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LODGE CAUSEWAY

S.M. GAUGE

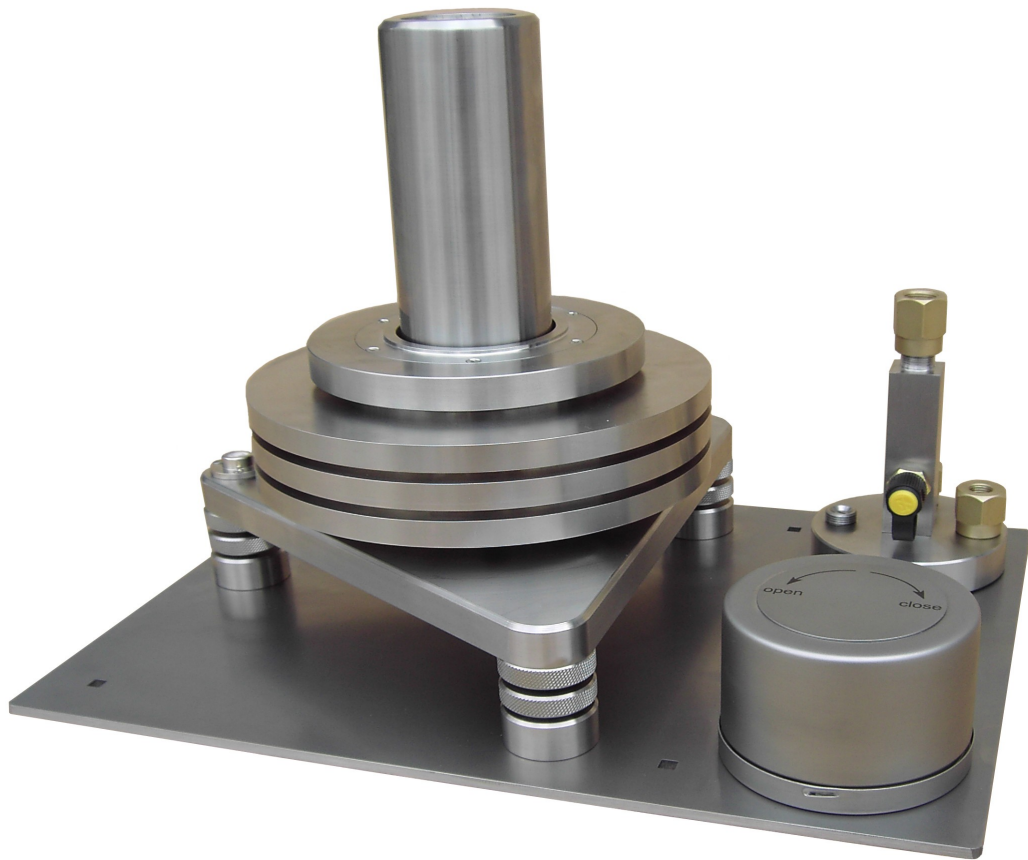
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DGS-001



**Gas operated oil lubricated
pressure standard for high line pressure**

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1 introduction

1.1 general product description

The DGS-001 pressure standard is a pneumatically operated deadweight tester used to calibrate test gauges, transducers and transmitters at line pressures up to 20 MPa. The system consists of the following main components :

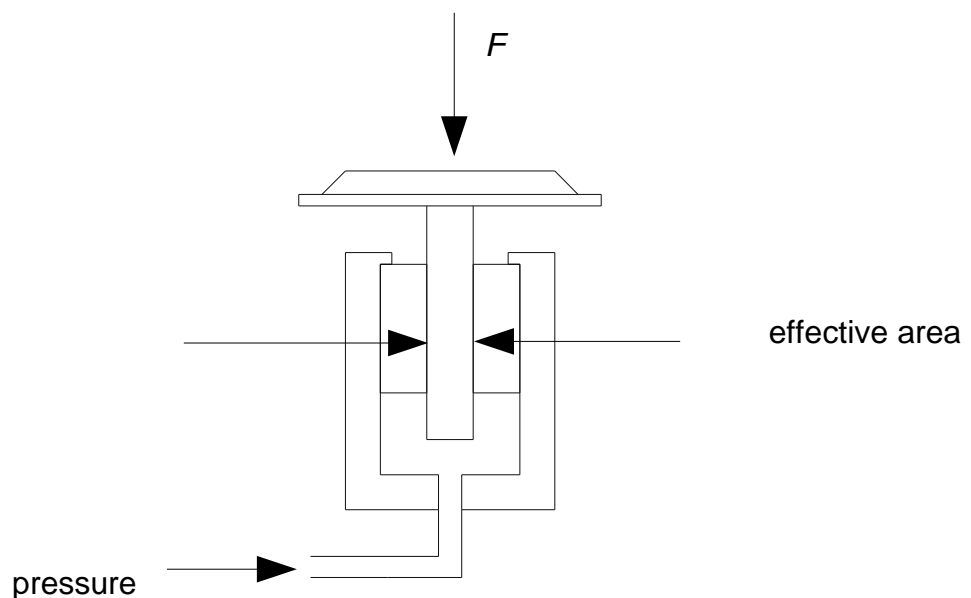
deadweight tester platform	x
piston cylinder assembly	x
mass set	x

To complete the system a dedicated pressure controller for pressure like the GPR200 plus interconnection hardware is necessary.

1.2 operating principle

The key components of the system are the mounting posts which combines the primary metro logical elements :

1. the piston-cylinder which defines an effective area, A .
2. the masses, of global value m , which act upon the piston.



The value of the pressure p_e which puts the piston into equilibrium is given by the formula:

$$p_e = \frac{m_c \cdot (1 - \rho_a / \rho_m) \cdot g_l}{A_{20} \cdot (1 + (\alpha_p + \alpha_c) \cdot (t - 20))} \cdot 10^{-3} \quad [\text{kPa}]$$

where	p_e	:	gauge pressure at reference level	[kPa]
	m_c	:	conventional mass	[kg]
	$1 - \rho_a / \rho_m$:	air buoyance correction	(= 0,99985) [-]
	g_l	:	local gravity	[N/kg]
	A_{20}	:	effective area at 20 °C / mid pressure	[m ²]
	$\alpha_p + \alpha_c$:	thermal expansion coefficient piston + cylinder	(= 9.10 ⁻⁶) [°C ⁻¹]
	t	:	piston cylinder temperature	[°C]

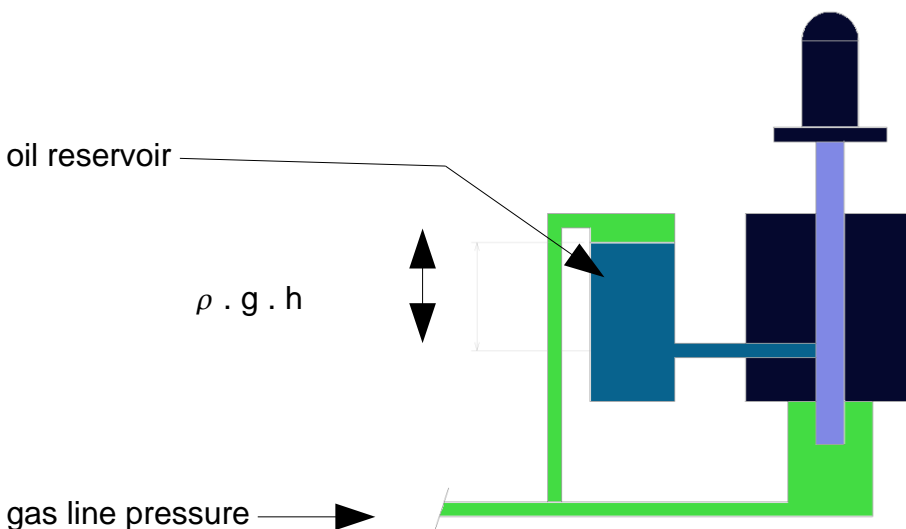
The oil lubricated / gas operated pistons of the DGS series are specially designed to have superior performance at higher gas pressures without the problems of other types of pistons :

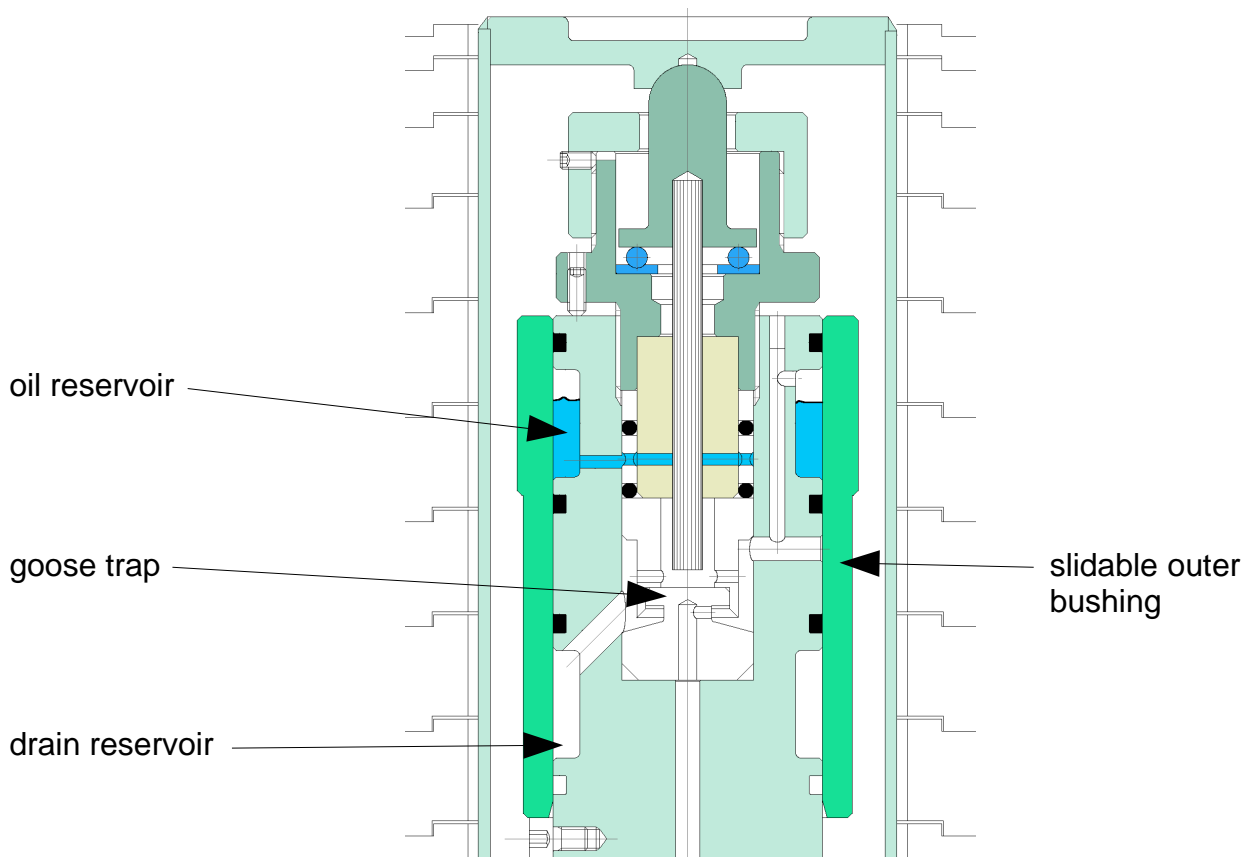
- gas lubricated / gas operated pistons cylinders

These piston cylinders have better sensitivity than oil lubricated pistons, however the natural drop rate at higher line pressure make them difficult to operate. Oil lubricated pistons have no significant drop rate as the oil acts as a seal.

- oil lubricated /oil operated pistons with oil gas interface

There are a lot of deadweight tester manufacturers who claim oil lubrication / gas operation, but they use a traditional oil / oil piston and an oil gas interface. The biggest and obvious disadvantage of this solution is that the surface level of the oil gas interface precisely has to be known. The added uncertainty especially in high line pressure applications make this solution not the most obvious one. The piston cylinder of the DGS series are really different. The oil is fed to the gap between piston and cylinder by means of an oil reservoir around the cylinder. As the oil surface is slightly higher than the entrance bore in the cylinder the oil pressure is also slightly higher than the gas pressure ensuring enough lubrication between piston and cylinder.





2 general specifications

pressure range	0 .. 20	MPa g
differential pressure range	0 .. 20	MPa d
measurement uncertainty p	$1 \cdot 10^{-4} \cdot p_e + 10 \text{ Pa}$	
certification	standard delivered with EA ¹ certificate	
max. supply pressure	25	MPa g
pressure connections	1/4" BSP female ²	
platform	stainless steel triangle shape	
footprint base plate	425 x 320	mm
overall height	315	mm
lubricating oil	DWT oil 812	

2.1 piston cylinder

material piston + cylinder	tungsten carbide	
nominal piston diameter	5	mm
nominal K_n	500	kPa/kg
thermal expansion ($\alpha_p + \alpha_c$)	$9 \cdot 10^{-6}$	°C ⁻¹
type	re-entrant	
medium	gas operated / oil lubricated	
certification	EA calibrated on effective area	

2.2 mass set

description	nominal mass		nominal pressure	
mass carrier (piston mass included)	1	kg	5	bar
	4	kg	20	bar
	2	kg	10	bar
	1	kg	5	bar
	500	g	2.5	bar
	200	g	1	bar
	100	g	0.5	bar
	50	g	250	mbar
	20	g	100	mbar
	10	g	50	mbar
optional*	5	g	25	mbar
	2	g	10	mbar
	1	g	5	mbar

certification **EA** certification on conventional mass

* optional small mass set

1 European Accreditation, see <http://www.european-accreditation.org>

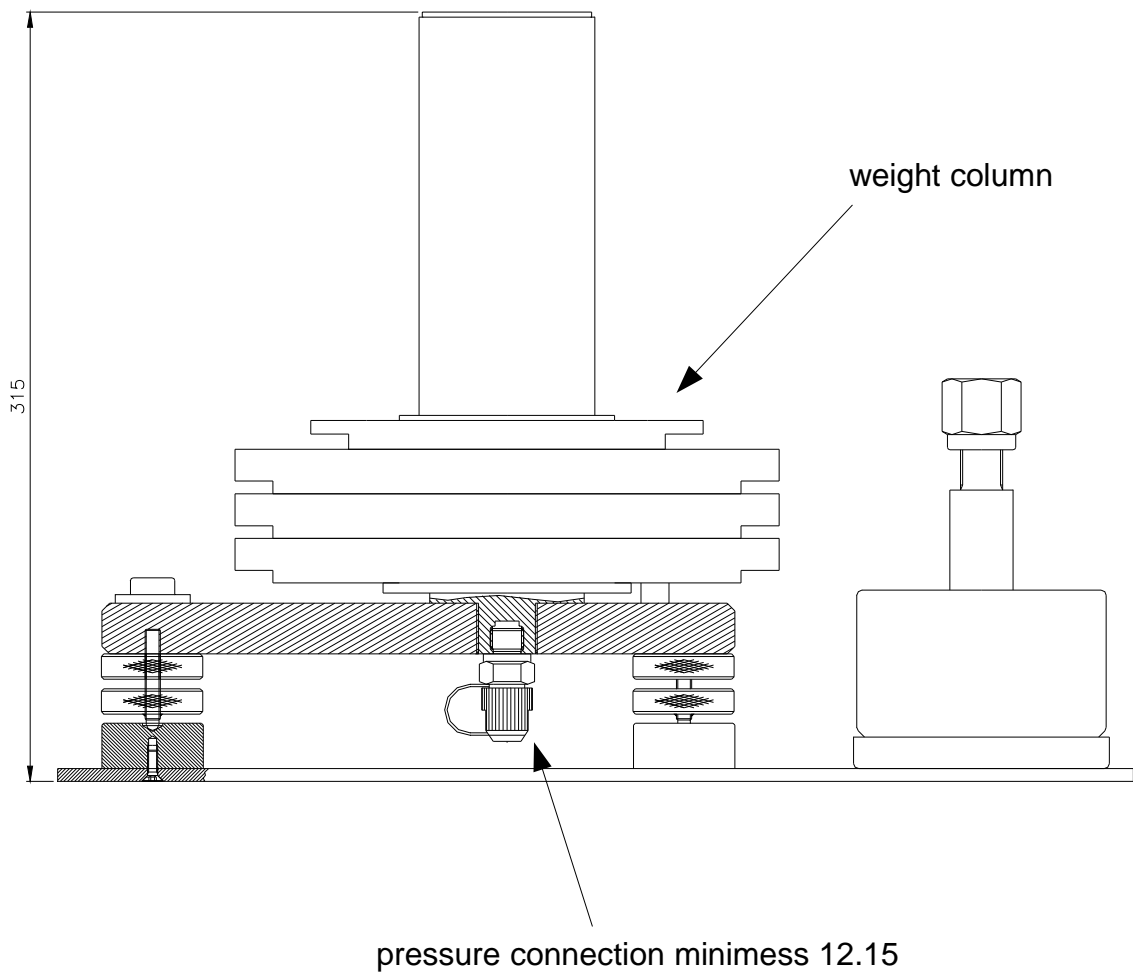
2 on request MM quick connectors can be supplied

2.3 available mass set configurations

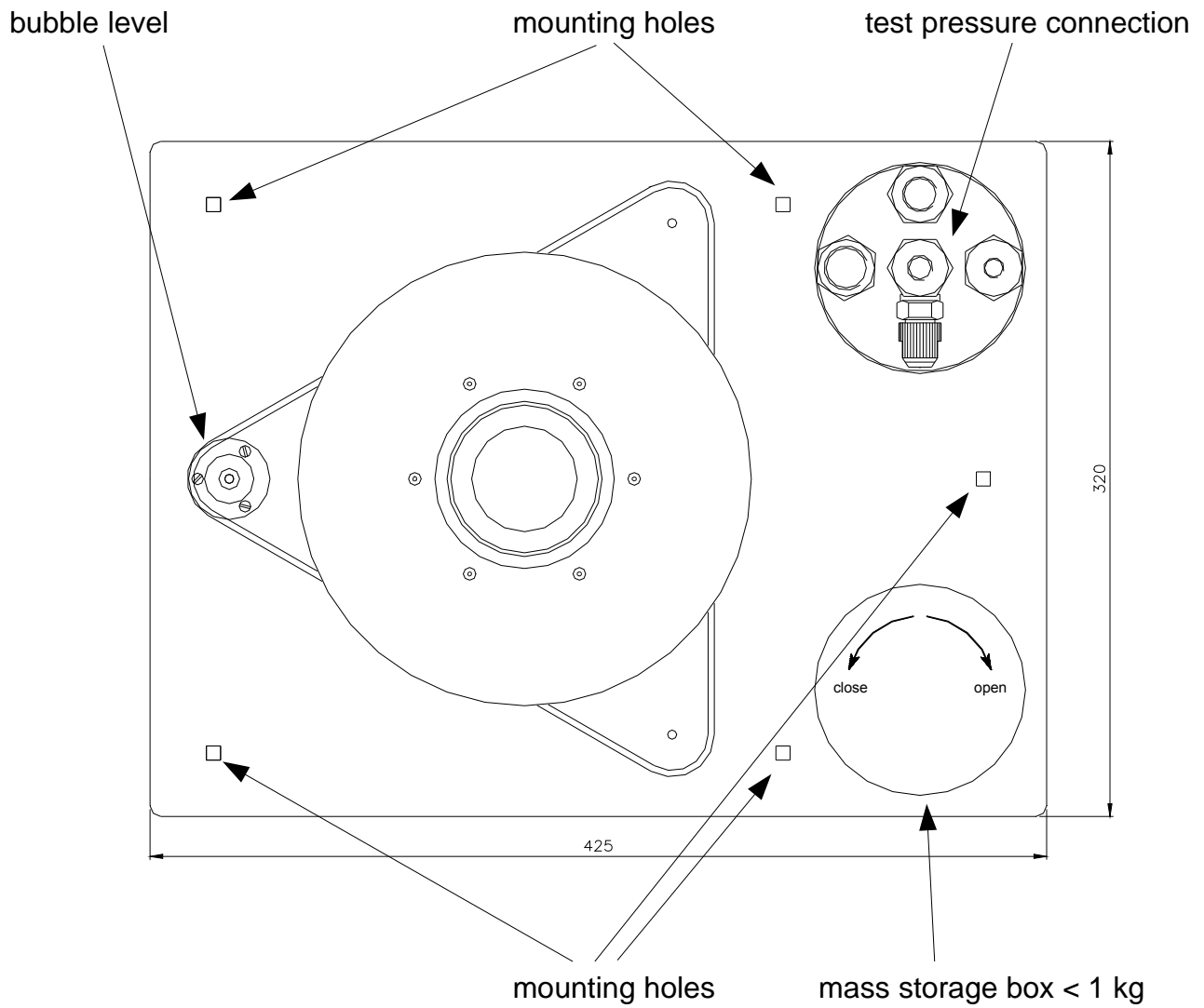
mass set	carrier	4	2	1	0.5	0.2	0.1	range
kg	kg	kg	kg	kg	kg	kg	kg	bar
5	1	0	1	1	1	2	1	5 - 25
10	1	1	1	2	1	2	1	5 - 50
15	1	2	2	1	1	2	1	5 - 75
25	1	5	1	1	1	2	1	5 - 125
35	1	7	2	1	1	2	1	5 - 175
41	1	9	1	1	1	2	1	5 - 205

2.4 instrument outline

2.4.1 front view



2.4.2 top view



3 installation

3.1 as received

The DGS-001 is sealed in plastic and packed in an export quality carton box. When opening the box, check the contents against the scope of delivery.

- !** As the piston cylinder mounting system is specially designed to protect the piston, they are normally mounted into the mounting post with a plastic transport cap. This protection is sufficient for transport and long term storage.
- !** The DGS-001 is transported without lubricating oil, do not operate the instrument before topping off the oil reservoir.

3.2 site requirements

The DGS-001 should be placed as close as possible to the pressure controller (like the GPR200) and the DUT³. A separate interconnection hardware kit for connecting the controller to other systems is available.

- Although the DGS-001 can operate with not perfectly clean gasses (like natural gas), optimal long term performance is achieved with Nitrogen class 5.0.
- The room in which the instrument is placed should have proper founding, no vibrations are allowed during operation of the DGS-001 as this results in unpredictable errors
- The DGS-001 should be placed on a rugged table which is rated for at least 100 kg without deforming. The table should be horizontally leveled.
- The DGS-001 base plate can be fixated on the table with stainless steel locking bolts (in the scope of delivery).
- Air movement in the neighborhood of the DGS-001 should be avoided.
- Room temperature needs to be stable during the time the DGS-001 is used to avoid uncertainties due to the thermal expansion coefficients of the piston cylinder and adiabatic effects in the measuring system.

3.3 setup

If the DGS-001 was purchased with the GPR200, make the connections to pressure controller. For more details a reference to the GPR200 manual is made.

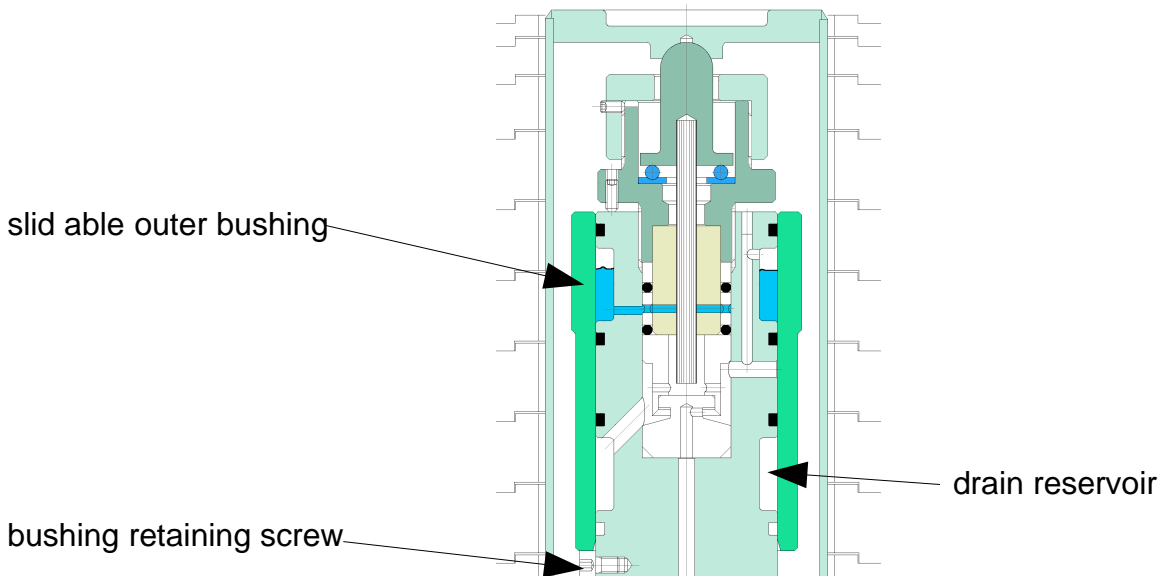
All DGS-001 pressure connections are 1/4" BSP female. Therefore, a 1/4" BSP male adapter is needed to make each of the connections. BSP connections can either be sealed with a metal ring or elastomer sealing ring.

- Connect the weight column pressure connections to the REF port on the pressure controller.
- Connect the pressure controller test ports to the DUT³.

! Make sure not to over pressurize the DUT

3 Device Under Test

3.4 topping off the lubricating oil



- remove the bushing retaining screw with the delivered allen key
- slide the slidable outer bushing down till the end of its stroke
- fill the the delivered syringe with 812 lubricating fluid
- fill the oil reservoir until the hollow meniscus levels the upper surface of the outer bushing in bottom position



- ! Make sure not to overfill the oil reservoir as this may result in oil entering the gas system ergo introducing unpredictable oil columns.
- carefully raise the slidable outer bushing until the drain reservoir opens to atmosphere
- operate the pressure controller to flow gas through the tubing towards the deadweight tester thus purging any trapped oil out of the drain reservoir.
- vent the system
- remount the bushing retaining screw
- carefully slide the slidable outer bushing down until it hits the retaining screw
- ! In time the O-rings encountering the slidable outer bushing may age resulting in needing excessive force to manipulate the bushing. Use lubricating oil to grease the O-rings or replace the O-rings by new ones.
- ! It is good practice to check both the oil and the drain reservoir every time before operating the DGS-001 to ensure its performance, see also chapter 5.2

4 operating DGS-001

The operation of the DGS-001 depends on the used pressure controller. In case of the GPR200 a reference is made to its operating manual.

The DGS-001 piston diameter is designed to have a nominal mass to pressure factor of 5 bar/kg, e.g. 1 kg represents approximately 5 bar. To calculate the mass needed to approach a desired pressure, just divide the pressure by 5 to get the nominal mass load. When using an DGS-001 in normal conditions a mass loading resolution of 100 gram is good enough as you compare the calculated deadweight tester pressure with the actual readout of the DUT.

example	:		
		nominal pressure point	94 bar g
		nominal mass to pressure constant	5 bar/kg
		calculated nominal mass	18.8 kg
		pressure calculation from certificate data	
		local gravity	9.812703 N/kg
		summarized conventional mass	18.8001 kg
		effective area	0.196255 · 10 ⁻⁴ m ²

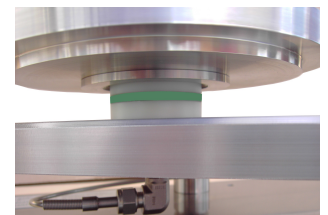
So in the above example, we loaded :

piston+mass carrier	:	1	kg
4 kg nr. 1..4	:	16	kg
1 kg	:	1	kg
500 gr	:	0,5	kg
200 gr	:	0,2	kg
100 gr	:	0,1	kg

- close vent valve
- carefully open inlet valve until the piston starts to raise

! the readout of the DUT can be used to monitor change in line pressure

- close the bypass valve of the variable volume
- fine tune the line pressure with the variable volume
- the piston mid stroke position is reached when the bottom of the mass carrying bell is leveled with the green colored band on the mounting post



5 maintenance

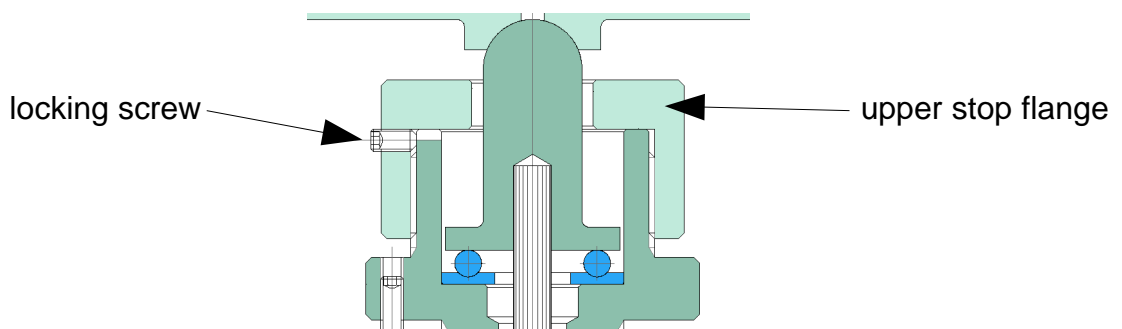
5.1 changing lubricating fluid / cleaning piston cylinder

It is good practice to change lubricating fluid at least once every year.

- make sure the deadweight tester is vented

! MM connectors have internal valves which close when flex tubes are removed and may result in trapped pressure. To be sure the deadweight tester is vented, connect a flex tube to the MM connector (if present) to vent.

- remove the piston upper stop flange, do not forget to loosen the locking screw



- place a towel around the base of the mounting post
- raise the slidable outer bushing until the drain reservoir opens to atmosphere
- carefully lift up the piston out of the cylinder

When the piston is removed, the oil will flow from the oil reservoir to the drain reservoir and downwards to the mounting post base.

- remove the outer bushing completely and remove the remaining fluid with lint free cloth.
- clean all surfaces with alcohol or cleaning solvent like Loctite 7061, also pour some solvent into the cylinder bore
- clean the piston with lint free cloth wetted with alcohol or cleaning solvent like Loctite 7061

! before assembly, make sure all solvent has vapoured

! the piston should be wetted with lubricating fluid 812 before assembly

5.2 overhaul

The DGS-001 is designed to be almost maintenance free. The in 5.1 described cleaning is expected to be the only regular maintenance performed by the end-user. On the longer term it might be necessary to exchange the cylinder o-rings, for this a separate overhaul kit is available, including:

- overhaul manual
- cylinder removing tool
- storage container for piston & cylinder
- spare o-ring kit

5.3 recalibration

Although the DGS-001 is designed to have a very good long term stability, the manufacturer recommends a first recalibration at 2 years after purchase is recommended both for piston cylinder and mass set. The results of the recalibration can be used as a guideline for future recalibration. Dependant on the environment and frequency of use a recalibration interval of 2 to 5 years is normal.

- !** It is not necessary to send the whole deadweight tester for recalibration, when the overhaul kit is purchased, the cylinder can be removed from the platform and shipped in the storage container.

6 parts list

Product	Part	Code	Qty.	Remark
Deadweight tester DGP-001	Mounting plate	425 x 320 mm	1	
	Weight column		1	gas operating, oil lubricated
	Adapter	2101-01-18.00	1	for minimess 1215 tubes
	O-ring	Ø17,13x2,62 90° NBR	3	for cilinder
	O-ring	Ø40x2,5 70° NBR	3	for oil reservoir
Weight set	Weight carrier		1	tared & certified
	4 kg	1 - ...	*	
	2 kg		*	
	1 kg		1	
	500 g		1	
	200 g	1; 2	2	
	100 g		1	
Test pressure connection	Adapter 1/2"bsp	027-411-26	1	
	Adapter 1/4"bsp	027-411-25	1	
	Adapter 3/8"bsp	027-411-14	1	
	Adapter 1/8"bsp	027-411-15	1	
	Multi seal	065-260-09	1	Ø13.2 x 6.9 x 1.3 mm
Other	EA certificate (RVA)		1	Minerva Meettechniek B.V.
	Weight box	for weight set	1	
	Dust cover	for weight column	1	
	Allen key	3 mm (M4)	1	for bushing retaining screw
	Bushing retaining screw	M4x8	1	
	Bolt and nut	M6 x 50 A2	5	fixing mounting plate
	Plastic tubing	S-100-AA-AJ-0100 DN2-400	1	Minimess 1215, angle connection for weight column
	Plastic tubing	S-100-AA-AA-0100 DN2-400	3	minimess 1215
	Deadweight tester oil	812	½ ltr.	

* quantity depending on the range



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