A company of
ThyssenKrupp
Elevator

ThyssenKrupp Elevator Sp. z o. o.

ThyssenKrupp

DOKUMENTACJA TECHNICZNA DŹWIGU

Park Naukowo Technologiczny Gdańsk

201900

2. Obliczenia techniczne

A Company
of ThyssenKrupp
Elevator

ThyssenKrupp Aufzugswerk Austria GmbH

ThyssenKrupp

Strenght calculation of the Elevator system

Date: 2008/01/14

Serial number:	201900	**Year of construction:**	2008
Operating location:	PL 81-547 Gdynia Park Technologiczny w Gdansku		
Owner of elevator:		**Manufacturer:**	ThyssenKrupp Aufzugswerk Austria GmbH Harter Straße 1a, A-8101 Gratkorn
Elevator type:	Passenger elevator		
Area of application:	Office/commercial building		

Capacity:	2000 kg or 26 persons		
Rated speed (up/down):	0,40 / 0,40 m/s	**Travel height:**	9,28 m
Machine type:	Hydraulic lift with soft-starting		
Machine layout:	T tandem-jack - 1:2		

Load assumptions:					
Rated load	Q	=	2.000 kg		
Car weight:	N	=	1.700 kg		
Travelling cable ((0,5 * travel height + 2) * weight/m tavelling cable)	Hk	=	4 kg		
Suspension			1:2		
Load carrier:					
Design of the rope			GW PAWO 819W		
Quantity of ropes	n	=	10		
Diameter of the rope	d	=	10 mm		
Minimum breaking load of a rope	B	=	70.300 N		
Weight per meter of a rope			4 N/m		
Bending of the rope:					
Minimum diameter of the pulley	D_1	=	400 mm		
$D_1/d \geq 40$	D_1/d	=	**40,0**	≥	**40**
Weight of the ropes (travel height/2 * weight/m rope)	S	=	186 N		
Tensile stress of the load carrier:					
Stress of all load carriers	Q_1+P_1				
$P_1 = N + S$	Q_1+P_1	=	36.521 N		
Minimum safety of the rope	s	=	12		
Page 1/1 (z*B) / (Q+P1)		=	**19,25**	≥	**s**

Signature and address:

The planner and
authorized manufacturer of the elevator:

ThyssenKrupp Aufzugswerk Austria Gm
Harter Straße 1a, A-8101 Gratkorn

The Sheet was automatically printed on 2008-01-23

System Values

THYSSENKRUPP AUFZUGSWERK AUSTRIA GMBH
CALCULATION OF GUIDE RAILS ACCORDING TO EN81:1998

ThyssenKrupp

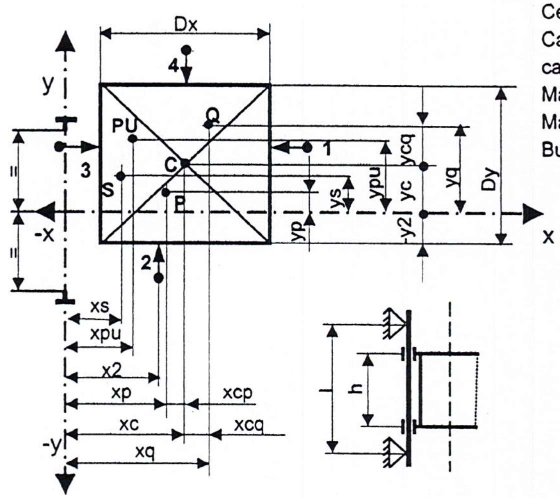
Date 23.01.2008

Unit number			
intern		201900	
Car			Guide rail: T 125/B (125x82x16)
Masses of the car	P [kg]	1700,00	
Rated load	Q [kg]	2000,00	☐ Fork lift loading
Balance factor (Q*q+P=CTW)	q	0,00	
Force on the sill	Fs [N]	7848,00	
Load distribution		on the right / left	in the front / rear
Car depth	Dx [mm]	2660,00	
Car width	Dy [mm]	1400,00	
Numbers of guide rails	n	2,00	
Distance between guide shoes	h [mm]	3300,00	
Distance from C to y-axis	xc [mm]	0,00	
Distance from P to y-axis	xp [mm]	0,00	
Distance from Q to y-axis	xq+ [mm]	0,00	332,50
Distance from Q to y-axis	xq- [mm]	0,00	-332,50
Distance from S to y-axis	xs [mm]	0,00	
Distance from PU to y-axis	xpu [mm]	0,00	
Distance between C and P inthe x-direction	xcp [mm]	0,00	0,00
Distance between C and Q in the x-direction	xcq [mm]	0,00	332,50
Distance car door 1 to y-axis	x1 [mm]	1450,00	
Distance car door 2 to y-axis	x2 [mm]	0,00	
Distance car door 3 to y-axis	x3 [mm]	-1450,00	
Distance car door 4 to y-axis	x4 [mm]	0,00	
Distance from C to x-axis	yc [mm]	0,00	
Distance from P to x-axis	yp [mm]	0,00	
Distance from Q to x-axis	yq+ [mm]	175,00	0,00
Distance from Q to x-axis	yq- [mm]	-175,00	0,00
Distance from S to x-axis	ys [mm]	0,00	
Distance from PU to x-axis	ypu [mm]	0,00	
Distance between C and P in y-direction	ycp [mm]	0,00	0,00
Distance between C and Q in y-d rection	ycq [mm]	175,00	0,00
Distance car door 1 to x-axis	y1 [mm]	0,00	
Distance car door 2 to x-axis	y2 [mm]	0,00	
Distance car door 3 to x-axis	y3 [mm]	0,00	
Distance car door 4 to x-axis	y4 [mm]	0,00	

Car buffer:
- (●) Energie accumulation type
- ( ) Energie dissipation type

Car: Safety gear / rupture valve
- (●) progressive safety gear
- ( ) safety gear of the captive roller type
- ( ) respond of the rupture valve

Centre of car doors	1,2,3,4
Car suspension	S
car centre	C
Mass centre of gravity of the car	P
Mass centre of gravity of the load	Q
Buffers	PU



Accesses: ☑ Car door 1 ☑ Car door 3 ☐ Car door 2 ☐ Car door 4

Counterweight (suspension and buffer in the centre)			Guide rail: KEINE
Numbers of guide rails		0,00	
Distance between guide shoes	hggw [mm]	0,00	
Counterweight depth	tggw [mm]	0,00	
Counterweight width	bggw [mm]	0,00	
Weight of the counterweight	[N]	16677,00	
Levers in x-direction	xggw [mm]	0,00	
Levers in y-direction	yggw [mm]	0,00	

CTW: safety gear
- (●) without safty gear
- ( ) progressive safety gear
- ( ) safety gear of the captive roller type

ThyssenKrupp Aufzugswerk Austria GmbH
Harter Straße 1a, A-8101 Gratkorn

THYSSENKRUPP AUFZUGSWERK AUSTRIA GmbH
CALCULATION OF GUIDE RAILS ACCORDING TO EN81:1998

ThyssenKrupp

Date 23.01.2008

Results of the calculation

Unit number

intern 201900

☐ Steel structure shaft

☑ Consideration of the deflection by driving on buffer

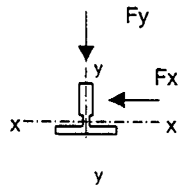
Car

		Normal use		Safty gear operation		Driving onto buffer		Car door 1	Car door 2	Car door 3	Car door 4	Guide shoes
Distance between guide brackets	l [mm]	2750,00		recommended: 2939,2117		max. possible 3265,79						
Bending stresses									Loading			
Impact factor	k	1,20		2,00		3,00						Pdyn
Bending force in the Y-axis	Fx [N]	0,00	-1186,12	0,00	-1976,86	0,00	-2965,30	1724,18	0,00	-1724,18	0,00	-296,53
Bending stress about Y-axis	σy [N]mm²]	0,00	-24,08	0,00	-40,13	0,00	-60,20	35,00	0,00	-35,00	0,00	
Bending force in the X-axis	Fy [N]	-1248,55	0,00	-2080,91	0,00	-3121,36	0,00	0,00	0,00	0,00	0,00	-312,14
Bending stress in the X-axis	σx [N]mm²]	-24,57	0,00	-40,95	0,00	-61,43	0,00	0,00	0,00	0,00	0,00	
Combined stress	σm [N]mm²]	24,57	24,08	40,95	40,13	61,43	60,20	35,00	0,00	35,00	0,00	
Buckling												
Compressive force	Fd=Fk [N]	0,00	0,00	36297,00	36297,00	0,00	0,00	0,00	0,00	0,00	0,00	
Force due to auxiliary equipment	M [N]	0,00										
Impact factor	k3	0,00										
Buckling stress	σk [N]mm²]	0,00	0,00	38,86	38,86	0,00	0,00	0,00	0,00	0,00	0,00	
Combined stress												
Bending and compression stress	σ [N]mm²]	24,57	24,08 < 150	56,85	56,03 < 206	61,43	60,20 < 206	35,00 < 150	0,00 < 150	35,00 < 150	0,00 < 150	
Bending and buckling stress	σc [N]mm²]	------------	------------	75,72	74,98 < 206	------------	------------	------------	------------	------------	------------	
Flange bending												
Flange bending stress	σf [N]mm²]	0,00	-21,94 < 150	0,00	-36,57 < 206	0,00	-54,86 < 206	31,90 < 150	0,00 < 150	-31,90 < 150	0,00 < 150	
Deflections												
in the X-axis	δx[mm]	0,00	-1,08 < 5	0,00	-1,80 < 5	0,00	-2,69 < 5	1,57 < 5	0,00 < 5	-1,57 < 5	0,00 < 5	
in the Y-axis	δy[mm]	-1,19	0,00 < 5	-1,99	0,00 < 5	-2,99	0,00 < 5	0,00 < 5	0,00 < 5	0,00 < 5	0,00 < 5	

Counterweight

		Normal use		Safty gear operation		Bouncing	
Distance between guide brackets	lggw [mm]	0,00	#NV	recommended: #NV		max. possible #NV	
Bending stresses							
Impact factor	k	0,00		0,00		0,00	
Bending force in the Y-axis	Fx [N]	0,00		0,00		0,00	
Bending stress about Y-axis	σy [N]mm²]	0,00		0,00		0,00	
Bending force in the X-axis	Fy [N]	0,00		0,00		0,00	
Bending stress in the X-axis	σx [N]mm²]	0,00		0,00		0,00	
Combined stress	σm [N]mm²]	0,00		0,00		0,00	
Buckling							
Compressive force	Fd=Fk [N]	0,00		0,00		0,00	
Force due to auxiliary equipment	M [N]	0,00					
Impact factor	k3	0,00					
Buckling stress	σk [N]mm²]	#NV	#NV	#NV	#NV	#NV	#NV
Combined stress							
Bending and compression stress	σ [N]mm²]	0,00 < 0		0,00 < 0		0,00 < 0	
Bending and buckling stress	σc [N]mm²]	#NV	#NV	#NV	#NV	#NV	#NV
Flange bending							
Flange bending stress	σf [N]mm²]	0,00 < 0		0,00 < 0		0,00 < 0	
Deflections							
in the X-axis	δx[mm]	0,00 < 0		0,00 < 0		0,00 < 0	
in the Y-axis	δy[mm]	0,00 < 0		0,00 < 0		0,00 < 0	

		Car	Counterweight
Tensile strength	σb [N/mm²]	440,00	0,00
Loading / normal operation	σperm [N/mm²]	150,00	0,00
Safty gear operation	σperm [N/mm²]	206,00	0,00
cross sectional area modulus	Wy [mm³]	25400,00	1,00
cross sectional area modulus	Wx [mm³]	26200,00	1,00
second moment of area	Iyy [mm4]	1590000,00	1,00
second moment of area	Ixx [mm4]	1510000,00	1,00
Flange width	c [mm]	10,00	1,00
Modulus of elasticity	E [N/mm²]	210000,00	1,00
cross section area	A [mm²]	2283,00	1,00
Allowable deflection	δperm[mm]	5,00	0,00
Slenderness	λmax	107,00	0,00
Omega value	ω	2,44	#NV



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Cylinder calculation BZH 100/ 5-1x4860

Name of custome	: ThyssenKrupp Aufzugswerk Au	**Offer**	: EZ-2008-0072 / 21.01.2008
Calculator	: Zürcher Ester	**Your inquiry**	: 1-71848 - 201900-07

Lift data

Q	Capacity (Q)	[kg]	: 2000	l_A	Travel	[mm]	: 9280
P_3	Car weight including frame	[kg]	: 1700	Z	Number of cylinder		: 2
P_{rh}	Weight of pulley	[kg]	: 150	c_m	Type of construction (1 = 1:1; 2 = 2:1)		: 2
l_R	Height of pulley	[mm]	: 300	P_{rg}	Counter weight / cylinder	[kg]	: 0 2:1
P_V	Weight of cylinder rod extension	[kg]	: 0.0	s_E	Required safety factor		: 2
l_V	Extension cylinder rod	[mm]	: 0	g_n	Acceleration of drop	[m/s²]	: 9.81

Cylinder data

d_a	Outer diameter	[mm]	: 100.0	d_i	Inner diameter	[mm]	: 90.0
l_H	Cylinder stroke	[mm]	: 4860	l_o	Piston dead stroke	[mm]	: 40
A	Piston surface	[mm²]	: 7854.0	A_1	Piston cross section	[mm²]	: 1492.3
J_1	Moment of inertia	[cm^4]	: 168.8	i_1	Radius of inertia	[mm]	: 33.6
P_r	Weight of piston rod	[kg]	: 69.2				:
E	Modulus of elasticity	[N/mm²]	: 2.10E+5	R_m	Tension strength	[N/mm²]	: 490.0

Calcululation on pressure

Actual pressure force	$F_d := g_n \cdot \left[\frac{(Q + P_3) \cdot c_m}{Z} + P_{rh} + P_V + P_r \right]$	F_d	[N]	= 38448
Static pressure at max. load	$p_{stat} := \frac{F_d}{A}$	P_{stat}	[bar]	= 49.0
Permissible static pressure at cylinder		P_{stzul}	[bar]	= 59.7

Buckling calculation according EN 81

Buckling length	$l_k := l_H + l_0 + l_R + l_V$	l_k	[mm]	= 5200
Slenderness ratio	$\lambda := \frac{l_k}{i_1}$	lambda		= 155
Actual buckling force	$F_5 := 1.4 \cdot g_n \cdot \left[\frac{(Q + P_3) \cdot c_m}{Z} + P_{rh} + P_V + 0.64 \cdot P_r \right]$	F_5	[N]	= 53484
Permissible buckling force	$F_{5z} := \frac{\pi^2 \cdot E \cdot J_1}{s_E \cdot l_k^2}$	F_{5z}	[N]	= 64697

Permisssible static pressure at the cylinder

$$p_{stMax} \le p_{stzul} \le \frac{\frac{F_{5z}}{1.4} + g_n \cdot (P_r - 0.64 \cdot P_r)}{A}$$

P_{stMax} [bar] = 59.2

Neuheim, 21.01.2008

Visa: ....

Bucher Hydraulics AG · Industriestrasse 15 · Postfach 78 · CH · 6345 Neuheim · Tel. +41 41 757 03 33

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Certificate of compliance for hydraulic jacks

Jack type : **BZH 100 / 5**

Working pressure p stat max:	59.7	bar
Test pressure = p stat max * 2.3	137.31	bar

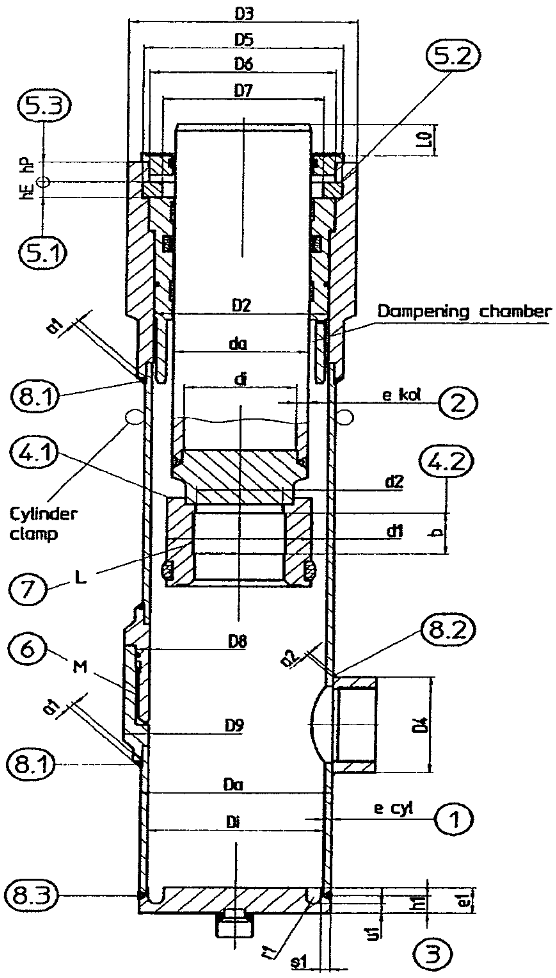
Material quality + Dimensions

Ram	St 52	∅	100 x 5
Ram bottom	St 52	≥∅	106
Cylinder tube	St 52	∅	139.7 x 5.6
Cylinder bottom	St 52 - 3	≥∅	139.7

Jack is manufactured with these materials. After assembly, it undergoes a pressure test. Further certificates of material are avaible on request.

03.03.2006

Lift cylinder dimensions



BZH	100/5	
da	100	mm
di	90	mm
d1	106	mm
d2	76	mm
Da	139.7	mm
Di	128.5	mm
D2	126	mm
D3	158	mm
D4	63.5	mm
D5	144	mm
D6	134	mm
D7	118	mm
D8	152	mm
D9	165	mm
a1	3.92	mm
a2	2.8	mm
b	32	mm
e cyl	5.6	mm
e kol	5	mm
e0	1	mm
e1	20	mm
hE	12	mm
hR	16	mm
h1	14	mm
r1	5	mm
s1	7.85	mm
u1	8	mm
L0	40	mm
L	M80x2	-
LF	78.701	mm
LK	77.546	mm
LP	2	mm
M	Tr 150x6	-
MF	147	mm
MK	143	mm
MP	6	mm

Required dimensions at max. load

stat. max. pressure (1 MPa = 10 bar = 1 N/mm2)		p	**5.97**	MPa
1) cylinder tube - wall thic		e cyl	5.59	mm
2) piston tube - wall thickn		e kol	4.29	mm
3) cylinder bottom - wall th		e1 min	14.88	mm
		h1 min	13.00	mm
		r1 min	5.00	mm
		u1 min	6.62	mm
		u1 max	11.78	mm
4) piston stroke stop	4.1) pressure per unit of area	σ D exist	132.67	N/mm2
	4.2) shearing tension	τ exist	14.11	N/mm2
5) splitted insert ring	5.1)	hE.1	2.45	mm
		hE.2	9.67	mm
	5.2)	pF	78.41	N/mm2
	5.3)	hR	7.37	mm
6) thread M		τ exist	18.23	N/mm2
7) thread L		τ exist	73.23	N/mm2
8) welding seam	8.1)	σ exist	119.00	N/mm2
	8.2)	σ exist	74.56	N/mm2

Method of calculation for BZH - Jack

calculation according to EN 81 T2 - 12 (Unit of p in MPa or N/mm2)

1) Cylinder tube - wall thickness

material: St 52.0
$R_{p0.2}$ = 355 N/mm²
DIN 1626 or DIN 1629

$$ecyl = \frac{2.3 * 1.7 * p * Da}{Rp0.2 * 2} + e0$$

2) Piston tube - wall thickness (Piston-solid without calculation)

material: St 52
$R_{p0.2}$ = 355 N/mm²
DIN 2391 or DIN 1629

$$ekol = \frac{2.3 * 1.7 * p * da}{Rp0.2 * 2} + e0$$

3) Cylinder bottom - wall thickness Flat bottom with relief groove

material: St 52
$R_{p0.2}$ = 320 N/mm²

$$e1 \geq 0.4 * Di * \sqrt{\frac{2.3 * 1.7 * p}{Rp0.2}} + e0$$

Condition: $r_1 \geq 0,2 * e_1$ and $r_1 \geq 5$ mm
$u_1 \leq 1,5 * s_1$
$h_1 \geq u_1 + r_1$

$$u1 \geq 1.3 * \left(\frac{Di}{2} - r1\right) * \frac{2.3 * 1.7 * p}{Rp0.2} + e0$$

4) Piston stroke stop

4.1) pressure per unit of area material: St 52
$\sigma_{D\ adm}$ = 210 N/mm²

$$\sigma Dexist = \frac{2.3 * p * da^2 * \pi * 4}{\left(di^2 - (da+1)^2\right) * 4 * \pi}$$

4.2) shearing tension material: St 52.0
τ_{adm} = 140 N/mm²

$$\tau exist = \frac{2.3 * p * da^2 * \pi}{d2 * \pi * b * 4}$$

5) Splitted insert ring AD - Instruction sheet B8 - 6.10 (Calculation at failure: piston at stroke stop)

material: St 52
$R_{p0.2}$ = 355 N/mm²
$\sigma_{D\ adm}$ = 210 N/mm²

5.1)

$$hE.1adm = \frac{0.4 * 2.3 * 1.7 * p * D2^2 * \pi}{D6 * Rp0.2 * 4}$$

$$hE.2adm = \sqrt{1.91 * \frac{2.3 * 1.7 * p * D2^2 * \pi}{D6 * Rp0.2 * 4} * \frac{D6 - D7}{2}}$$

5.2)

$$pFexist = 1.27 * \frac{2.3 * p * D2^2}{\left(D5^2 - D6^2\right)} * \frac{\pi}{4}$$

5.3)

$$hRadm = \sqrt{1.91 * \frac{2.3 * 1.7 * p * D2^2 * \pi}{D5 * Rp0.2 * 4} * \frac{D5 - D6}{2}}$$

6) Thread M M_F : flank Ø M_K : core Ø M_P : pitch

material: St 52.0
τ_{adm} = 140 N/mm²
factor 5: in presumption that the first thread takes over 1/5 of cpl. tractive force

$$\tau exist = \frac{2.3 * p * 2 * D8^2 * \pi}{(MF + MK) * \pi * 4 * MP * 5}$$

7) Thread L L_F : flank Ø L_K : core Ø L_P : pitch

material: 8.8 / C40 Cylinder bolt DIN 912 - 8.8 / Piston-solid (di = 0)
St 52 Piston tube
τ_{adm} = 140 N/mm²
factor 3: in presumption that the first thread takes over 1/3 of cpl. load force

$$\tau exist = \frac{2.3 * p * 2 * da^2 * \pi}{(LF + LK) * \pi * 4 * LP * 3}$$

8) Welding seam general calculation basic DIN 18800
welding seam thickness "a" acc. DIN 18800 T1 - 7.3.1
admissible tension at load situation H, acc. DIN 18800 T1 Tab. 11 all welding seams; St 52: σ_{adm} = 170 N/mm²

8.1)

$$\sigma exist = \frac{2.3 * p * Da^2 * \pi}{(Da + a1) * a1 * \pi * 4}$$

8.2)

$$\sigma exist = \frac{2.3 * p * D4^2 * \pi}{(D4 + a2) * a2 * \pi * 4}$$

8.3) the calculation of welding seam is not applicable due to a cpl. around-welded V-seam (DIN 8558 T1 - 9.1)

Cushioned stop EN 81 T2 - 12.2.3.3 average deceleration <1,0 g_n

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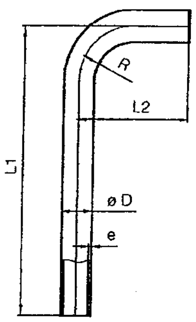
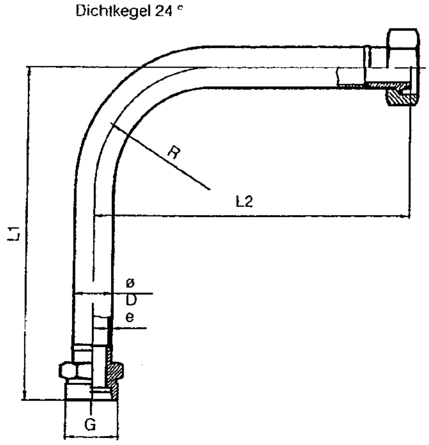
Rohrbogen 90°
Massblatt und Berechnung





Bemerkung: Bei Verwendung als Zwischenbauteil werden jeweils noch 2 Gerade-Verschraubungen der entsprechenden Grösse benötigt. Bei Verwendung anstatt einer Schwenkverschraubung wird noch je eine Gerade-Verschraubung und ein Einschraubstutzen benötigt.

Typ	DN[1] [mm]	ø D [mm]	e_{vorh} [mm]	L1 [mm]	L2 [mm]	R [mm]	G	Bi	Rp0.2 [N/mm^2]	p max [bar]	e_{erf} [mm]
RB 18	16	18	1.5	236	71	36	-	1.17	225	54.6	1.499
RB 22	19	22	2	238	78	38	-	1.23	225	63.7	1.998
RB 28	25	28	3	248	98	48	-	1.23	225	83.5	2.999
RB 35	31	35	3	260	125	60	-	1.24	235	69	2.991
RB 42	38	42	3	280	165	80	-	1.19	235	60	2.995
RB 50	51	50	4	410	410	150	M68X2	1.14	235	73.6	3.990

[1] DN = Nennweite Hochdruckschlauch

Werkstoff:
Stahlrohr St 37.4 DIN 2391-C

Berechnung:
(1 MPa = 10 bar = 1 N/mm^2)

$$e_{erf} = \frac{2.3 \times 1.7 \times p \times Bi \times D}{Rp0.2 \times 2} + 0.5$$

Berechnungsgrundlagen:
EN 81-2
DIN 2413; Beiwert Bi

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