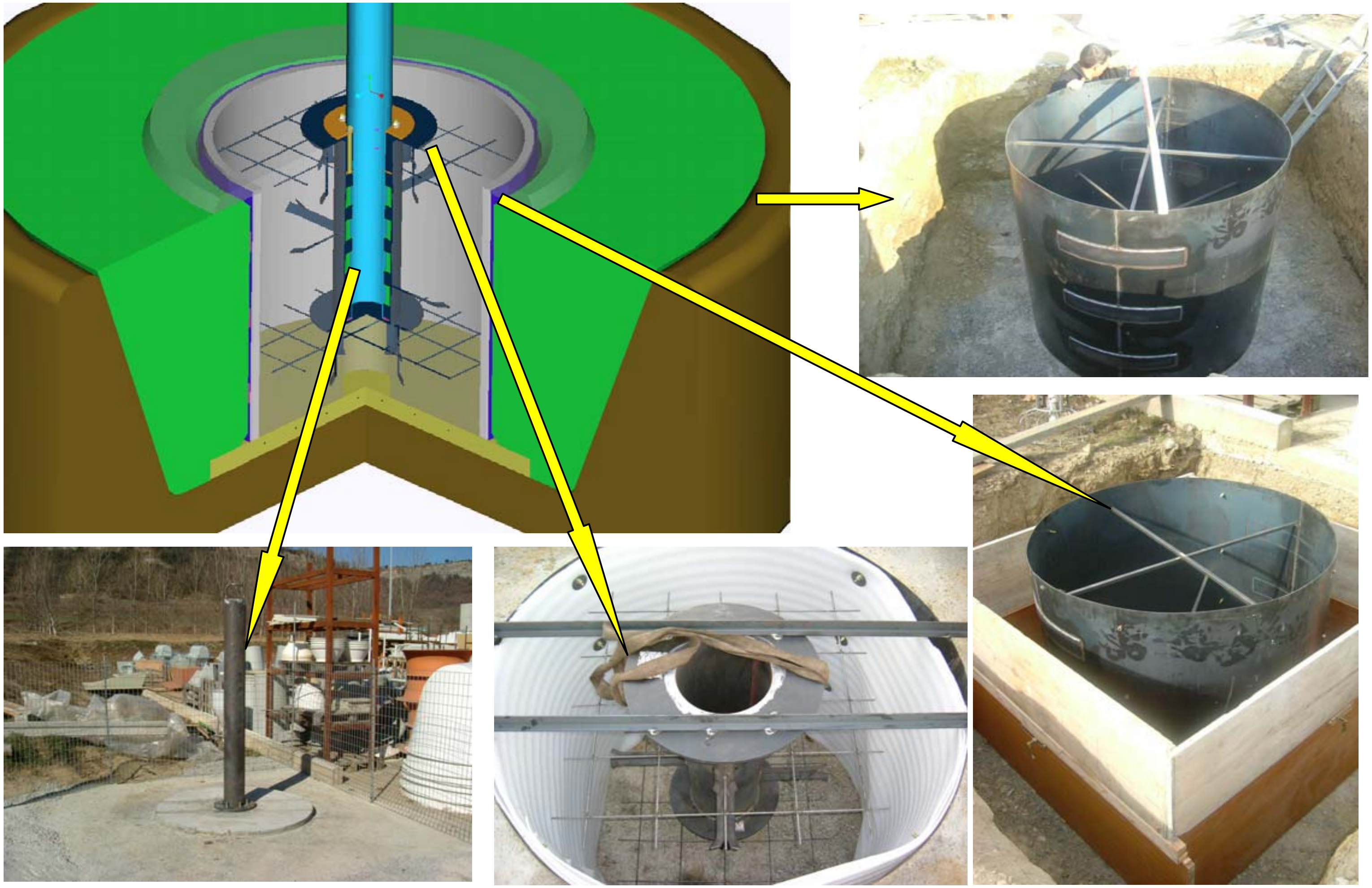
FIELD TESTING

Lab and Field Monitoring

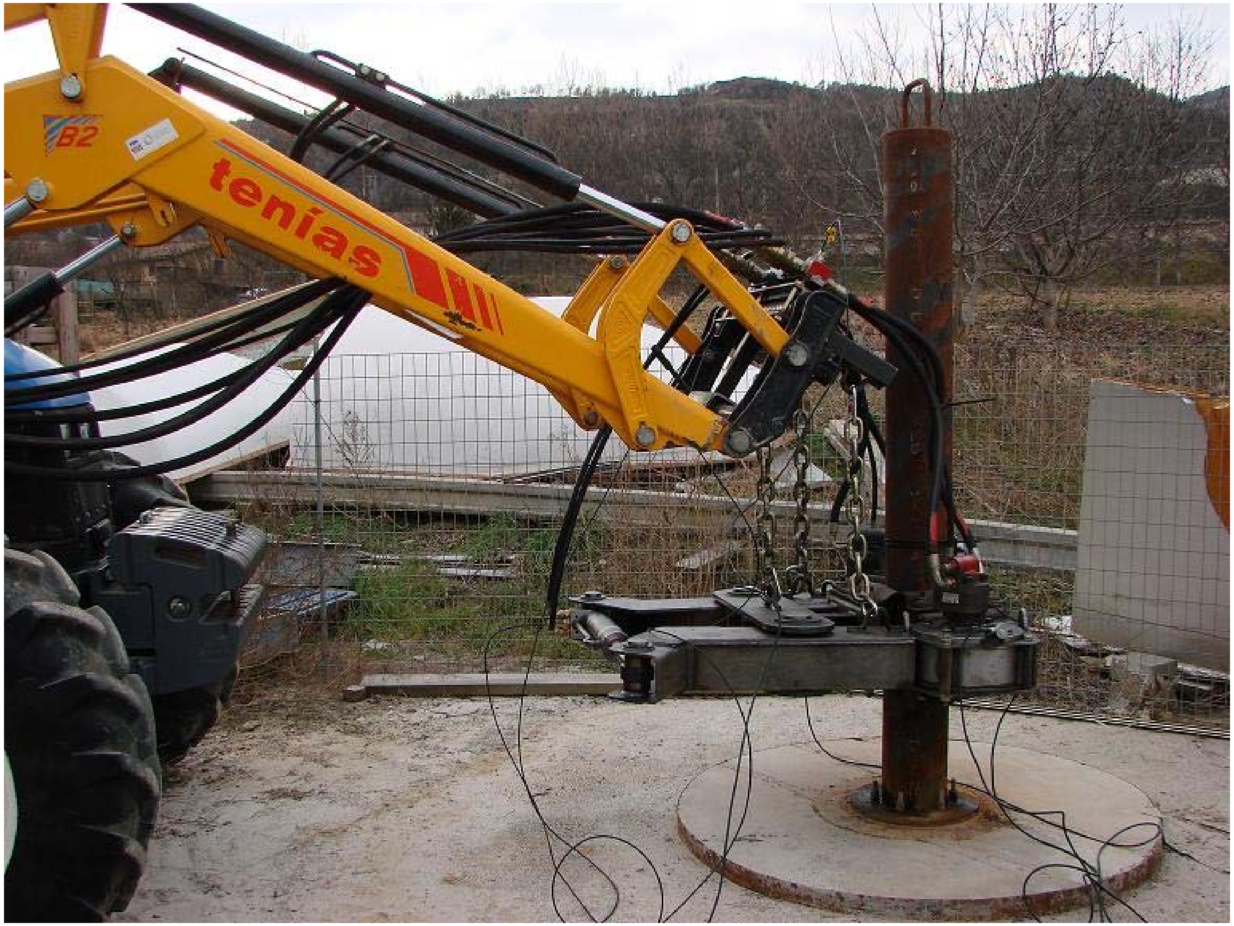
(Indoor test bench)

Indoor TEST BENCH



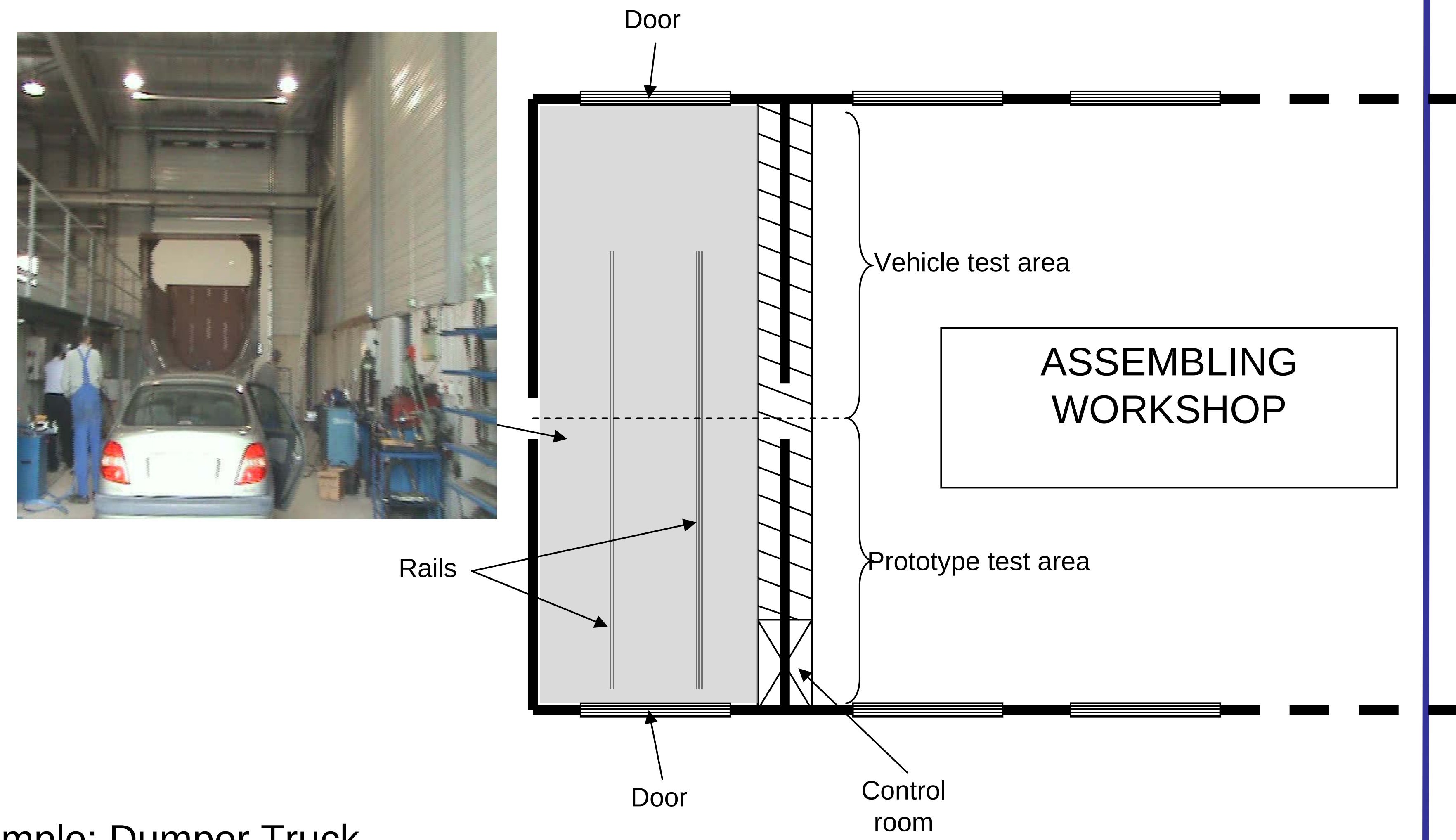
Example: Tree shaker
AGRIC test bencH
(reflecting real operating systems)

Indoor TEST BENCH



Example: Tree shaker
AGRIC test bencH
(reflecting real operating systems)

Indoor TEST BENCH



Door

Vehicle test area

ASSEMBLING WORKSHOP

Rails

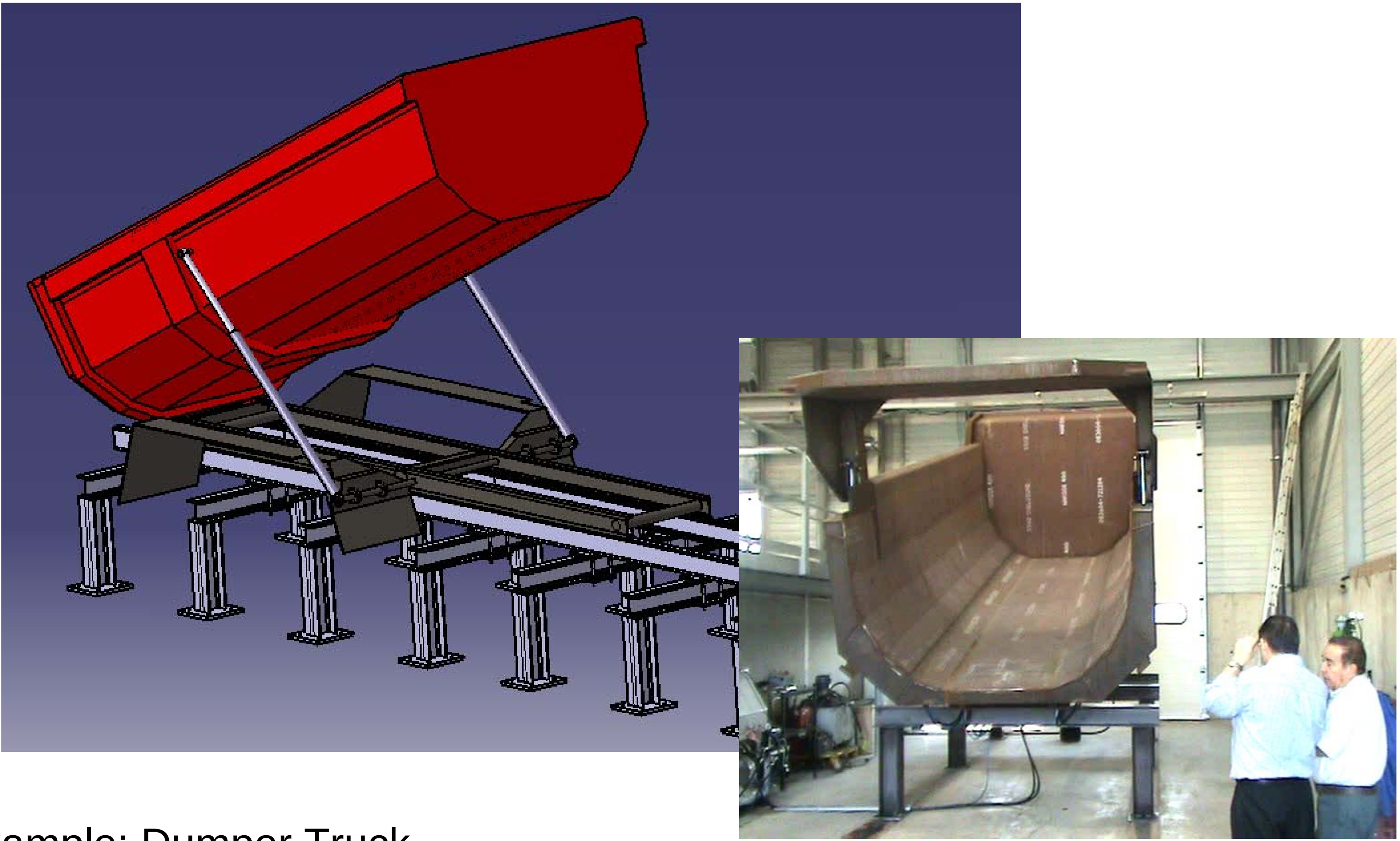
Prototype test area

Door

Control room

Example: Dumper Truck
Sempere test bench
(reflecting real operating systems)

Indoor TEST BENCH

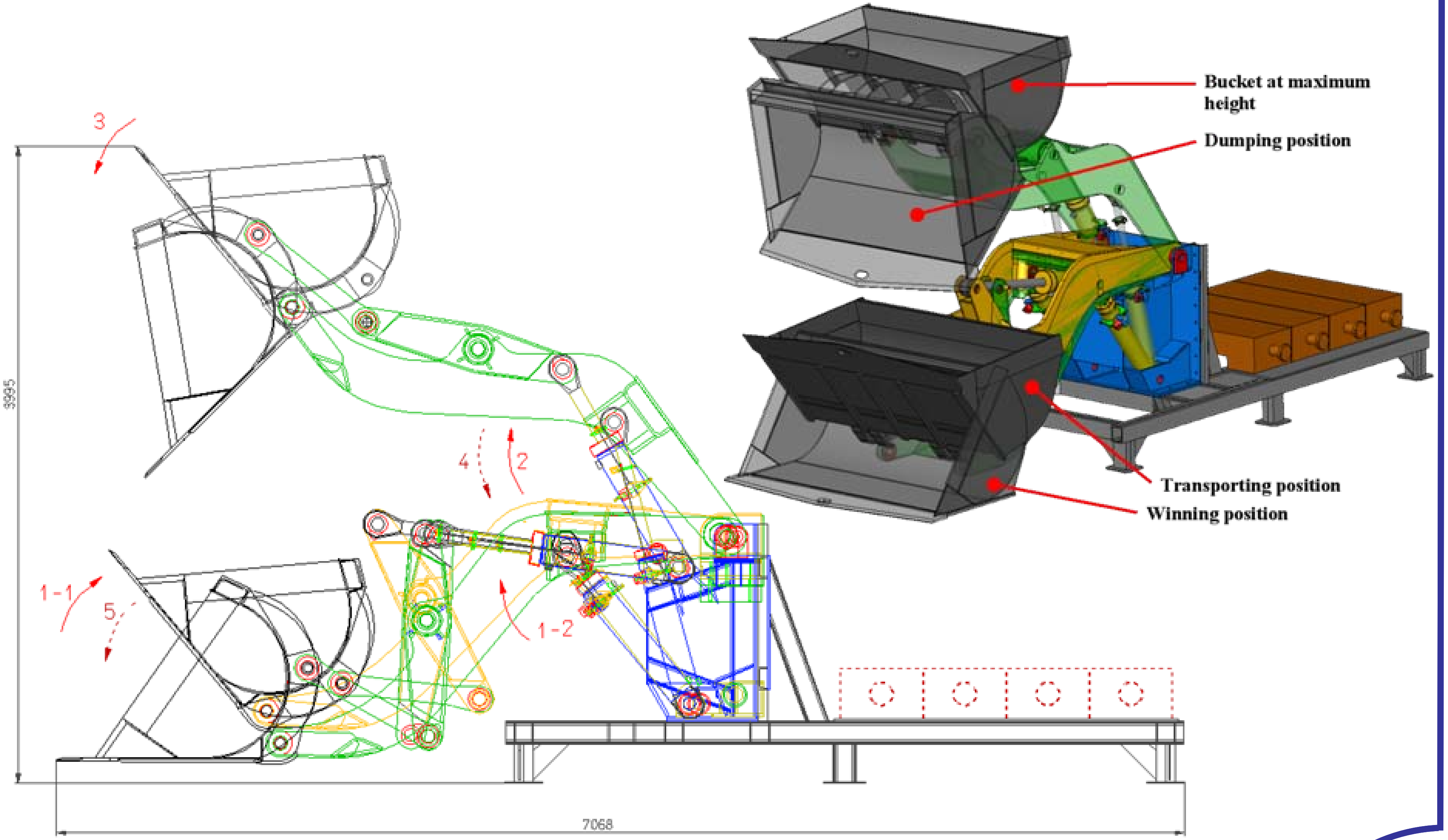


Example: Dumper Truck
Sempere test bench
(reflecting real operating systems)

Indoor TEST BENCH

Example: Dumper Truck
Sempere test bench
(reflecting real operating systems)

Indoor TEST BENCH



Test bench motions sequence.

1-1, 1-2 – winning (bucket closing and boom rising), 2 – preparing to dumping (rising the boom at max height), 3 – dumping (bucket opening), 4 – preparing to winning (boom lowering and bucket closing)

Indoor TEST BENCH

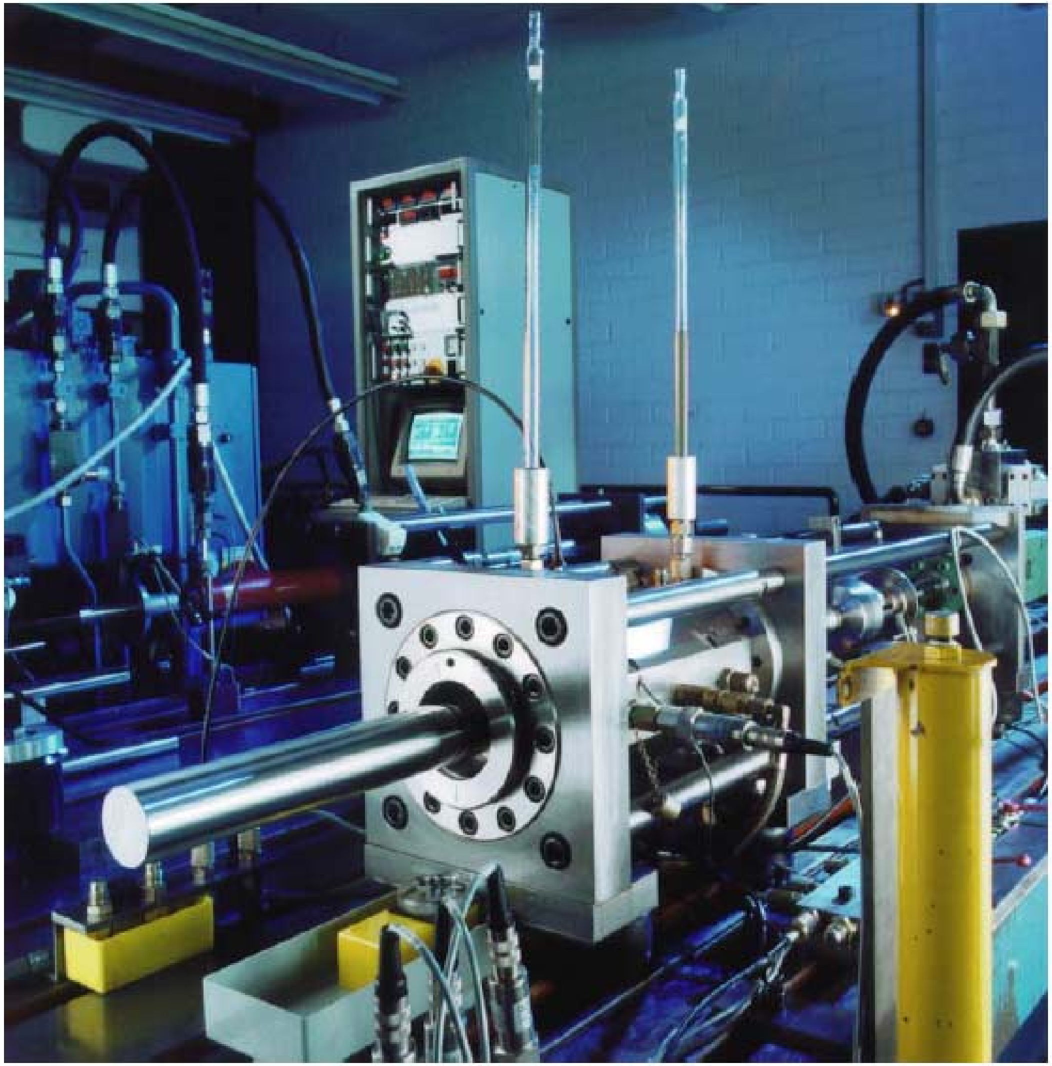
Examples: Mining Loader
Fadroma test bench
(reflecting real operating systems)

Lab tests

Test rig H6 for Rod Seals (Endurance testing of Sealing Systems)

Testing Conditions:
Pressure: 0 - 30 MPa
Medium: Öl HLP 46
Temperature: 60 °C
Velocity: 0,2 m/s
Stroke length: 280 mm
Endurance:
250.000 - 1 Mio.
Double strokes

Test bench by Trelleborg

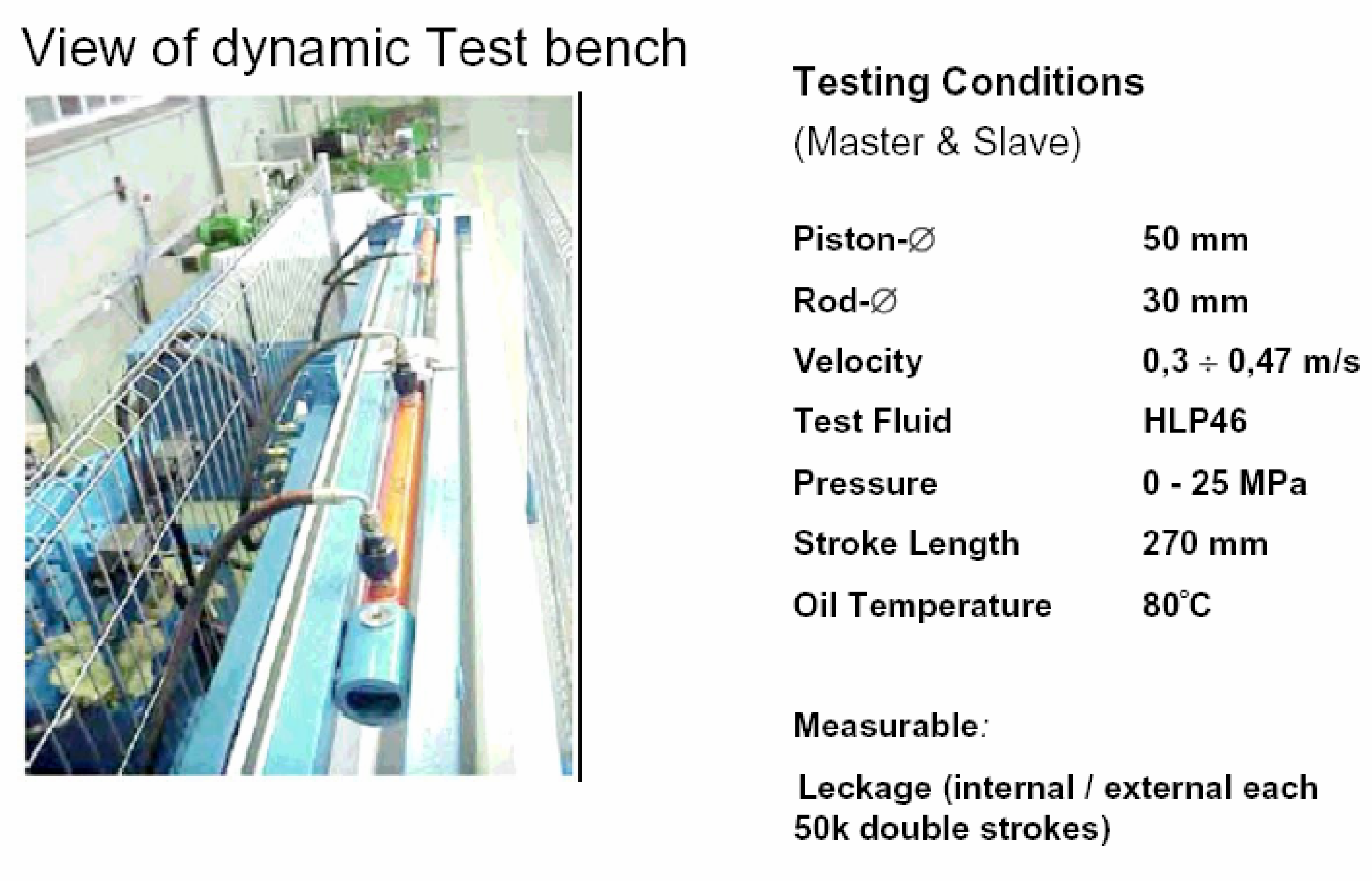


Test rig H2/H3 for Rod Seals
(single seals)

Testing Conditions:
Pressure: 0 - 20 MPa
Medium: Öl HLP 46
Temperature: 30 - 50 °C
Velocity: 0,01 - 0,4 m/s
Stroke length: 250 mm
Endurance: 66 hours

Test bench by Trelleborg

Test bench Pedro Roquet SA



View of dynamic Test bench

Testing Conditions

(Master & Slave)

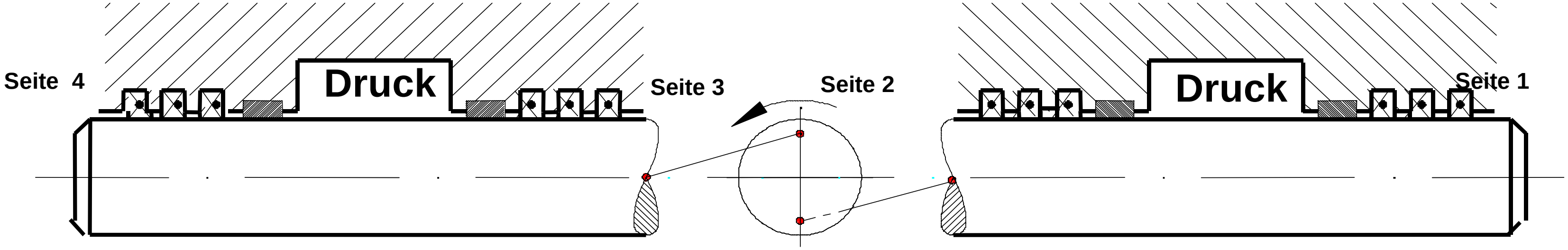
Piston-∅	**50 mm**
Rod-∅	**30 mm**
Velocity	**0,3 ÷ 0,47 m/s**
Test Fluid	**HLP46**
Pressure	**0 - 25 MPa**
Stroke Length	**270 mm**
Oil Temperature	**80°C**

Measurable:

Leckage (internal / external each 50k double strokes)

2. Testing of Rod Seals

Endurance Rod Seal Test Rig



Testing Conditions

Rod-∅	**32 mm**
Velocity	**0,2 m/s**
Test Fluid	**HLP46**
Pressure	**20 MPa const.**
Stroke Length	**200 mm**
Oil Temperature	**60˚C**

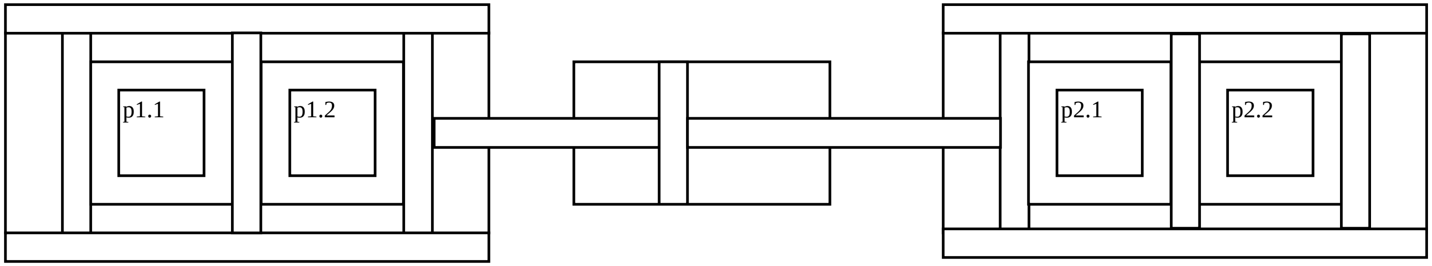
Measurable*:*

- **Pressure**
- **Leakage**
- **Oil temperature**
- **Stroke Length**

Test bench by Trelleborg

Piston Seal Test Rig

Schematic:

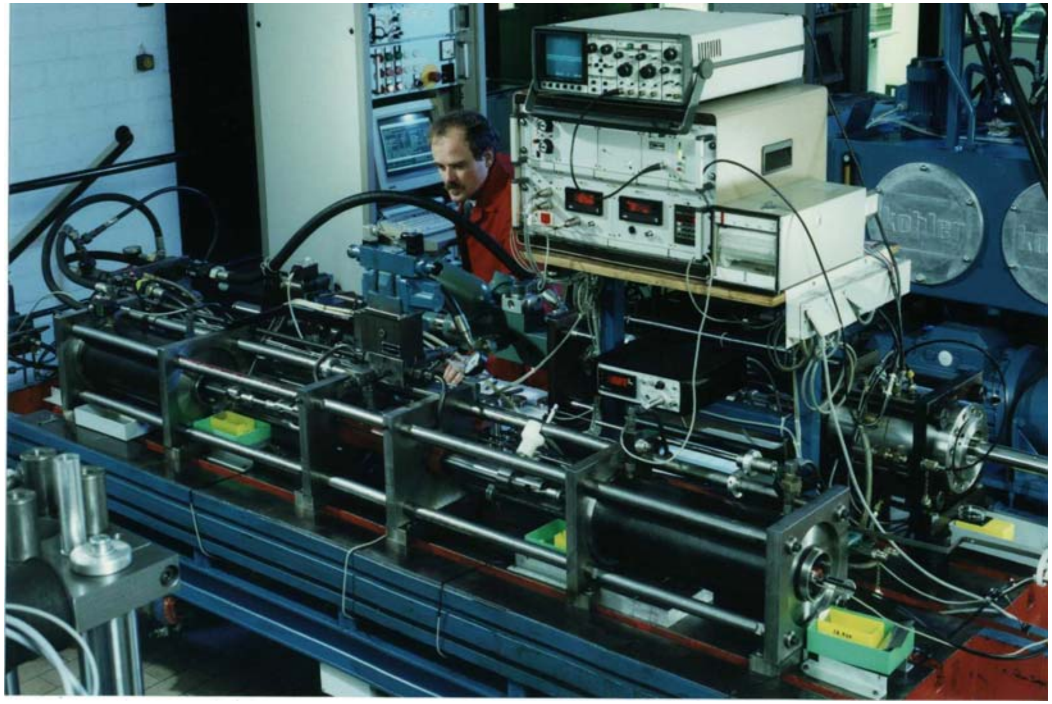


Testing Conditions

Piston-∅	**80 mm**
Velocity	**0,2 m/s**
Test Fluid	**HLP46**
Pressure	**0 - 30 MPa**
Stroke Length	**200 mm**
Oil Temperature	**60°C**

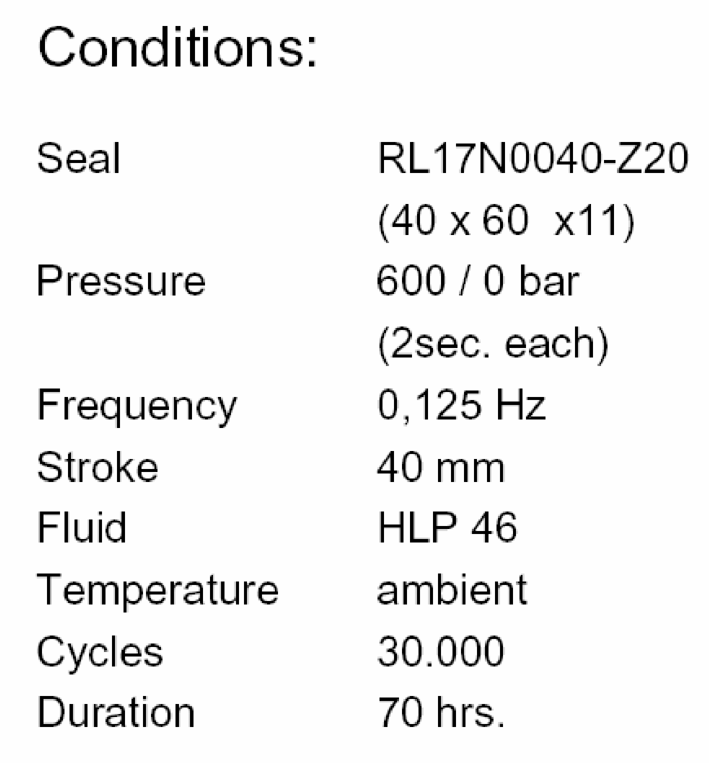
Measurable:

Pressure
Leakage
Oil temperature
Stroke Length
Friction Force



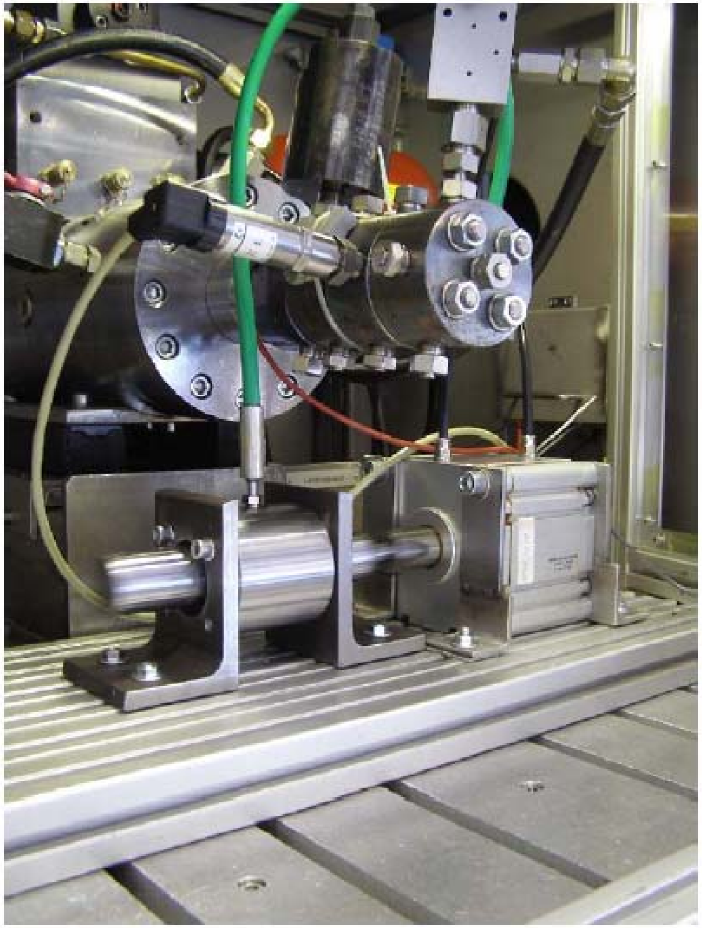
Test bench by Trelleborg

ROD SEALS
(High pressure)



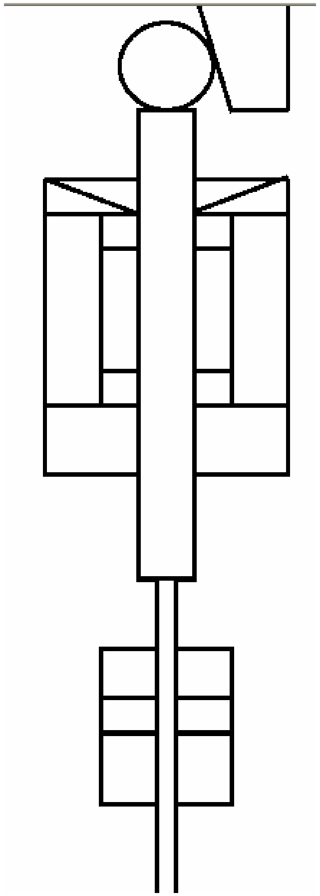
Conditions:

Seal	RL17N0040-Z20 (40 x 60 x11)
Pressure	600 / 0 bar (2sec. each)
Frequency	0,125 Hz
Stroke	40 mm
Fluid	HLP 46
Temperature	ambient
Cycles	30.000
Duration	70 hrs.

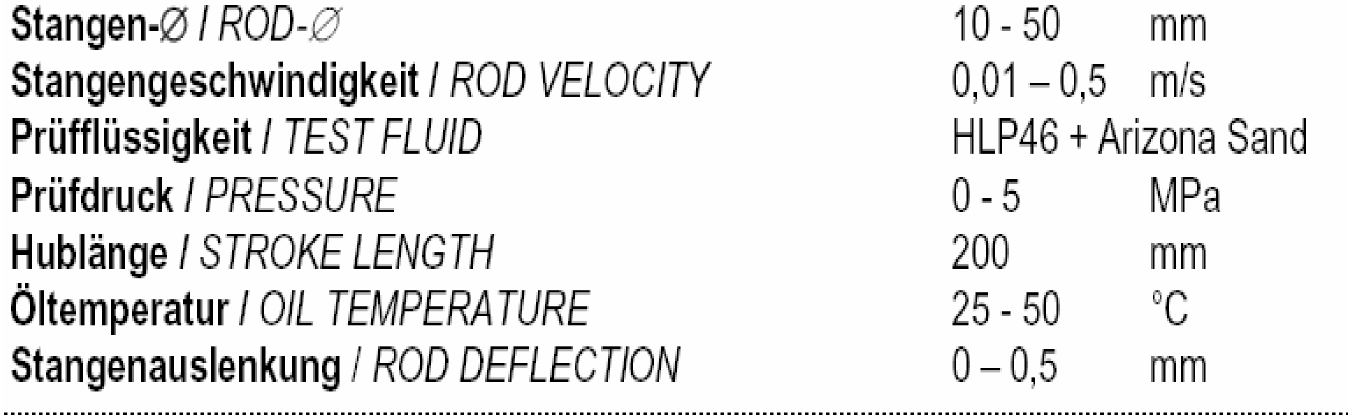


Test bench by Trelleborg

WIPER ENDURANCE TEST

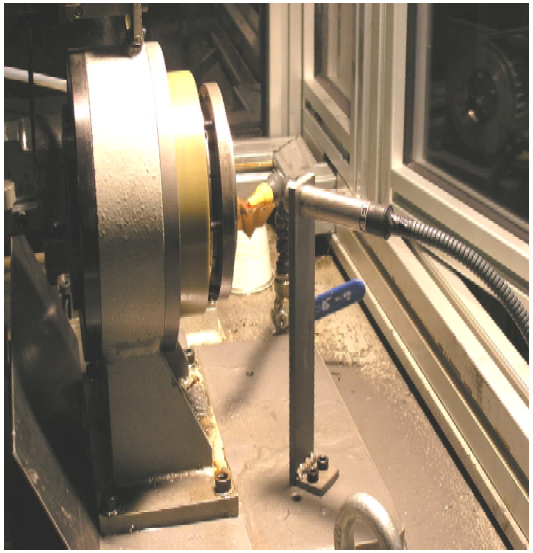


Test bench by Trelleborg



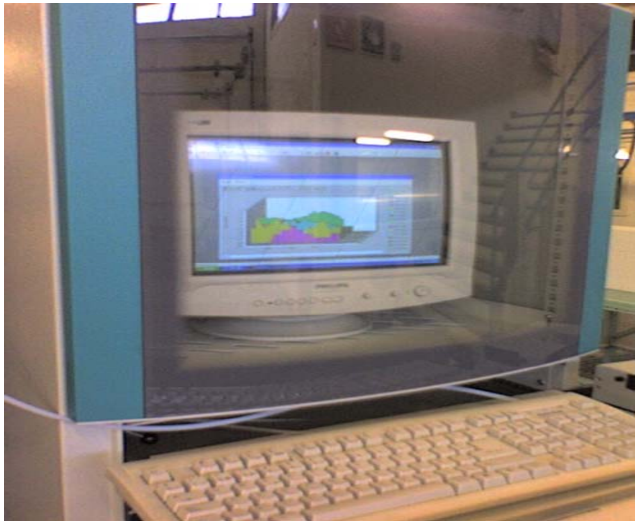
Stangen-Ø / *ROD-Ø*	10 - 50	mm
Stangengeschwindigkeit / *ROD VELOCITY*	0,01 – 0,5	m/s
Prüfflüssigkeit / *TEST FLUID*	HLP46 + Arizona Sand	
Prüfdruck / *PRESSURE*	0 - 5	MPa
Hublänge / *STROKE LENGTH*	200	mm
Öltemperatur / *OIL TEMPERATURE*	25 - 50	°C
Stangenauslenkung / *ROD DEFLECTION*	0 – 0,5	mm

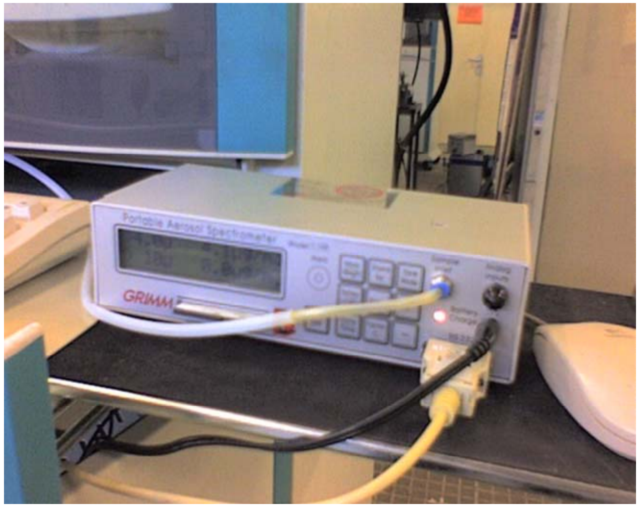
Honing test bench



HONINGTEC

OIL MIST

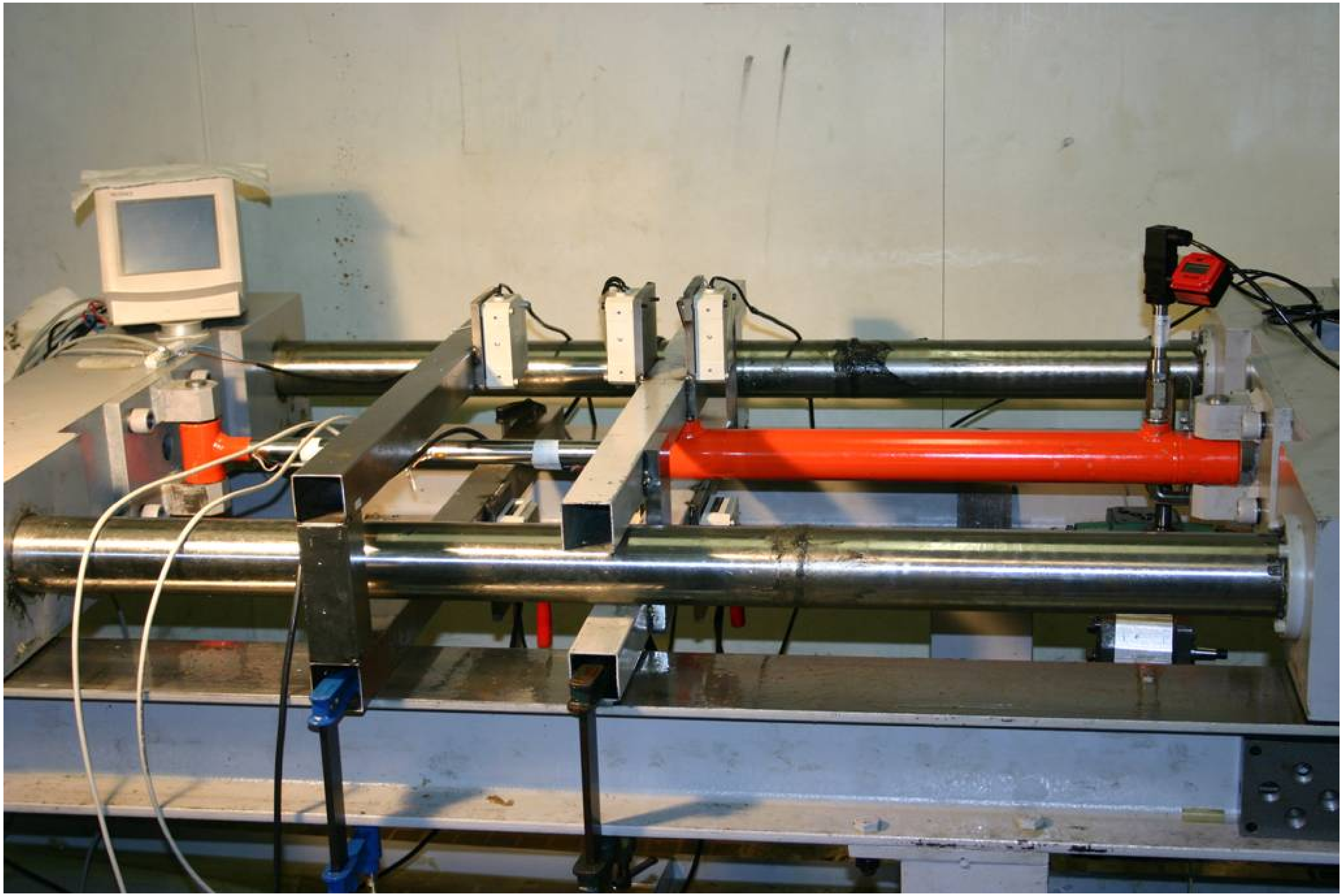




ALTERNATIVE TEST BENCH

PEDRO ROQUET SA

BUCKLING TEST BENCH



LABSON

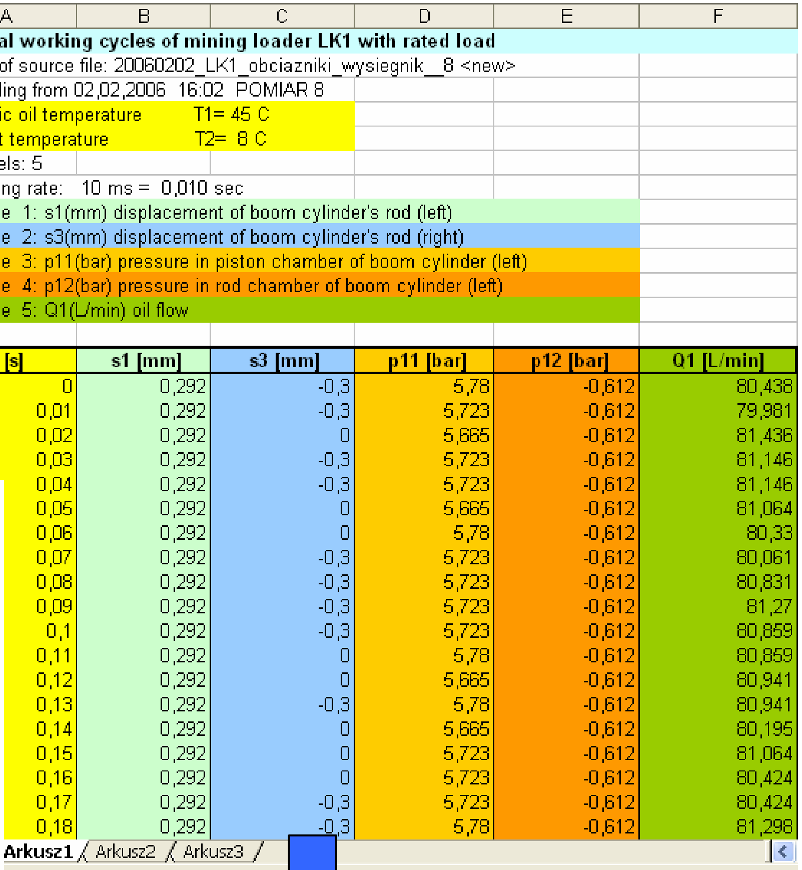
CUSHIONING TEST BENCH

PEDRO ROQUET

ACQUIRED DATA

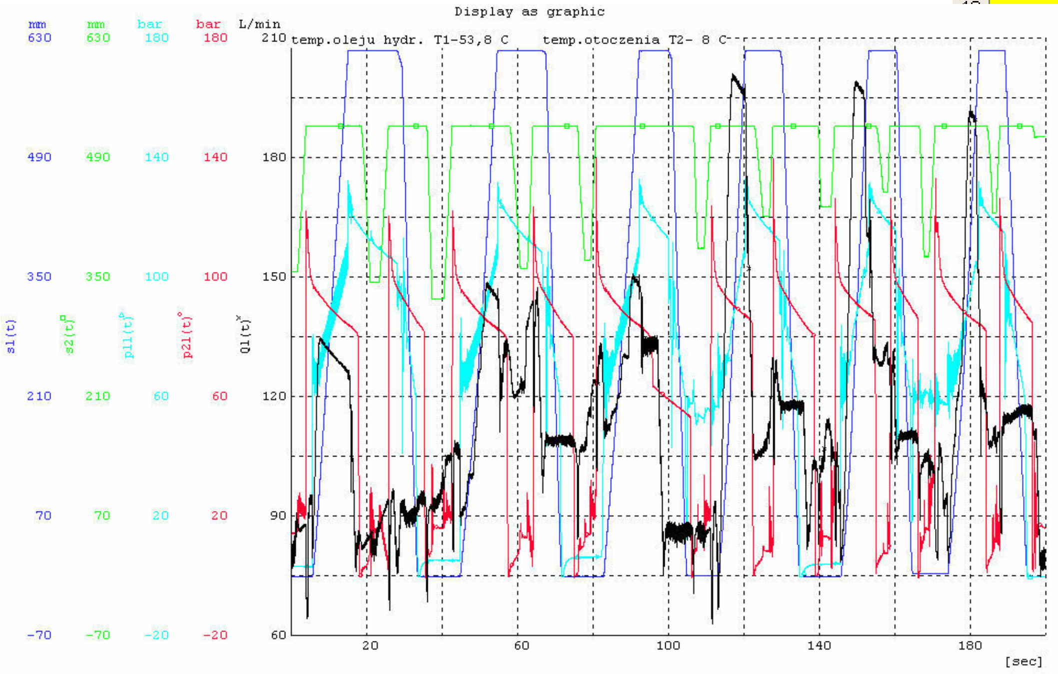
Measured parameters:

- Pressure in piston chamber
- Pressure in rod chamber
- Hydraulic oil temperature
- Ambient temperature
- Piston displacement
- Hydraulic oil cleanness
- Hydraulic oil flow

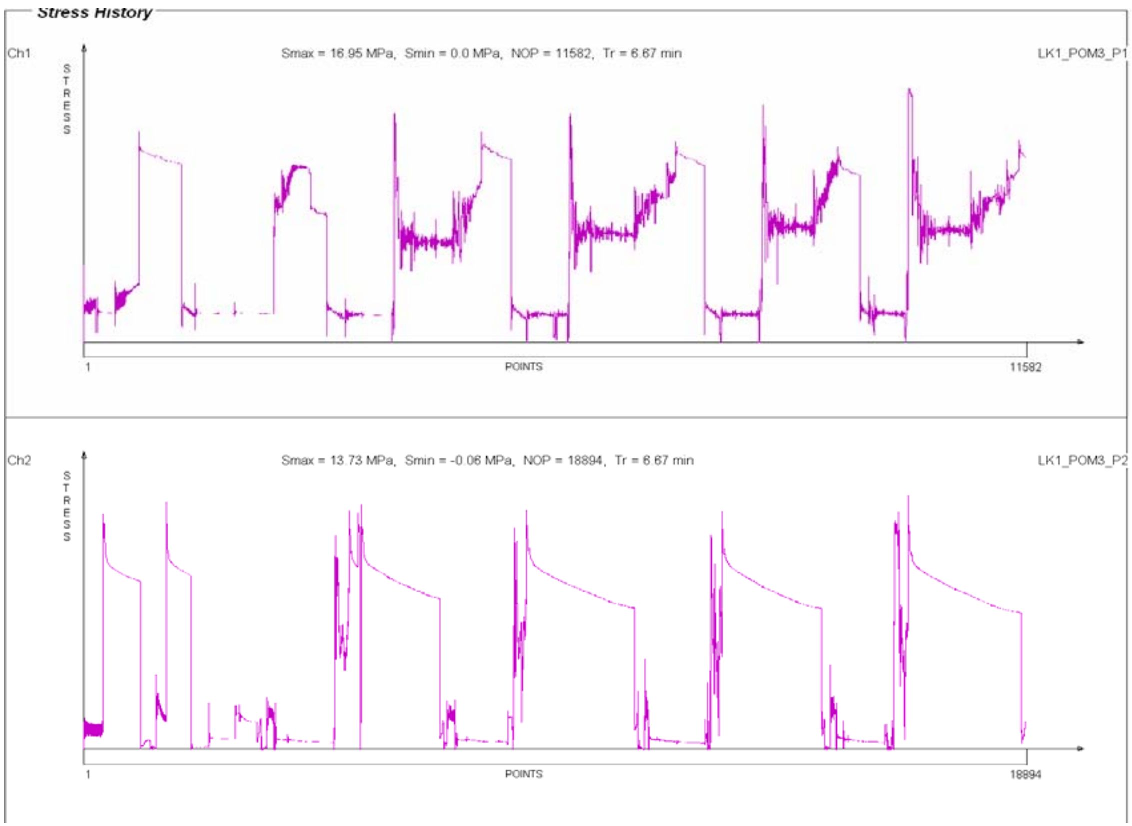


Seweral working cycles of mining loader LK1 with rated load
\Name of source file: 20060202_LK1_obciazniki_wysiegnik__8 <new>
\Recording from 02.02.2006 16:02 POMIAR 8
hydraulic oil temperature T1= 45 C
ambient temperature T2= 8 C
\Channels: 5
\Scanning rate: 10 ms = 0,010 sec
\Variable 1: s1(mm) displacement of boom cylinder's rod (left)
\Variable 2: s3(mm) displacement of boom cylinder's rod (right)
\Variable 3: p11(bar) pressure in piston chamber of boom cylinder (left)
\Variable 4: p12(bar) pressure in rod chamber of boom cylinder (left)
\Variable 5: Q1(L/min) oil flow

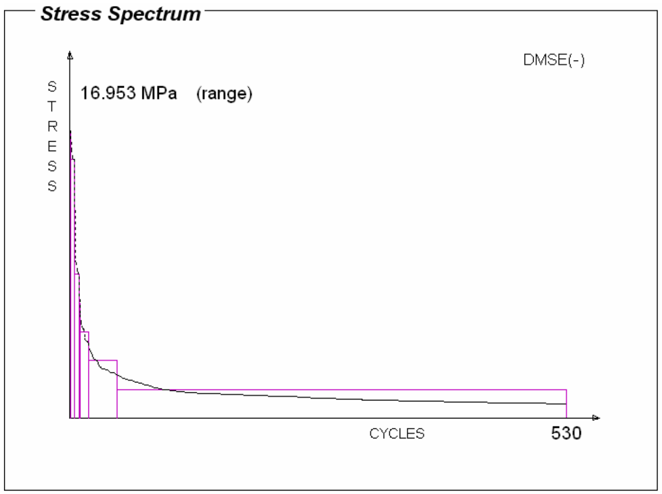
t [s]	s1 [mm]	s3 [mm]	p11 [bar]	p12 [bar]	Q1 [L/min]
0	0,292	-0,3	5,78	-0,612	80,438
0,01	0,292	-0,3	5,723	-0,612	79,981
0,02	0,292	0	5,665	-0,612	81,436
0,03	0,292	-0,3	5,723	-0,612	81,146
0,04	0,292	-0,3	5,723	-0,612	81,146
0,05	0,292	0	5,665	-0,612	81,064
0,06	0,292	0	5,78	-0,612	80,33
0,07	0,292	-0,3	5,723	-0,612	80,061
0,08	0,292	-0,3	5,723	-0,612	80,831
0,09	0,292	-0,3	5,723	-0,612	81,27
0,1	0,292	-0,3	5,723	-0,612	80,859
0,11	0,292	0	5,78	-0,612	80,859
0,12	0,292	0	5,665	-0,612	80,941
0,13	0,292	-0,3	5,78	-0,612	80,941
0,14	0,292	0	5,665	-0,612	80,195
0,15	0,292	0	5,723	-0,612	81,064
0,16	0,292	0	5,723	-0,612	80,424
0,17	0,292	-0,3	5,723	-0,612	80,424
0,18	0,292	-0,3	5,78	-0,612	81,298



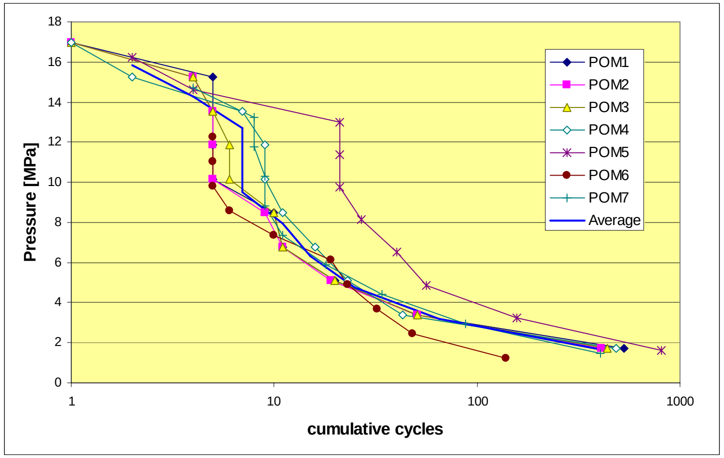
LOAD SPECTRA



Pressure histories

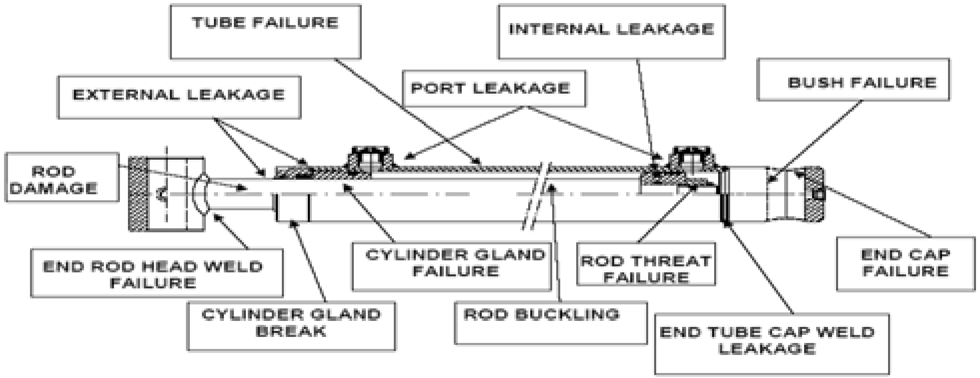


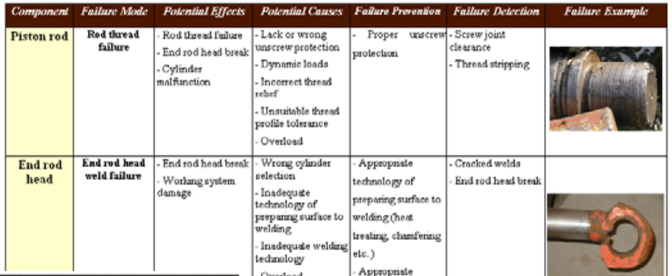
Pressure spectra



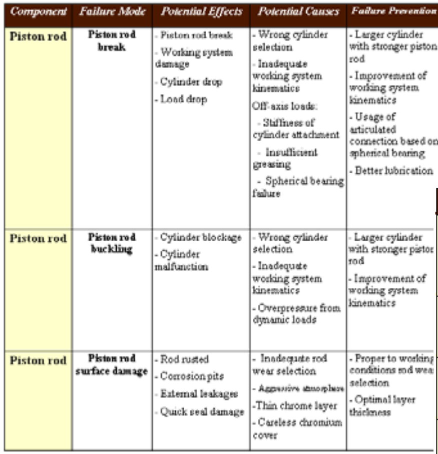
Pressure spectra created for 7 measurements

PRA analysis

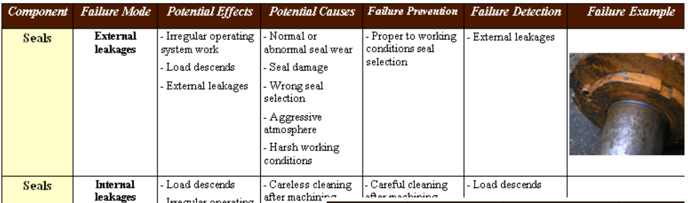




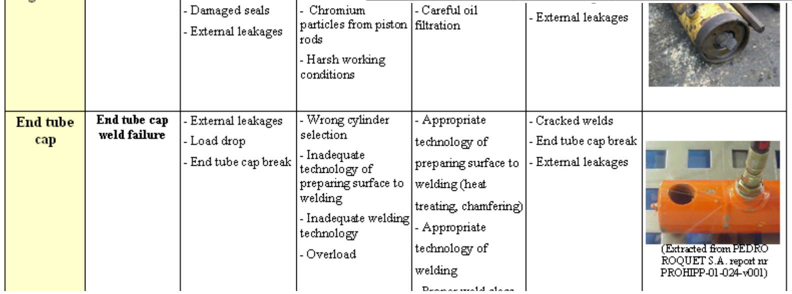
Component	Failure Mode	Potential Effects	Potential Causes	Failure Prevention	Failure Detection	Failure Example
Piston rod	Rod thread failure	- Rod thread failure - End rod head break - Cylinder malfunction	- Lack or wrong unscrew protection - Dynamic loads - Incorrect thread relief - Unsuitable thread profile tolerance - Overload	- Proper unscrew protection	- Screw joint clearance - Thread stripping	
End rod head	End rod head weld failure	- End rod head break - Working system damage	- Wrong cylinder selection - Inadequate technology of preparing surface to welding - Inadequate welding technology - Overload	- Appropriate technology of preparing surface to welding (heat treating, chamfering etc.) - Appropriate technology of welding - Proper weld class	- Cracked welds - End rod head break	
		k	- Wrong cylinder selection - Dynamic loads - Overload	- Stronger end piston rod head	- End piston rod head break - Load drop	



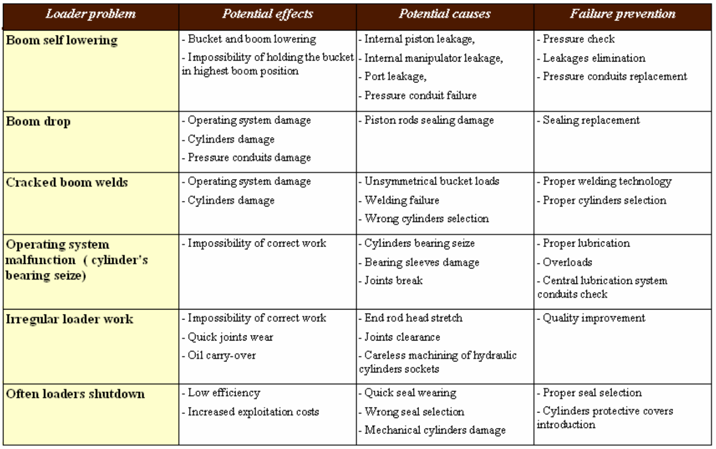
Component	Failure Mode	Potential Effects	Potential Causes	Failure Prevention	Failure Detection	Failure Example
Piston rod	Piston rod break	- Piston rod break - Working system damage - Cylinder drop - Load drop	- Wrong cylinder selection - Inadequate working system kinematics Off-axis loads: - Stiffness of cylinder attachment - Insufficient greasing - Spherical bearing failure	- Larger cylinder with stronger piston rod - Improvement of working system kinematics - Usage of articulated connection based on spherical bearing - Better lubrication	- Piston rod break - Cylinder blockage - Squealing during work	
Piston rod	Piston rod buckling	- Cylinder blockage - Cylinder malfunction	- Wrong cylinder selection - Inadequate working system kinematics - Overpressure from dynamic loads	- Larger cylinder with stronger pistor rod - Improvement of working system kinematics		
Piston rod	Piston rod surface damage	- Rod rusted - Corrosion pits - External leakages - Quick seal damage	- Inadequate rod wear selection - Aggressive atmosphere -Thin chrome layer - Careless chromium cover	- Proper to working conditions rod wea selection - Optimal layer thickness		



Component	Failure Mode	Potential Effects	Potential Causes	Failure Prevention	Failure Detection	Failure Example
Seals	External leakages	- Irregular operating system work - Load descends - External leakages	- Normal or abnormal seal wear - Seal damage - Wrong seal selection - Aggressive atmosphere - Harsh working conditions	- Proper to working conditions seal selection	- External leakages	
Seals	Internal leakages	- Load descends - Irregular operating system work	- Careless cleaning after machin - Wrong tub roughness - Metal impu hydraulic sy - Normal or abnormal se - Wrong seal selection	- Careful cleaning	- Load descends	
Pressure ports	Port leakages	- External leakages - Load descends - Irregular operating system work	- Welding de - Too high su roughness of face - Overpressu - Wrong pres conduits cou			



Component	Failure Mode	Potential Effects	Potential			
Cylinder gland	Cylinder gland break	- Cylinder malfunction - Oil flowing out of the cylinder	- Wrong cyl selection - Dynamic l			
Cylinder gland	Cylinder gland failure	- Damaged piston rod - Damaged seals - External leakages	- Metal imp in hydraulic - Chromium particles from piston rods - Harsh working conditions	- Careful oil filtration	- External leakages	
End tube cap	End tube cap weld failure	- External leakages - Load drop - End tube cap break	- Wrong cylinder selection - Inadequate technology of preparing surface to welding - Inadequate welding technology - Overload	- Appropriate technology of preparing surface to welding (heat treating, chamfering) - Appropriate technology of welding	- Cracked welds - End tube cap break - External leakages	(Extracted from PEDRO ROQUET S.A. report nr PROHIPP-01-024-v001)



Loader problem	Potential effects	Potential causes	Failure prevention
Boom self lowering	- Bucket and boom lowering - Impossibility of holding the bucket in highest boom position	- Internal piston leakage, - Internal manipulator leakage, - Port leakage, - Pressure conduit failure	- Pressure check - Leakages elimination - Pressure conduits replacement
Boom drop	- Operating system damage - Cylinders damage - Pressure conduits damage	- Piston rods sealing damage	- Sealing replacement
Cracked boom welds	- Operating system damage - Cylinders damage	- Unsymmetrical bucket loads - Welding failure - Wrong cylinders selection	- Proper welding technology - Proper cylinders selection
Operating system malfunction (cylinder's bearing seize)	- Impossibility of correct work	- Cylinders bearing seize - Bearing sleeves damage - Joints break	- Proper lubrication - Overloads - Central lubrication system conduits check
Irregular loader work	- Impossibility of correct work - Quick joints wear - Oil carry-over	- End rod head stretch - Joints clearance - Careless machining of hydraulic cylinders sockets	- Quality improvement
Often loaders shutdown	- Low efficiency - Increased exploitation costs	- Quick seal wearing - Wrong seal selection - Mechanical cylinders damage	- Proper seal selection - Cylinders protective covers introduction