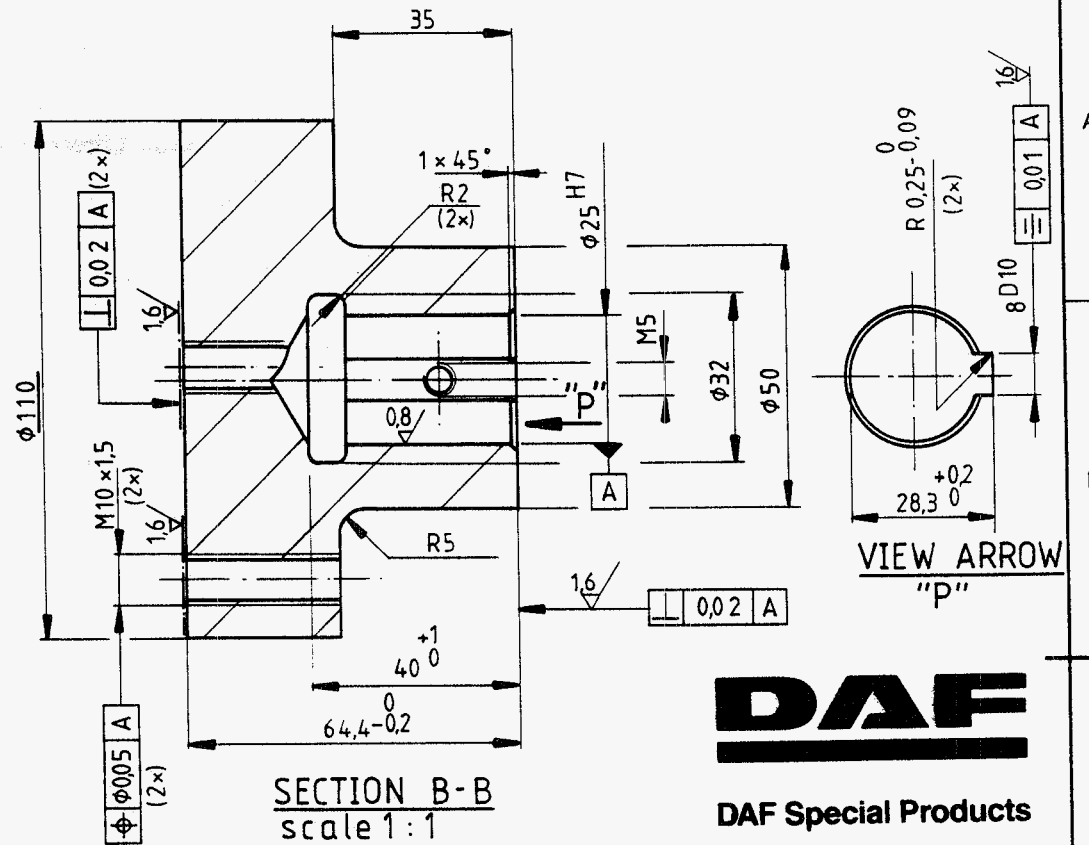
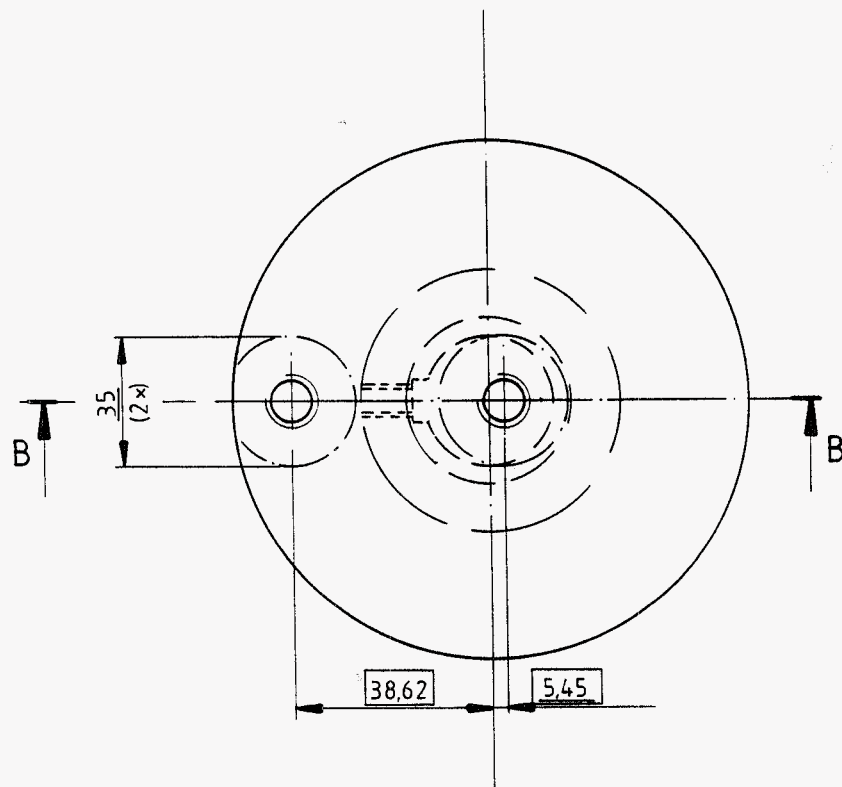
**DAF**  
DAF Special Products

SECTION B - B  
scale 1:1



8 N9	0,000 -0,052
φ 25 h6	0,000 -0,013

micro	c to s	msc	modification description	date	drawn by	auth. by	mod. no.	issue	
general tolerance	±0,5	±30'	tolerance principle refer to DAF-std.						
dimensions in mm			for drawing interpretation						
checked to standards			third angle projection						
material sign off			material C 60 W.st.no. 04011						
authorised by			heat/surface treatment /						
drawn by			paint spec.						
similar to			supersedes						
				date		sheet		title	
				91-05-15		1 of 1		SHAFT	
						regulated items		This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.	
						scale		model number	
						1 : 1			
				product spec.		size		drawing/issue number	
						A3		SP10275/	
				superseded by					



**DAF**

DAF Special Products

8 D10	+0,098 +0,040
φ25 H7	+0,015 0,000

32/

		5,45 was 2,33	91-05-23	PvB			3	
		2,33 was 2,88	91-05-22	PvB			2	
		φ110 was φ100	91-05-22	PvB			1	
micro	c to s	msc	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	tolerance principle	refer to DAF-std.	title <b>ROTOR</b>					
±0,5 ±30'	dimensions in mm	for drawing interpretation						
checked to standards	date	third angle projection	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.					
material sign off	date	material C 60 W.st.no 04011						
authorized by	date	heat/surface treatment	regulated items	scale	sheet 1 of 1			
drawn by	date	paint spec.	product spec.	size	model number 1 : 1			
				<b>A3</b>	drawing/issue number <b>SP10276/4</b>			
		similar to	supersedes	superseded by				

φ35(2x) was φ25 (2x)

91-05-24 PvB

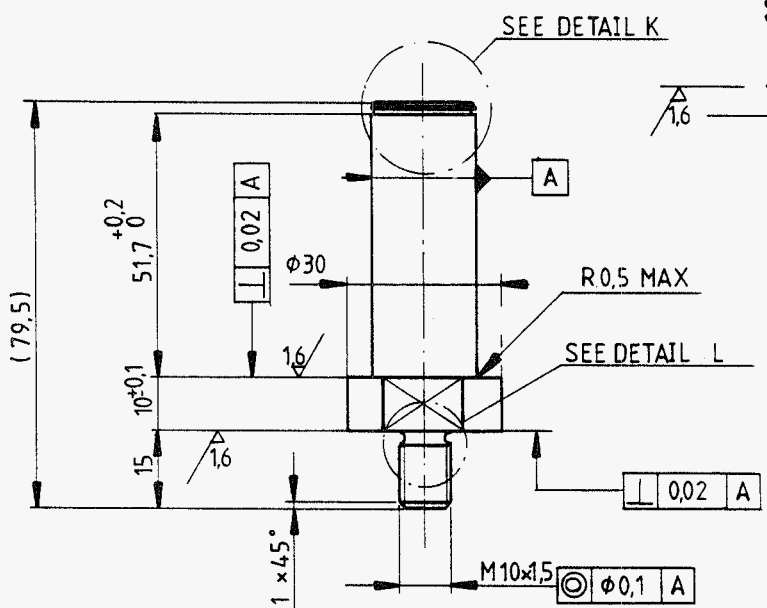
4

1

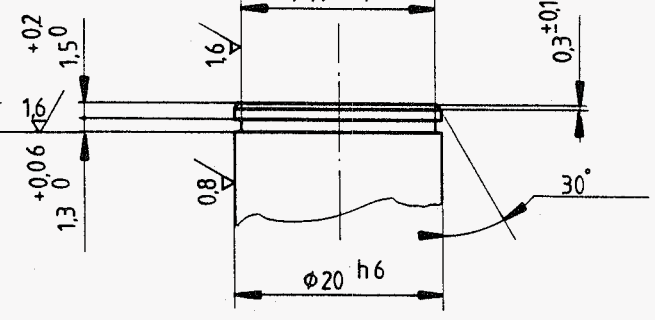
2

5

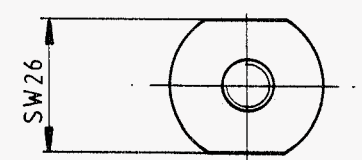
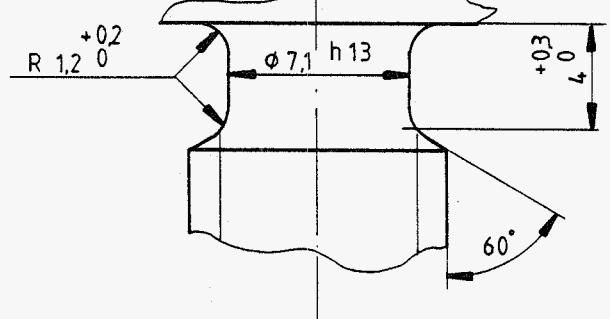
6



DETAIL K  
scale 2:1



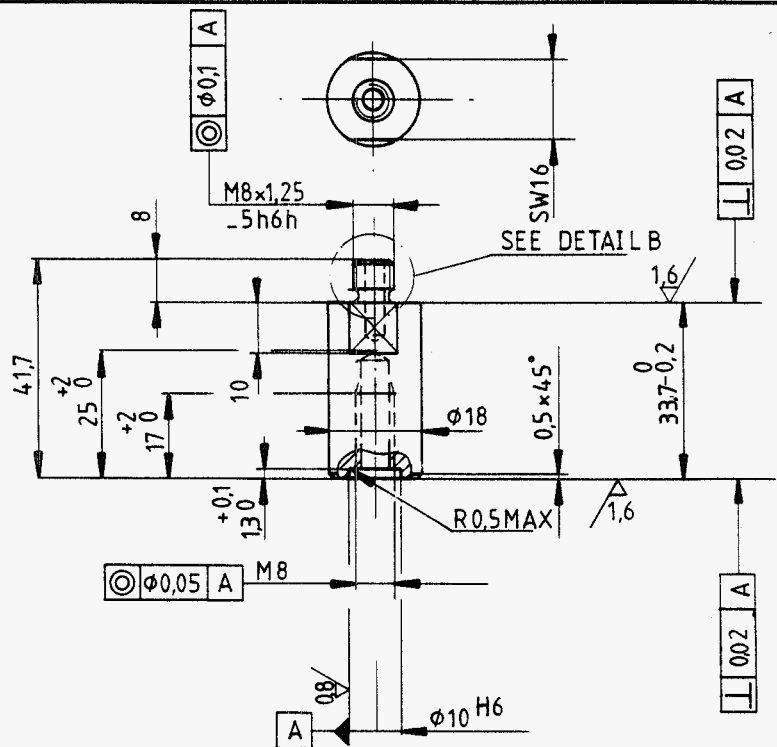
DETAIL L  
scale 5:1



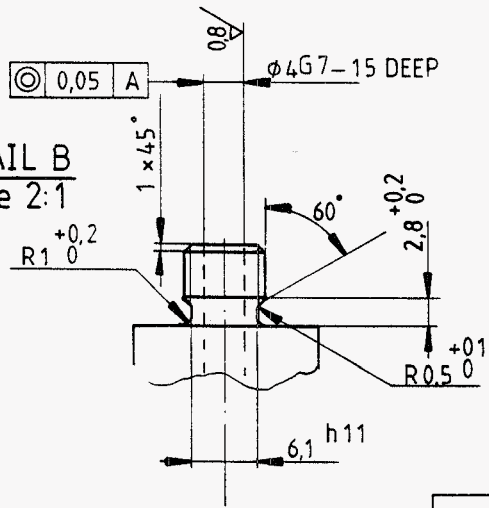
$\phi 7,1$	$h13$	0,000
		-0,120
$\phi 20$	$h6$	0,000
		-0,013

3,2/√

micro		c to s		mso		COMPLETE MODIF		91-05-22		P.v.B.				1	
general tolerance		tolerance principle		refer to DAF-std.		title		date		drawn by		auth. by		mod. no.	
$\pm 0,5$						ROTOR PIN									
dimensions in mm.						for drawing interpretation									
checked to standards		date		third angle projection											
material sign off		date		material		This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.				sheet		1 of 1			
authorised by		date		heat/surface treatment		regulated items		scale		model number					
P.v. Berlo		91-05-13		/				1:1 ; 2:1 ; 5:1							
drawn by		date		paint spec.		product spec.		size		drawing/issue number					
								A3		SP10277/1					
similar to				supersedes		superseded by									



DETAIL B  
scale 2:1



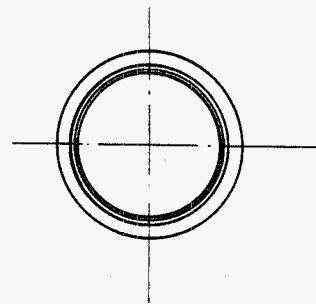
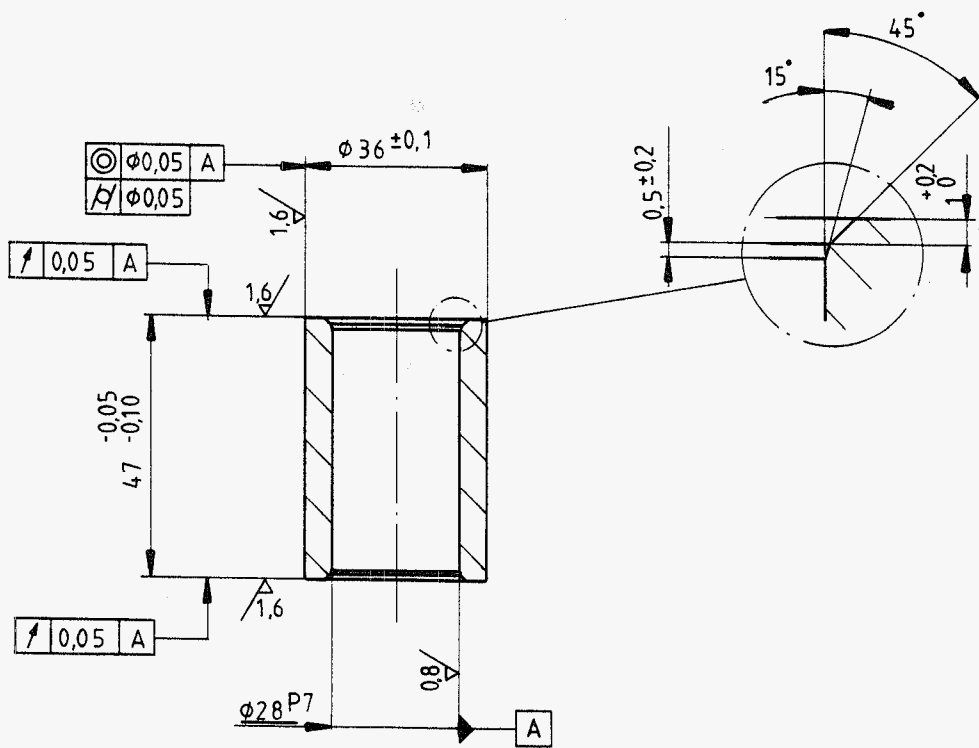
φ4 G7	+0,016 +0,004
φ10 H6	+0,009 0,000
φ6,1 h11	0,000 -0,090

3,2 ✓



DAF Special Products

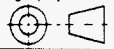
micro	c	s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
				COMPLETE MODIF.	91-05-23	PvB			1
general tolerance ±0,5 ±30' dimensions in mm				tolerance principle refer to DAF-std.	title POSITIONING PIN				
checked to standards				date	third angle projection				
material sign off				date	material: 35NCD16 1230_1370 MPa alt mat S99	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet 1 of 1	
authorised by				date	heat/surface treatment	regulated items	scale 1:1 2:1 5:1	model number	
drawn by Pv.Berlo				date 91-05-06	paint spec.	product spec.	size A3	drawing/issue number SP10278/1	
similar to				supersedes		superseded by			



$\phi 28 P7$   $-0,014$   
 $-0,035$

3.2 ✓

**DAF**  
DAF Special Products

micro	c to s	msc	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance	$\pm 0,5 \pm 30'$		tolerance principle	refer to DAF-std.	BUSH, TENSION PULLEY -				
dimensions in mm				for drawing interpretation					
checked to standards	date			third angle projection					
material sign off	date		material	C60 W.st.no. 04011					
authorised by	date		heat/surface treatment	/	regulated items	scale	model number		
drawn by	date		paint spec.		product spec.	size	drawing/issue number		
similar to			supersedes		superseded by				
						A3	SP10279/		

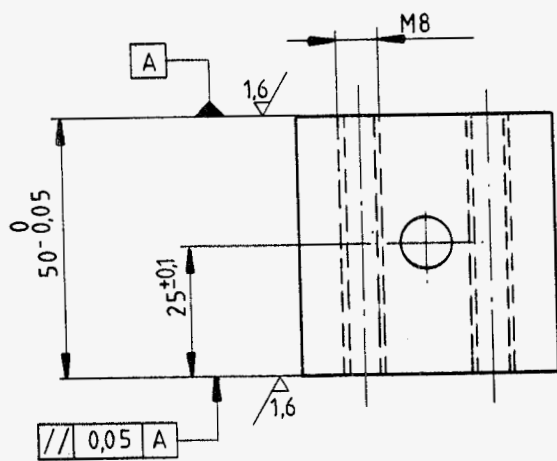
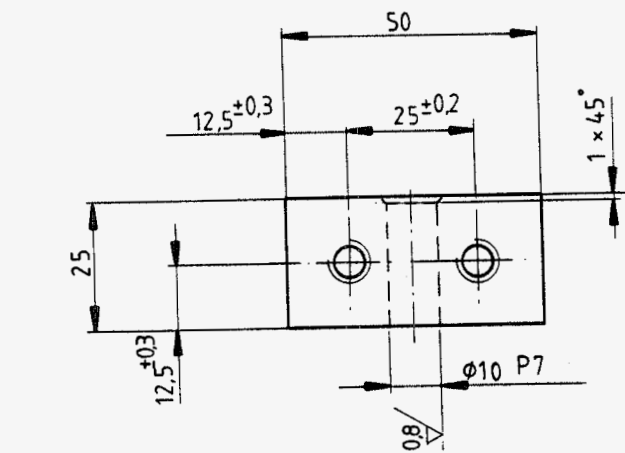
1

2

5

6





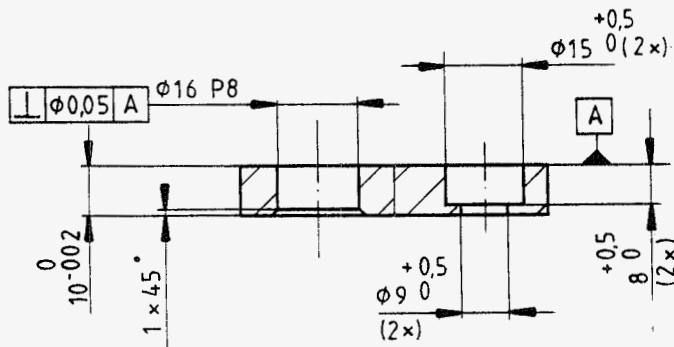
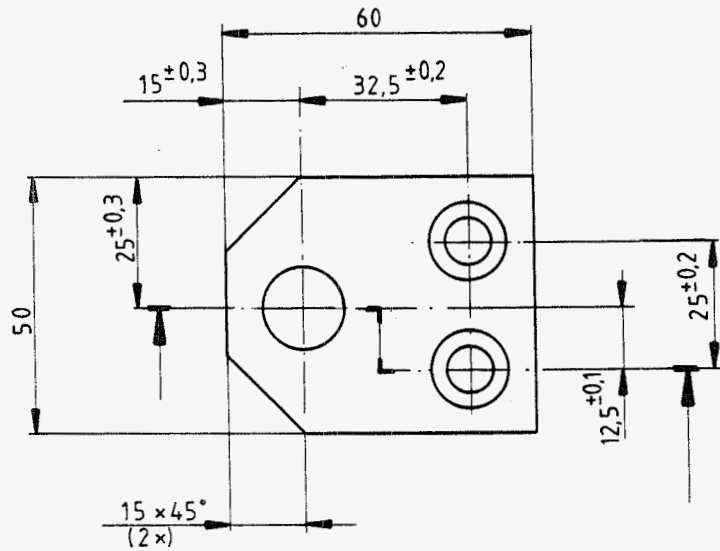
/// 0,05 A

φ10 P7 -0,009  
-0,024

3,2

**DAF**  
DAF Special Products

micro	c to s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance			tolerance principle	refer to DAF-std.		title		
±0,5 ±1			for drawing interpretation	BLOCK , TENSION PULLEY-				
dimensions in mm			third angle projection					
checked to standards	date		material	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet	1 of 1	
material sign off	date		C 60	W.st.no. 04011				
authorised by	date		heat/surface treatment	regulated items	scale	model number		
			/		1 : 1			
drawn by	date		paint spec.	product spec.	size	drawing/issue number		
P.v.Berlo	91-05-16				A3	SP10280/		
similar to			supersedes	superseded by				

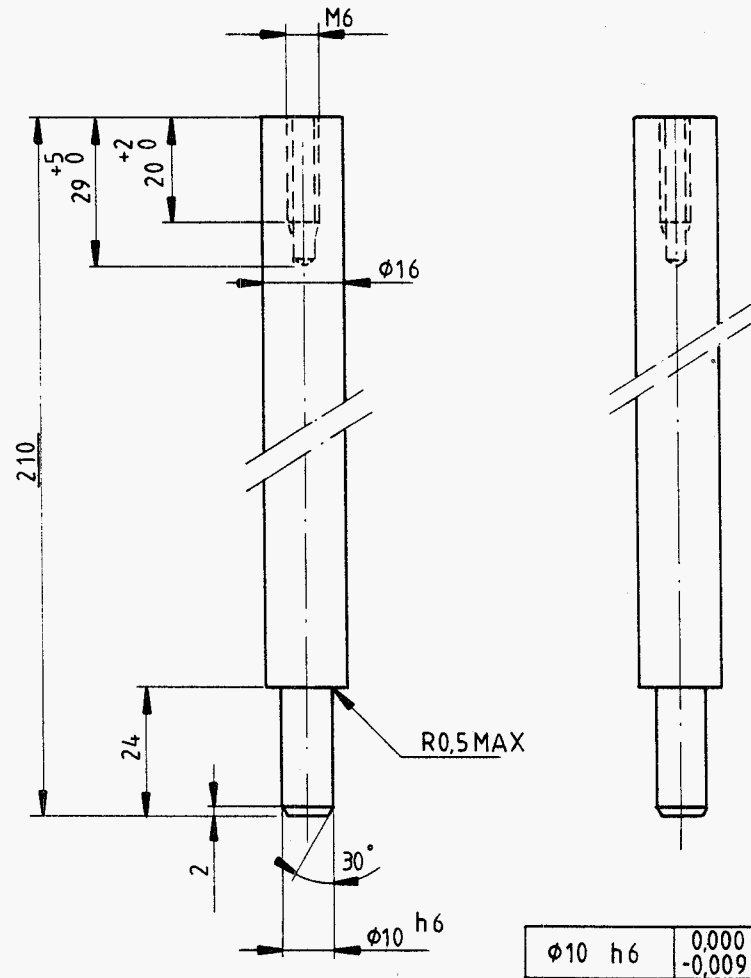


16 P8	-0.018
	-0.045

32 ✓

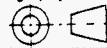
**DAF**  
DAF Special Products

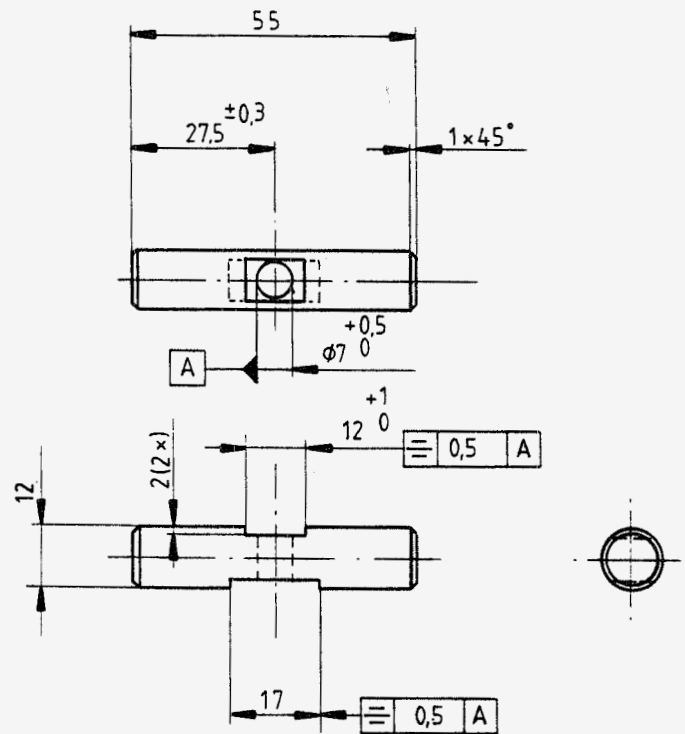
micro	c	s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance				tolerance principle	refer to DAF-sid.		title		
±0.5 ±1°					for drawing interpretation		STRAP, TENSION PULLEY-		
checked to standards				date	third angle projection		<small>This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.</small>		
							sheet		
material sign off				date	material: C60		1 of 1		<b>DAF</b>
					W.st. no. 04011		model number		
authorized by				date	heat/surface treatment		regulated items	scale	
					/			1 : 1	
drawn by				date	paint spec.		product spec.	size	drawing/issue number
P.v.Berlo				91-05-15				A3	SP10281 /
similar to				supersedes		superseded by			



$\phi 10$  h6 0,000  
-0,009

**DAF**  
DAF Special Products

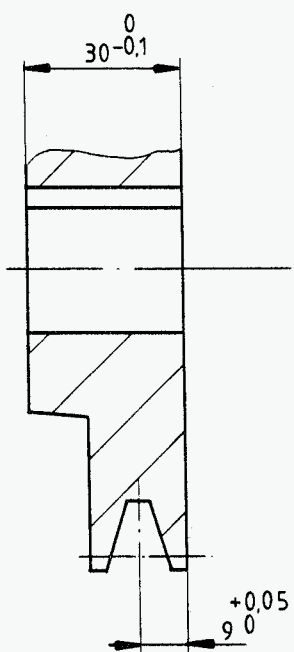
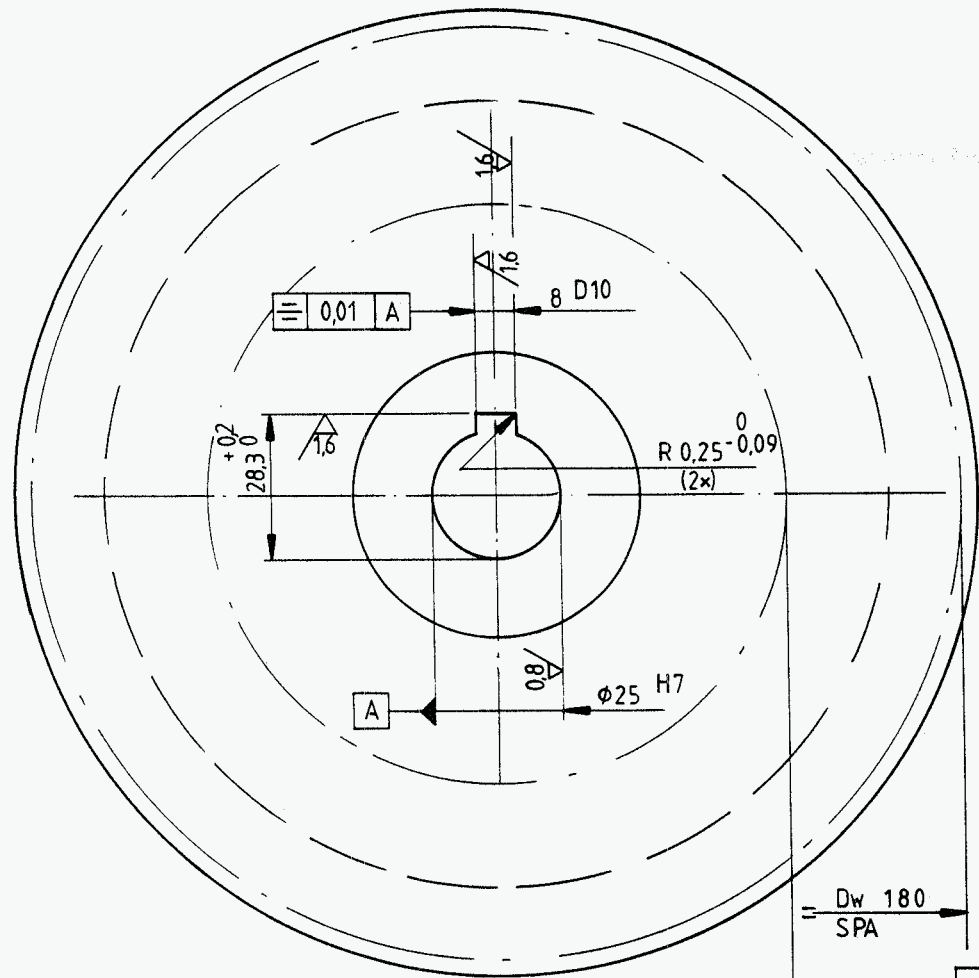
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general tolerance	$\pm 0,5$	$\pm 1^\circ$	tolerance principle	refer to DAF-std.	title				
dimensions in mm				for drawing interpretation	PIN, TENSION PULLEY -				
checked to standards			date	third angle projection					
material sign off			date	material	ST 37	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet	1 of 1
authorized by			date	heat/surface treatment	/	regulated items	scale	model number	
drawn by	P.v. Berlo		date	paint spec.	91-05-16	product spec.	size	drawing/issue number	
similar to			supersedes			superseded by	A3 SP10283/		



**DAF**  
DAF Special Products

micro	c to s	mso	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance	±0,5	±1°	tolerance principle	refer to DAF-std.					
dimensions in mm				for drawing interpretation					PIN
checked to standards			date	third angle projection					
material sign off			date	material C 60					This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.
				W.st.no. 04011					sheet 1 of 1 <b>DAF</b>
authorised by			date	heat/surface treatment /					model number
									regulated items scale 1 : 1
drawn by			date	paint spec.					product spec. size A3 drawing/issue number SP10284/
similar to				supersedes					superseded by

FABRIKANT: OPTIBELT  
 LEVERANCIER: v.d. HEIJDEN  
 TYPE: SPA -112 /SPA -180

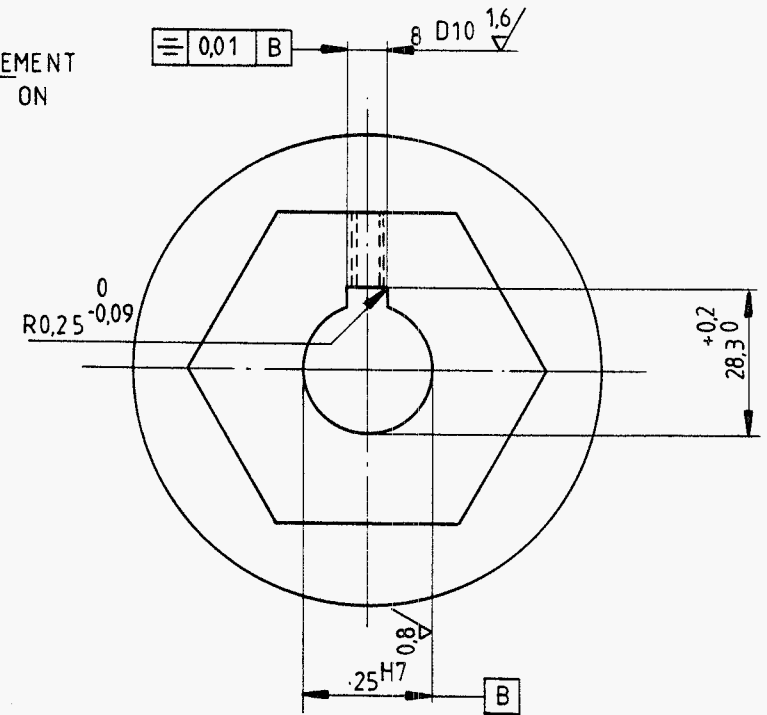
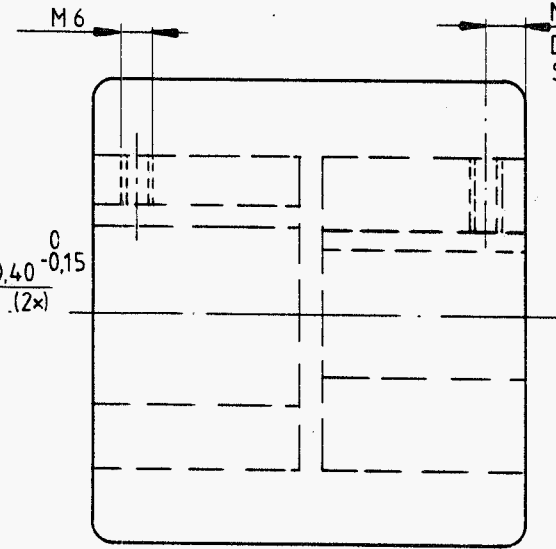
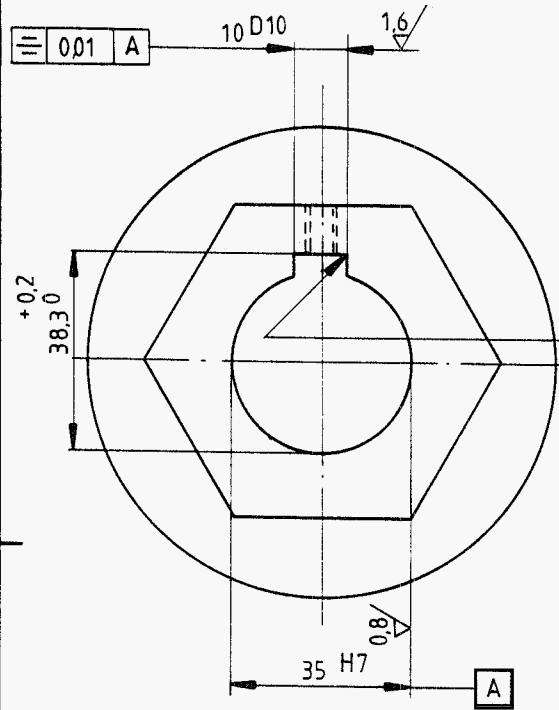


Dw 180  
SPA

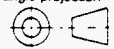
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SPA

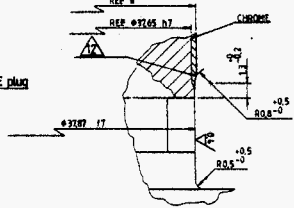
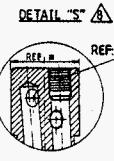
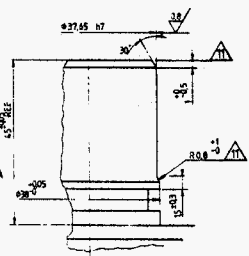
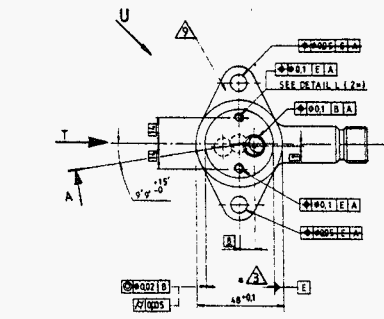
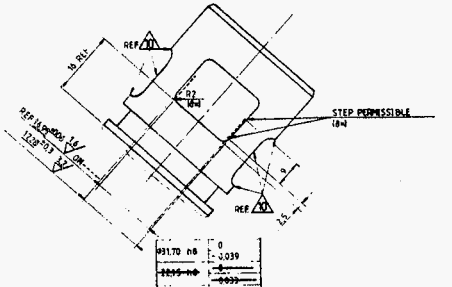
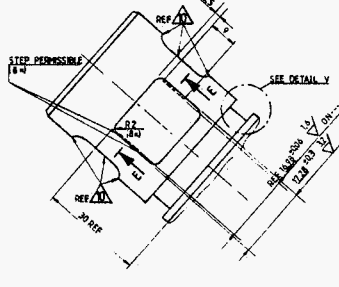
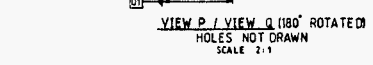
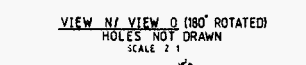
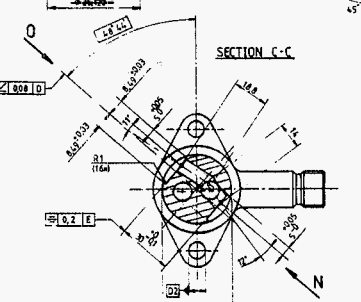
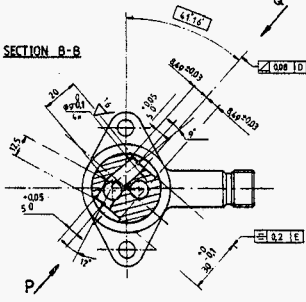
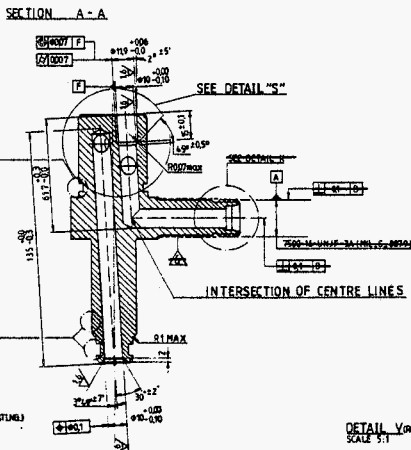
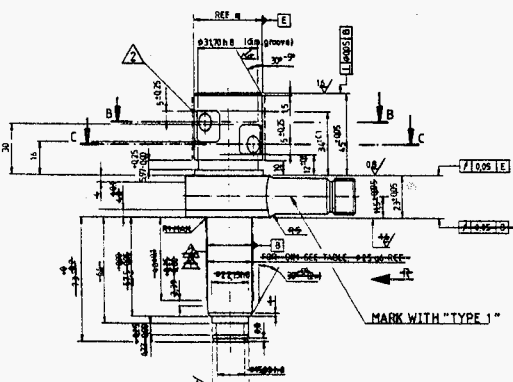
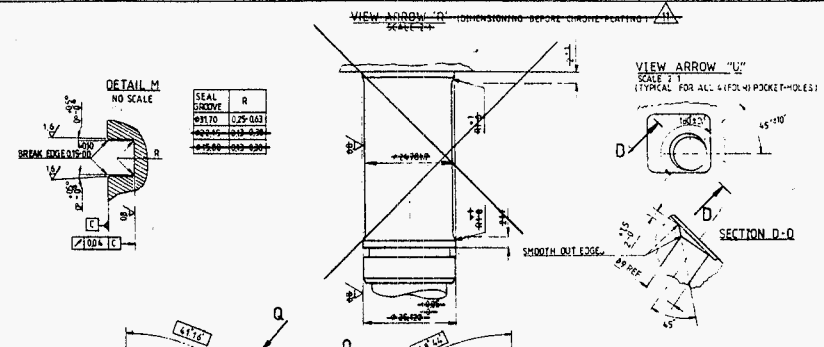
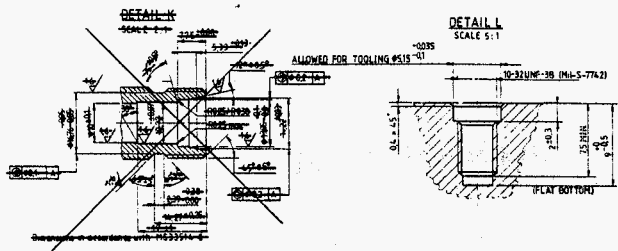
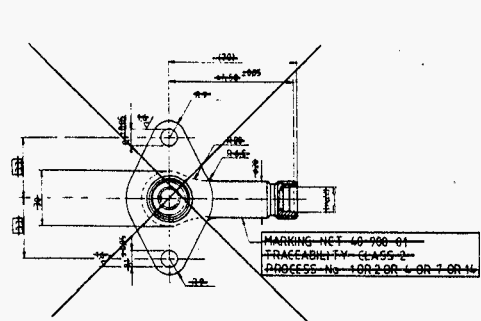
PRODUKT NO	TYPE
SP10285	SPA 112
SP10286	SPA 180

		toegevoegd 9+0,05 30-0,1		91-05-24	PvB			1	
micro	c	s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	tolerance principle		refer to DAF-std.	title					
dimensions in mm			for drawing interpretation	SNAARSCHIJF					
checked to standards	date		third angle projection						
material sign off	date		material						
authorised by	date		heat/surface treatment	regulated items	scale	sheet			
drawn by	date		paint spec.	product spec.	size	1 of 1 <b>DAF</b>			
	P.v.Berlo		91-05-17		A3	model number			
						drawing/issue number			
						SP10285 / 1			
similar to	supersedes		superseded by						



Fabrikant: STEMIN  
 LEVERANCIER: STEMIN machinefabriek b.v.  
 TYPE: HYFLEX 80

micro	c to s	mso	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance	tolerance principle	refer to DAF-std.	title						
dimensions in mm		for drawing interpretation	COUPLING, FLEXIBEL - 						
checked to standards	date	third angle projection							
material sign off	date	material	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.				sheet	1 of 1	<b>DAF</b>
authorised by	date	heat/surface treatment	regulated items	scale			model number		
drawn by	date	paint spec.	product spec.	size				1 : 1	
similar to		supersedes	superseded by					<b>A3</b>	<b>SP10287/</b>



- EDGE SMOOTHED OUT
- CHROME RUN-OUT PER NCT 40-934-11
- BREAK EDGES WITH R0.2-0.3 BEFORE CHROME-PLATING AND R01-0.2 AFTER CHROME-PLATING.
- ALLOWABLE AREA FOR HARDNESS-CHECK (331HBmin-401HBmax)
- ASSEMBLE LEE-PLUG p/n: PLGA4681020 class 1. BEFORE GRINDING DIAM. = TO SIZE.
- KEEP CORE AND HOUSE AFTER PAIRING TOGETHER.
- INDICATED SURFACE TO BE GRINDED TO EXCEPTED THREAD
- MARK HOUSE, AFTER MATCHING WITH CORE, WITH "TYPE J"
- PASSIVATE ACC TO I.T.F. 40-742-01, MASK LEE-PLUG/TOPLUG BORES Ø9 AND Ø10.72 WHICH ARE CONNECTED WITH LEE-PLUG BOTTOM.
- FLAW DETECTION ACC TO GEN 73-02
- CORE (SP 10288) AND HOUSE (SP 10262) ARE MATCHED, PAIRING PER TYPE CODE DIAMETRICAL CLEARANCE 8-12 µm (ON DIAM.) INDICATED SURFACE
- CHROME PLATE ACC TO I.T.F. 40-834-00 TYPE IIB SEQUENCE 4B ON INDICATED SURFACE

NB: IT IS NOT PERMITTED TO ASSEMBLE CORE AND HOUSE

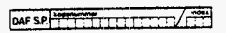
TABLE FOR CHROME PLATE DIMENSIONS			
DIM BEFORE CHROME-PLATING	±0.03	±0.04	±0.05
DIM AFTER CHROME-PLATING	±0.02	±0.03	±0.04
SURFACE ROUGHNESS BEFORE CHROME-PLATING	0.8	0.6	0.4
SURFACE ROUGHNESS AFTER CHROME-PLATING	0.4	0.3	0.2
DIM BEFORE CHROME-PLATING	±0.05	±0.06	±0.08
DIM AFTER CHROME-PLATING	±0.04	±0.05	±0.07
SURFACE ROUGHNESS BEFORE PLATING	0.6	0.4	0.3
SURFACE ROUGHNESS AFTER PLATING	0.3	0.2	0.1

15-5 PH H1025  
1069 MPa  
H40 61900

EUROPEE  
PROJEKTE  
**DAF**  
DAF Special Products

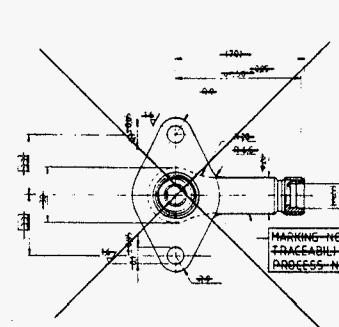
A330/340 5 790 Pz Berio 91-06-03  
CORE experimental type "I"  
with lee plug

NB: Bij vragen direkt bellen met afd. R&D tel: 3637

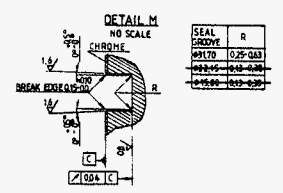
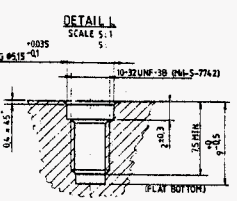
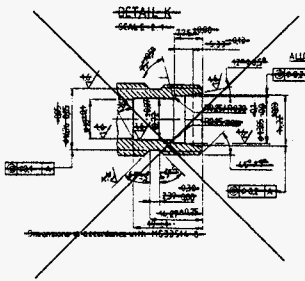


SP10288

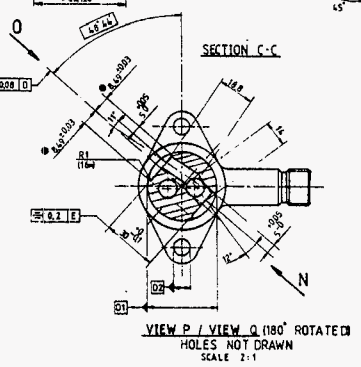
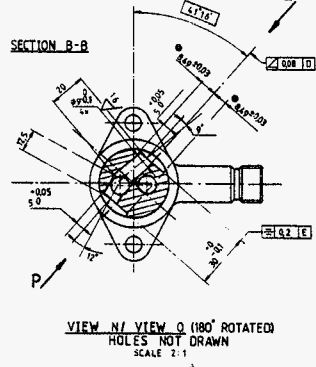
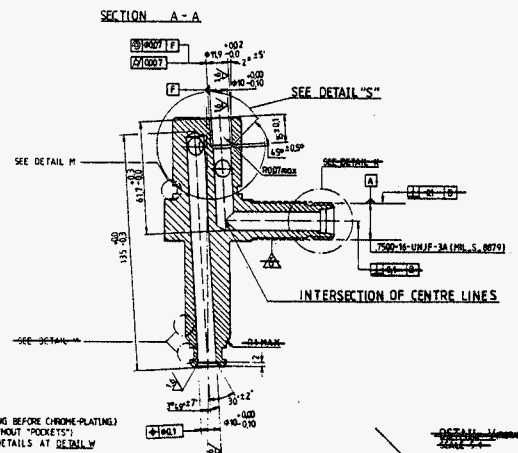
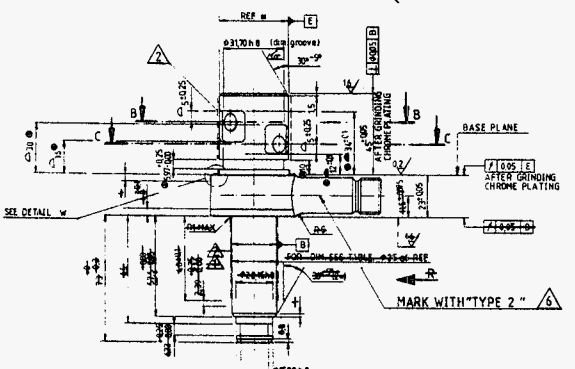
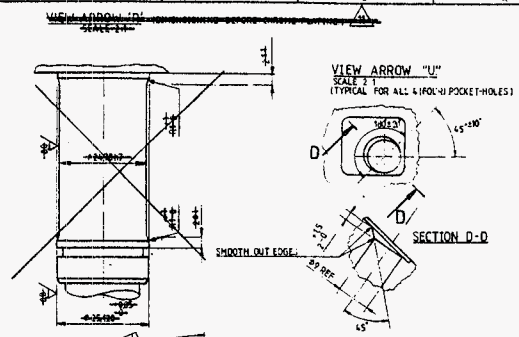
DAF-SP



MARKING NCT 40-834-01  
TRACEABILITY CLASS 2  
PROCESS No. 1 OR 2 OR 4 OR 7 OR 14



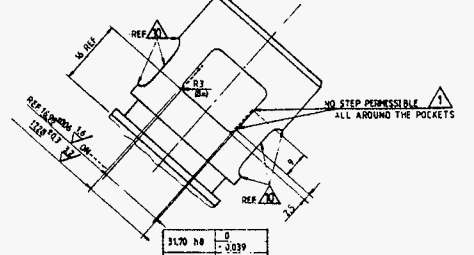
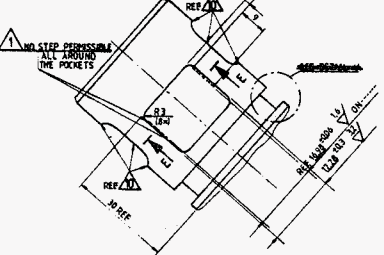
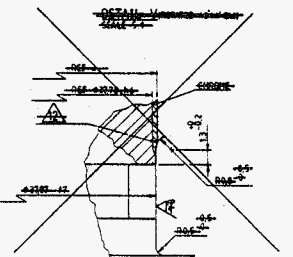
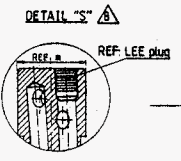
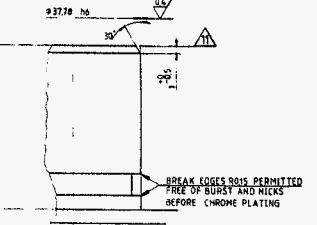
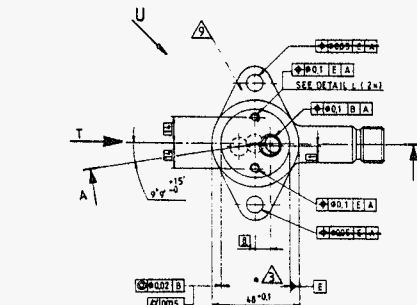
SEAL	R
0.170	0.20-0.03
0.230	0.30-0.03
0.450	0.50-0.03



VIEW ARROW 'T' (DIMENSIONING BEFORE CHROME PLATING)  
SCALE 2:1  
DRAWN WITHOUT 'POCKETS'  
FURTHER DETAILS AT DETAIL W

VIEW N / VIEW Q (180° ROTATED)  
HOLES NOT DRAWN  
SCALE 2:1

VIEW P / VIEW Q (180° ROTATED)  
HOLES NOT DRAWN  
SCALE 2:1



14 PREMACHINING .01mm UNDERSIZED FOR DIMENSIONS MARKED WITH  $\phi$  IS PERMITTED BEFORE CHROME PLATING  
13 **BEWARE:** THE  $\Delta$  MARKED DIMENSIONS SHOULD BE GRINDING TO FINAL DIMENSION AFTER GRINDING OF THE INDICATED BASE PLANE. THE DIMENSIONS MARKED  $\ominus$  STAY WITHIN THEIR TOLERANCE.

- $\Delta$  EDGE SMOOTHED OUT
- $\Delta$  CHROME RUN-OUT PER NCT 40-834-11
- $\Delta$  ALL POCKETS SHARP EDGES AFTER GRINDING CHROME PLATING BEFORE CHROME PLATING R015 PERMITTED
- $\Delta$  ALLOWABLE AREA FOR HARDNESS-CHECK (331 HBmin-401 HBmax)
- $\Delta$  ASSEMBLE LEE-PLUG  $\phi$ m: PLGA4681020 class 3. BEFORE GRINDING  $\phi$  = TO SIZE.
- $\Delta$  KEEP CORE AND HOUSE AFTER PAIRING TOGETHER.
- $\Delta$  MARK HOUSE AFTER MATCHING WITH CORE WITH "TYPE 2"
- $\Delta$  FLAW DETECTION ACC TO GEN 73-02
- $\Delta$  CORE (SP 10289) AND HOUSE (SP10262) ARE MATCHED PAIRING PER TYPE CODE. DIAMETRICAL CLEARANCE 8-12  $\mu$ m (ON DIAM.)
- $\Delta$  CHROME PLATE ACC TO I.T.F. 40-834-00 TYPE BA SEQUENCE 4B --- ON INDICATED SURFACE
- $\Delta$  LAST GRINDING TO  $\frac{1}{2}$  OF FINAL MEASUREMENTS 8.49  $\pm$  0.03 OVER TOTAL AREA OF 9 WITH BOTH RADII, IN ONE TOOLING OPERATION.

**NB: IT IS NOT PERMITTED TO ASSEMBLE CORE AND HOUSE**

Bij vragen direct bellen met afd. R & D tel: 3637

TABLE FOR CHROME PLATE DIMENSIONS

DIAMETER	THICKNESS	ROUGHERNESS
0.170	0.020	0.030
0.230	0.030	0.030
0.450	0.050	0.030

15-5 PH H1025  
1069 MPa  
HAD 61990

EUROPESE  
PROJECTIE  
**DAF**  
DAF Special Products

A330/340 s 790  
CORE experimental type "2" with lee plug

DAF SP

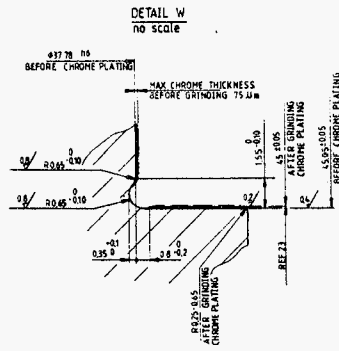
SP 10289

DAF-SP



**NB: IT IS NOT PERMITTED TO ASSEMBLE CORE AND HOUSE**

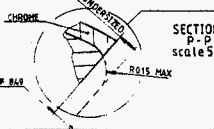
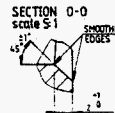
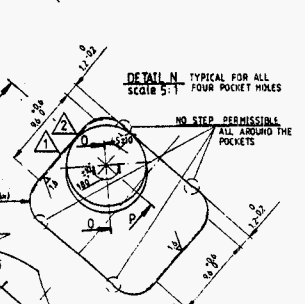
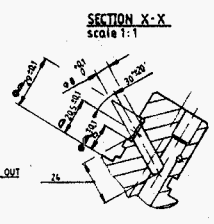
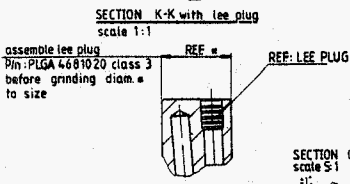
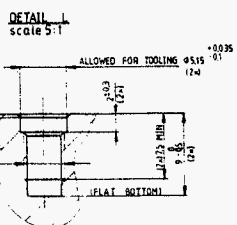
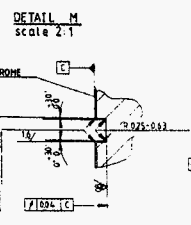
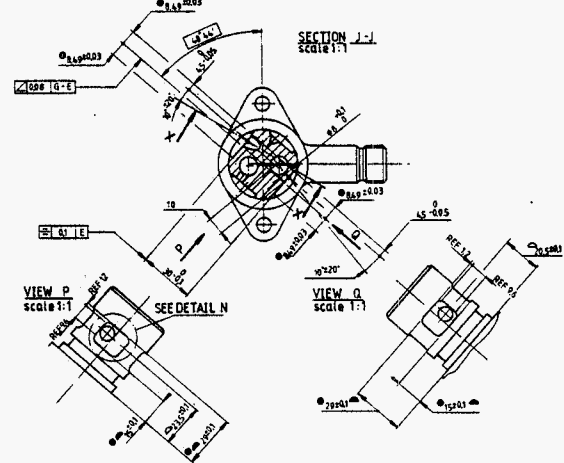
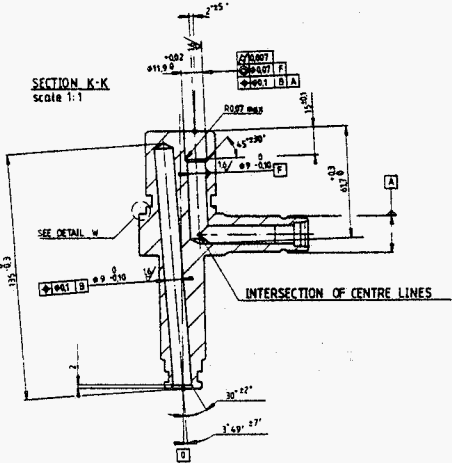
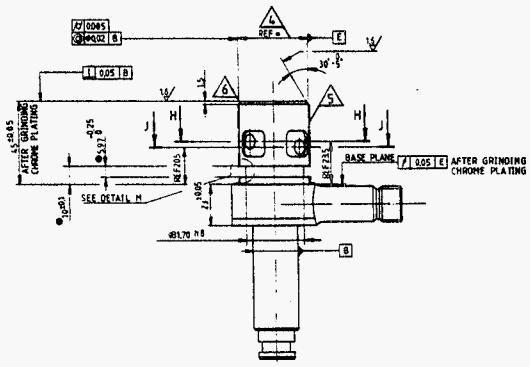
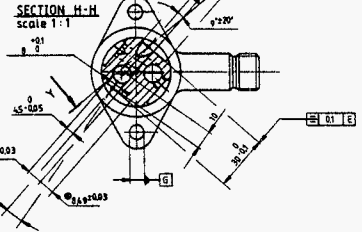
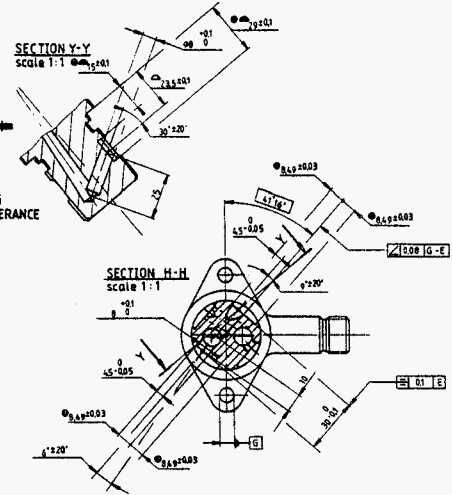
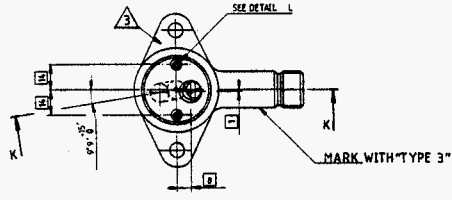
11 PREMACHINING .01mm UNDERSIZED, FOR DIMENSIONS MARKED WITH .15 IS PERMITTED BEFORE CHROME PLATING



- ⚠ LAST GRINDING TO  $\frac{1}{4}$  OF FINAL MEASUREMENTS  $8.69 \pm 0.03$ ; OVER TOTAL AREA OF  $9.6 \pm 0.6$  WITH BOTH RADII, in one tooling operation
- ⚠ ALL POCKETS, SHARP EDGES AFTER GRINDING CHROME PLATING. BEFORE CHROME PLATING RO15 PERMITTED, ON 0.1mm UNDERSIZING
- ⚠ ALLOWABLE AREA FOR HARDNESS-CHECK (331 HB min-401 HB max)
- ⚠ CORE SP10290 AND HOUSE SP10262 ARE MATCHED, DIAMETRICAL CLEARANCE 8-12µm (ON DIAM.) AFTER MATCHING MARK HOUSE WITH "TYPE 3" KEEP HOUSE AND CORE AFTER PAIRING TOGETHER
- ⚠ CHROME PLATING ACC. TO ITF 40-834-00 TYPE IIA SEQUENCE 4B ON INDICATED SURFACE
- ⚠ CHROME RUN OUT PER NCT 40-834-11
- 8 FLAW DETECTION ACC. TO GEN 73-02
- 9 MAX. THICKNESS OF CHROME TO APPLY: 75µm PER SIDE
- 10 BEWARE: THE MARKED DIMENSIONS SHOULD BE GRINDING TO FINAL DIMENSION AFTER GRINDING OF THE INDICATED BASE PLANE. THE DIMENSIONS MARKED  $\ominus$  STAY WITHIN THEIR TOLERANCE

TABLE FOR CHROME PLATE DIMENSIONS

DIM BEFORE CHROME PLATING	$\ominus 3170$
DIM AFTER GRINDING, SEE $\ominus$ 15mm note	$\ominus 3170$
SURFACE ROUGHNESS BEFORE PLATING	Ra 0.4
SURFACE ROUGHNESS AFTER PLATING	Ra 0.2



$\ominus 3170$ M8	$\ominus 3170$
$\ominus 3170$ M4	$\ominus 3170$
$\ominus 3170$ M6	$\ominus 3170$

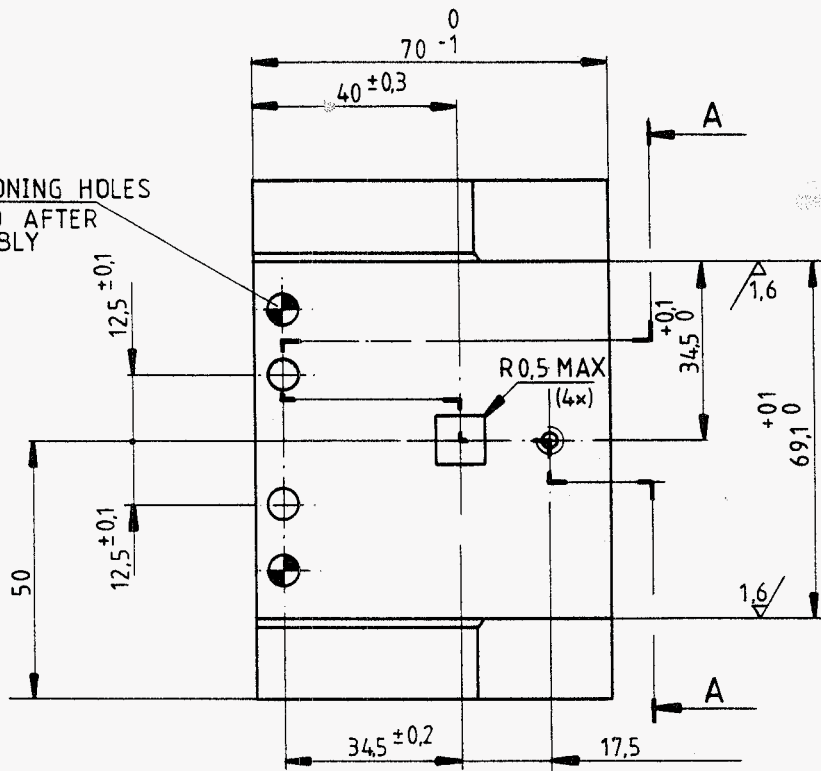


NB: Bij vragen direkt bellen met afd. R&D tel: 3637

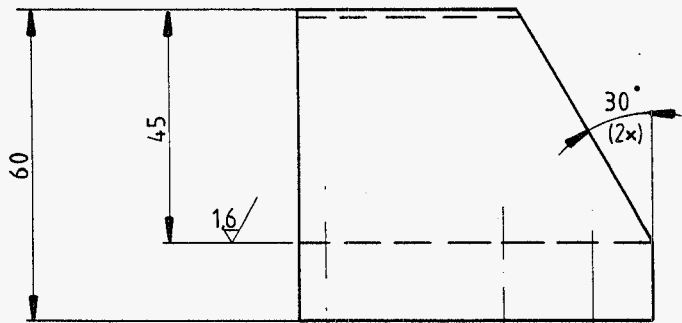
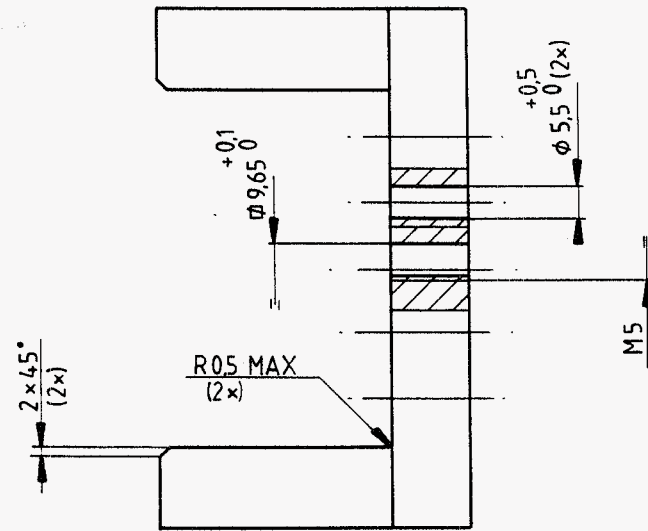
CORE experimental type "3" with lee plug	
Scale	1:1
Author	AO
Date	31-06-05
SP10290 /	

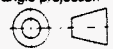



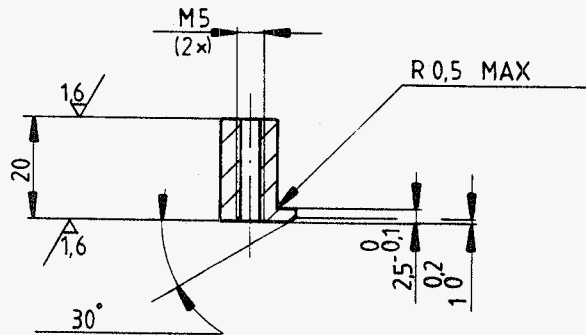
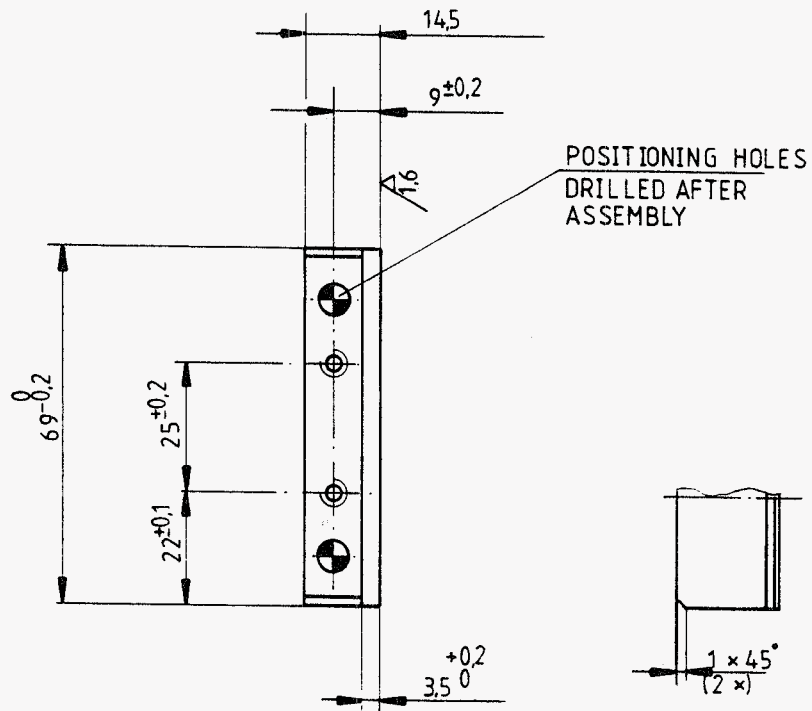
POSITIONING HOLES  
DRILLED AFTER  
ASSEMBLY



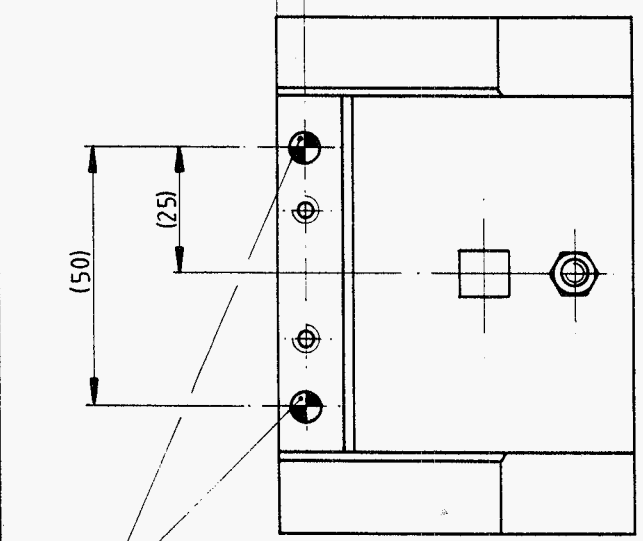
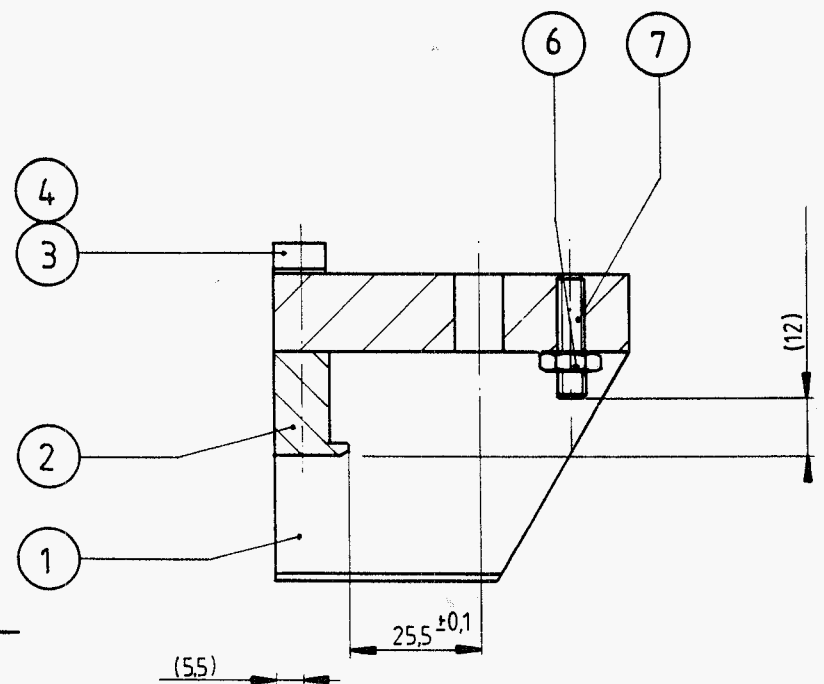
SECTION A-A



micro	c	s	mso	modification description		date	drawn by	auth. by	mod. no.	issue
±0,5	±1°			tolerance principle	refer to DAF-std.					
dimensions in mm					for drawing interpretation	BASE PLATE TORQUE TOOL				
checked to standards				date	third angle projection					
material sign off				date	material	This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		sheet		
authorised by				date	heat/surface treatment	regulated items	scale	model number		
drawn by				date	paint spec.	product spec.	size	drawing/issue number		
				P.v.Berlo	91-06 - 13		A3	SP10292/		
similar to					supersedes	superseded by				

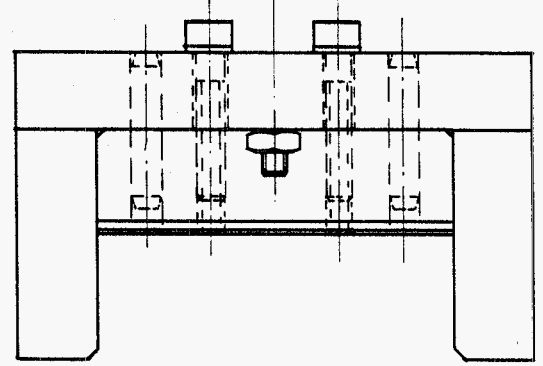


micro	c to s	mso	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance			tolerance principle	refer to DAF-std.	POSITIONING STRAP				
±05 ±30'			for drawing interpretation						
dimensions in mm			third angle projection		This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.				
checked to standards									
material sign off			date	material	regulated items	scale	sheet		
authorised by			date	heat/surface treatment	1 : 1		1 of 1 <b>DAF</b>		
drawn by			date	paint spec.	product spec.	size	model number		
P.v.Berlo			91-06-13			A3	drawing/issue number		
similar to			supersedes		superseded by				

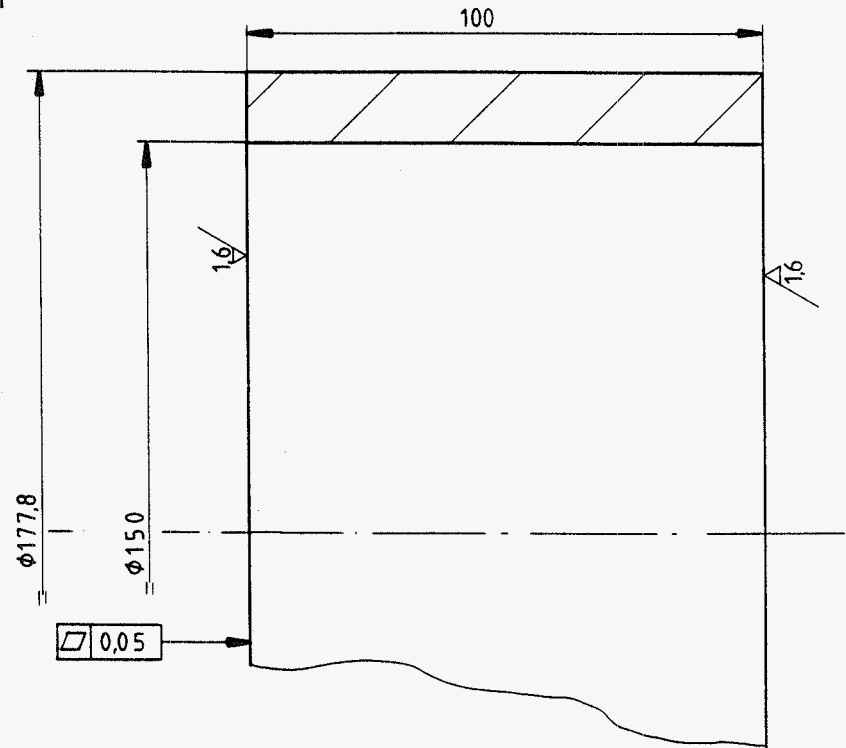
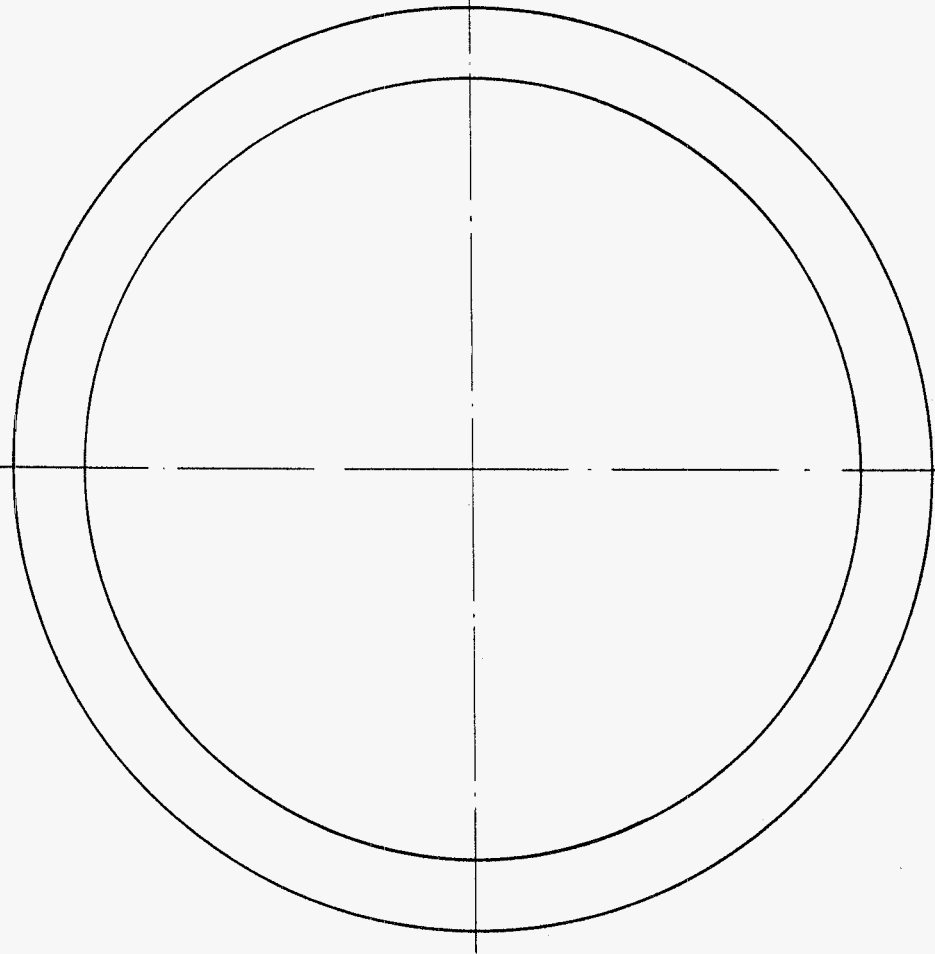


5 DRILL HOLES  $\phi 6 H7 (2 \times)$  AFTER POSITIONING POS 2

7		1		M5 x 25	STELSCHROEF DIN 916 GL	
6		1		M5	MOER, ZESK.	
5	DIN 7979	2	ST	$\phi 6 m6 \times 30$	PASPEN	
4		2		$\phi 5,5$	SLUITRING	
3		2		M5 x 30	CIL.KOPSCHROEF m.b.z.	
2	SP 10293	1	C 60 / 0 4 0 1 1	20 x 14,5 x 69	POSITIONING STRAP	
1	SP 10292	1	C 60 / 0 4 0 1 1	100 x 60 x 70	BASE PLATE TORQUE TOOL	
Pos.	Bl.	Code / werkst.nr.	aantal	Materiaal	Afmetingen	Benaming / omschrijving



micro	c to s	mso	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	tolerance principle	refer to DAF-std.	title	ASSEMBLY TORQUE TOOL				
$\pm 0,5$								
dimensions in mm		for drawing interpretation		This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.				
checked to standards	date	third angle projection						
material sign off	date	material	regulated items	scale	sheet			
authorised by	date	heat/surface treatment			1 : 1	1 of 1 <b>DAF</b>		
drawn by	date	paint spec.	product spec.	size		model number		
	P.v.Berlo	91-06-13		A3	drawing/issue number			
similar to		supersedes	superseded by	SP10294/				



125/

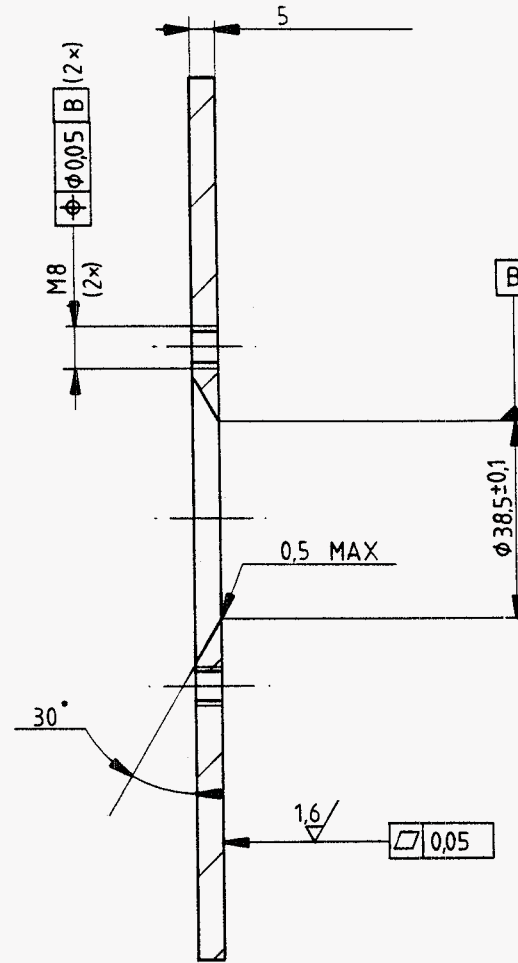
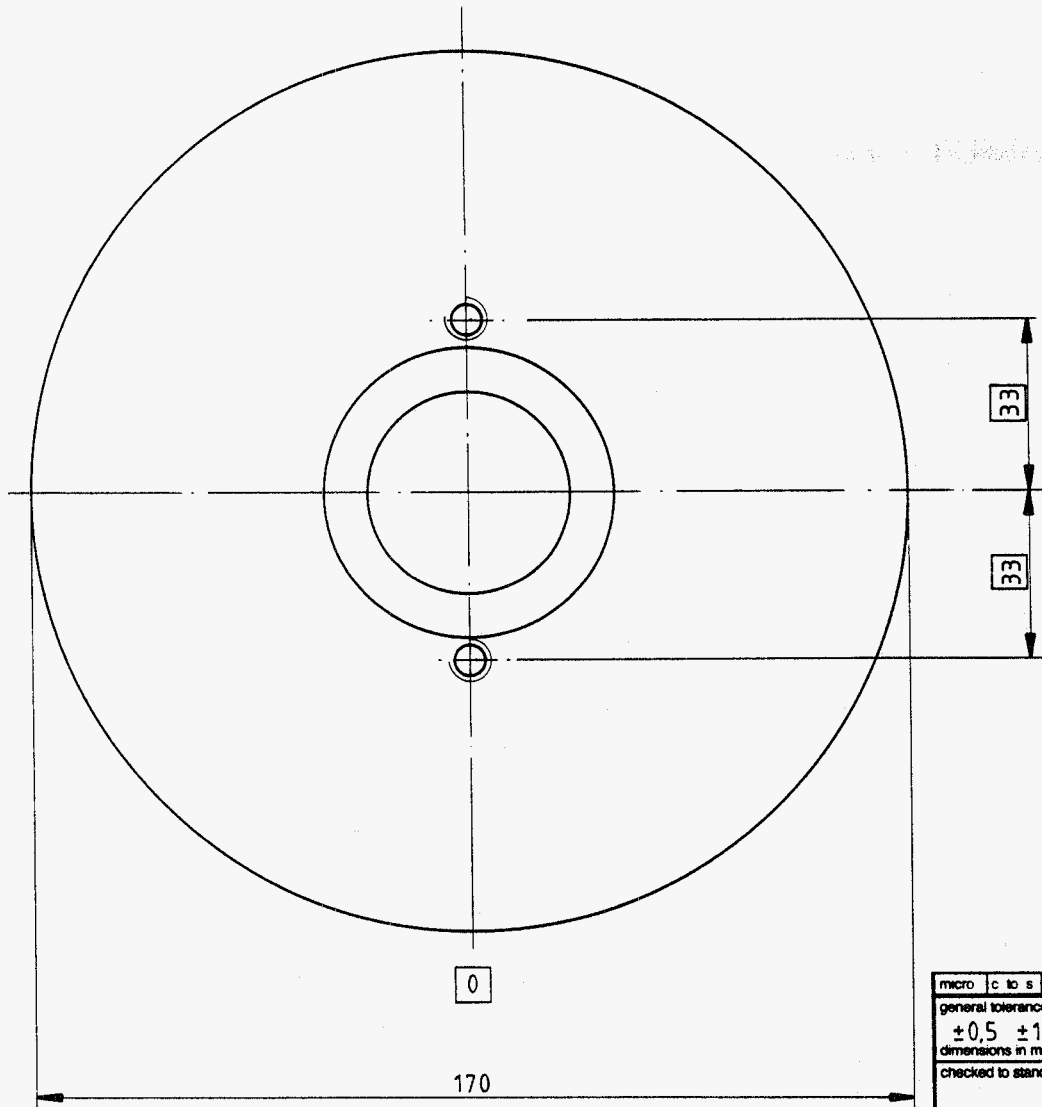
micro	c to s	mso	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance	±1	dimensions in mm	tolerance principle	refer to DAF-std.				<b>POSITIONING RING</b> <b>for ionic nitriding S.V.</b>	
checked to standards		date		for drawing interpretation					
material sign off		date	material	ST 52			<small>This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.</small>		sheet 1 of 1
authorised by		date	heat/surface treatment	/			regulated items	scale	model number
drawn by	P.v.Berlo	91-06-14	paint spec.				product spec.	size	drawing/issue number
similar to			supersedes					A3	SP 10295/

1

2

5

6



3.2

micro	c to s	rnc	modification description	date	drawn by	auth. by	mod. no.	issue
general tolerance	±0,5 ±1	dimensions in mm	tolerance principle refer to DAF-std.					
checked to standards	date		for drawing interpretation third angle projection					
material sign off	date		material ST 52					
authorised by	date		heat/surface treatment /					
drawn by	date		paint spec.					
similar to			supersedes					
This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.				regulated items	scale 1 : 1	sheet 1 of 1		
				product spec.	size A3	drawing/issue number SP10296 /		
				superseded by				

1

2

5

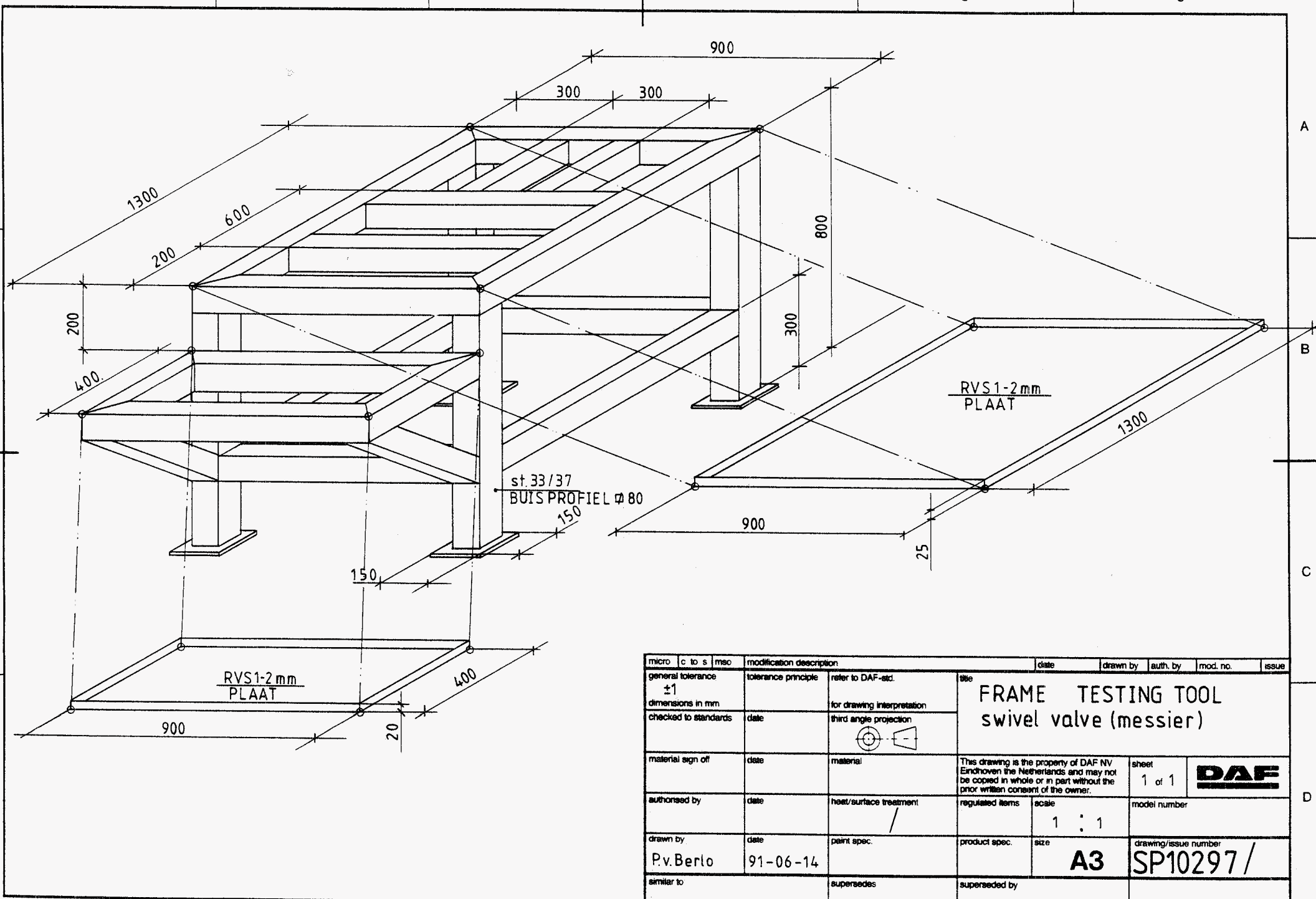
6

A

B

C

D



micro	c to s	meso	modification description		date	drawn by	auth. by	mod. no.	issue
general tolerance	±1		tolerance principle	refer to DAF-std.	<b>FRAME TESTING TOOL</b> <b>swivel valve (messier)</b>		This drawing is the property of DAF NV Eindhoven the Netherlands and may not be copied in whole or in part without the prior written consent of the owner.		
dimensions in mm	checked to standards		date	for drawing interpretation					
material sign off	date	material	heat/surface treatment	regulated items	scale	sheet		<b>DAF</b> 1 of 1	
authorised by	date	paint spec.	product spec.	size	model number				
drawn by	date	supersedes		superseded by		drawing/issue number		<b>A3</b> <b>SP10297/</b>	

1

2

5

6



III ELECTRIC MOTOR CALCULATION

The driving disc must be able to run at two velocities namely at 0.5 rot./s for test manoeuvre A and at 1.5 rot./s for test manoeuvre B.

When a transmission between the electric motor and the driving disc is used with two identical disc pairs, one driving belt can be used to switch between the discs (see figure III.1).

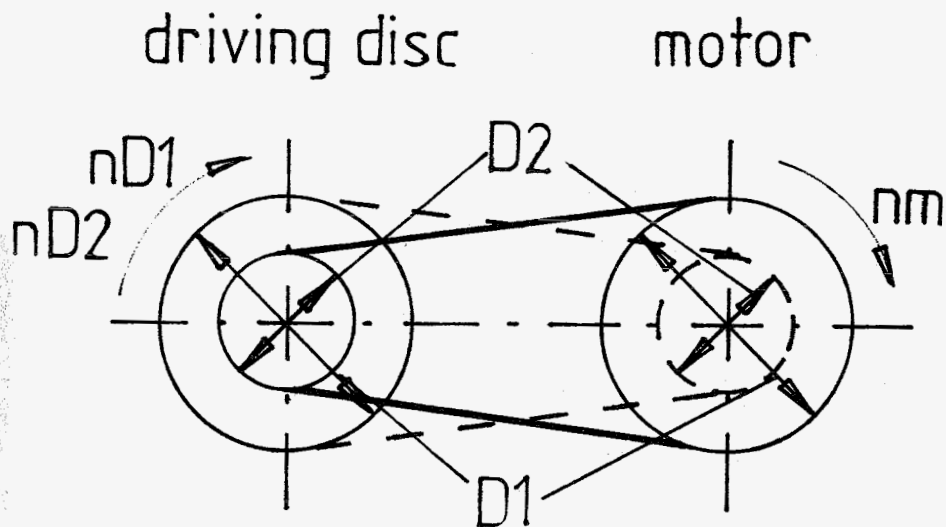


Figure III.1 : Transmission between electric motor and driving disc.

When using 1 driving belt and 2 identical disc pair to achieve the 2 different angular velocities for the driving disc, the relation between the diameters on the disc pairs can be calculated.

One disc pair is connected to the electric motor shaft and the other disc pair is connected to the driving disc shaft. The combination in transmission between the 2 discs is :

motor --- driving disc

- 1) small diameter --- large diameter --> 0.5 rot./s
- 2) large diameter --- small diameter --> 1.5 rot./s

with using 2 identical large diameters and 2 small diameters.

If we are using one driving belt and 2 identical disc pairs to achieve the 2 different angular velocities for the driving disc, the relation between the diameters on the disc pairs can be calculated.

One disc pair consist of 2 disc with diameter D1 and D2.  
nD1 and nD2 are the angular velocities of the driving disc  
with values : nD1=1.5 rotations/s  
nD2=0.5 rotations/s.

Because of the same velocities at the edge of the disc 1 and disc 2 of the disc pair and nm is the motor angular velocity then :

$$v_1 = v_2 = n_m \times D_1 = n_{D1} \times D_2 \rightarrow n_{D1} = n_m \times D_1/D_2 = 1.5$$
$$\text{and } v_2 = v_1 = n_m \times D_2 = n_{D2} \times D_1 \rightarrow n_{D2} = n_m \times D_2/D_1 = 0.5$$

$$\text{so } D_1/D_2 = \sqrt{3}$$
$$\text{and } n_m = 0.87 \text{ rotations/s}$$

So the needed angular velocity for the electric motor is 0.87 rotations per second.

The following diameters for the discs have been selected :

$$D_1 = 180 \text{mm}$$

$$D_2 = 112 \text{mm}$$

From earlier tests it is known the maximum torque between house and core of the Swivel Valve is 36Nm. Building in a

safety factor of 2 the torque is 72Nm.  
Considering this torque and considering testing for 4 configurations at once, the power needed can be calculated. It is assumed that the absolute torque in the house is constant maximum (see figure III.2).

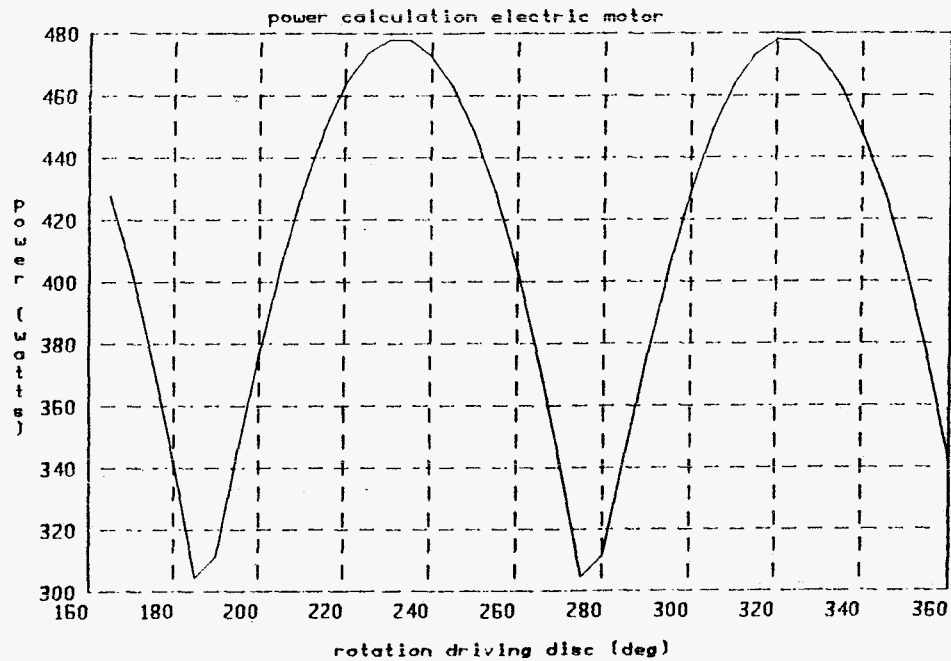


figure III.2 : Power used for 4 Swivel Valve configurations versus rotation driving disc.

Figure III.2 shows that the maximum power is 477.98 Watts.

Regarding this it was decided to choose an Electrim

Electric motor with build on reduction case :

electric motor : Kollmer SKG 90S4

1.1 KW 1415r 2/3V 50Hz

B5, Ip-54, iso-F

reduction gear : RF2/63 1:25

case N2=56rot./min.

B5 flens construction,

axle 35x70mm

servo factor 2:1

-III4-

So the angular velocities for the driving disc will be :

$$nD1 = nm \times D2/D1 = 1.5 \text{ rotations/s}$$

$$\begin{aligned} nD2 &= nm \times D1/D2 = 56/60 \times 112/180 \\ &= 0.58 \text{ rotations/s} \end{aligned}$$