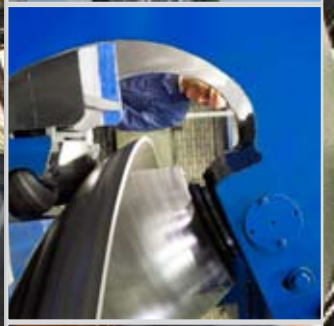
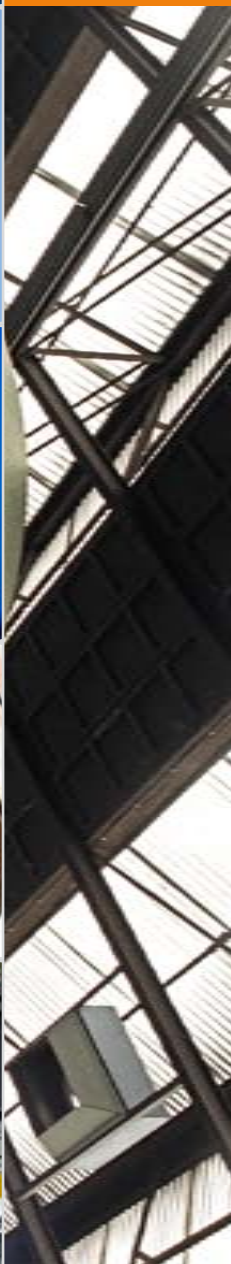
ANTONIUS

VESSELHEADS BV

All there is to know about Vesselheads





VARIOUS VESSEL HEADS
CONCENTRIC AND ECCENTRIC CONES
PIPE CAPS, WELDING BENDS, EXPANSION JOINTS
NOZZLES, REDUCERS, BRANCH UNITS, TORI
HOT AND COLD PRESS WORKING AND FLANGING
MACHINING, PLASMACUTTING, QUALIFIED WELDING
ANNEALING, DESCALING AND PICKLING
AUXILIARY WORK

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FOREWORD

With this new catalogue we hope to meet the requirements of manufacturers and constructors of boilers, pressure vessels and accessories in the design, construction and ordering of the various parts of their products.

The Vessel head capacities, dimensions etc. are mathematically determined and are thus attainable in practice. The weights are calculated based on a density of 8 kg/m^2.

The Vessel heads, cones etc. are listed according to our normal delivery program.
Other sizes and shapes can, of course, be requested without obligation.

We can accept no responsibility for printer's errors.

We are accustomed to working in accordance with the following standards and inspection authorities:

A.B.S.
AD 2000
A.I.B.
ASME
B.S.
BUREAU VERITAS
DIN
ISO 9001
LLOYD'S REG. OF SHIPPING
NORSOK
Ö-NORM
PD 5500
PED
SMS
STOOMWEZEN
SVTI
TÜV
U.S. COAST GUARD
VINÇOTTE

And others.

CONTENTS

INQUIRIES, ORDERS

The following information should accompany all enquiries and orders:

1. Type and Number of heads, cones, etc.
2. Internal or external diameter
3. Height of straight flange (or total height)
4. Edge preparation type
5. Thickness:
    a. Minimum thickness after forming
    b. Nominal thickness
    c. Initial plate thickness
6. Central hole: whether allowed
7. Material specification
8. Whether test pieces are required
9. Heat-treatment: Procedure and special requirements
10. Destructive and/or non destructive examination
11. Descaling, pickling and/or polishing
12. Certificates and reports required
13. Standard and Inspection Authority
14. Tolerances, if different from standard
15. Delivery, term of delivery, packing, terms of payment and shipping address.

MATERIALS, TOLERANCES REPORTS, GENERAL

Material types

We are equipped to produce a wide range of vessel head types and sizes. A partial list of the materials from which vessel heads, cones, etc. are made includes:

- Non alloy steels
- Steel of low alloy contents
- Fine grained steel
- Ferritic steel
- Stainless steel
- Chromium steel
- Monel, Inconel, Incoloy
- Hastelloy, Titanium, Zirconium
- Aluminium and aluminium alloys
- Copper, Brass, Bronze and Silver
- Cladded steels
- High strength steels

Due to the large variety of material types, it is impossible to hold all in stock.
All required qualities can be supplied, or can be supplied by the customer (workmanship only).

Standard tolerances

Circumferential tol.:	+ 0.5 %, - 0.25 %
Total height tol.:	± 2 %
Circularity tol.:	Dmax. – Dmin ≤ 1% (max. 30 mm)

The circumference is calculated with π = 3.1416

Reports

If required the following reports can be delivered with the vessel heads:

- Material certificate
- Test report destructive testing
- Heat treatment certificate and graphs
- Test report non destructive testing
- X-ray report and photos
- Dimensional check report

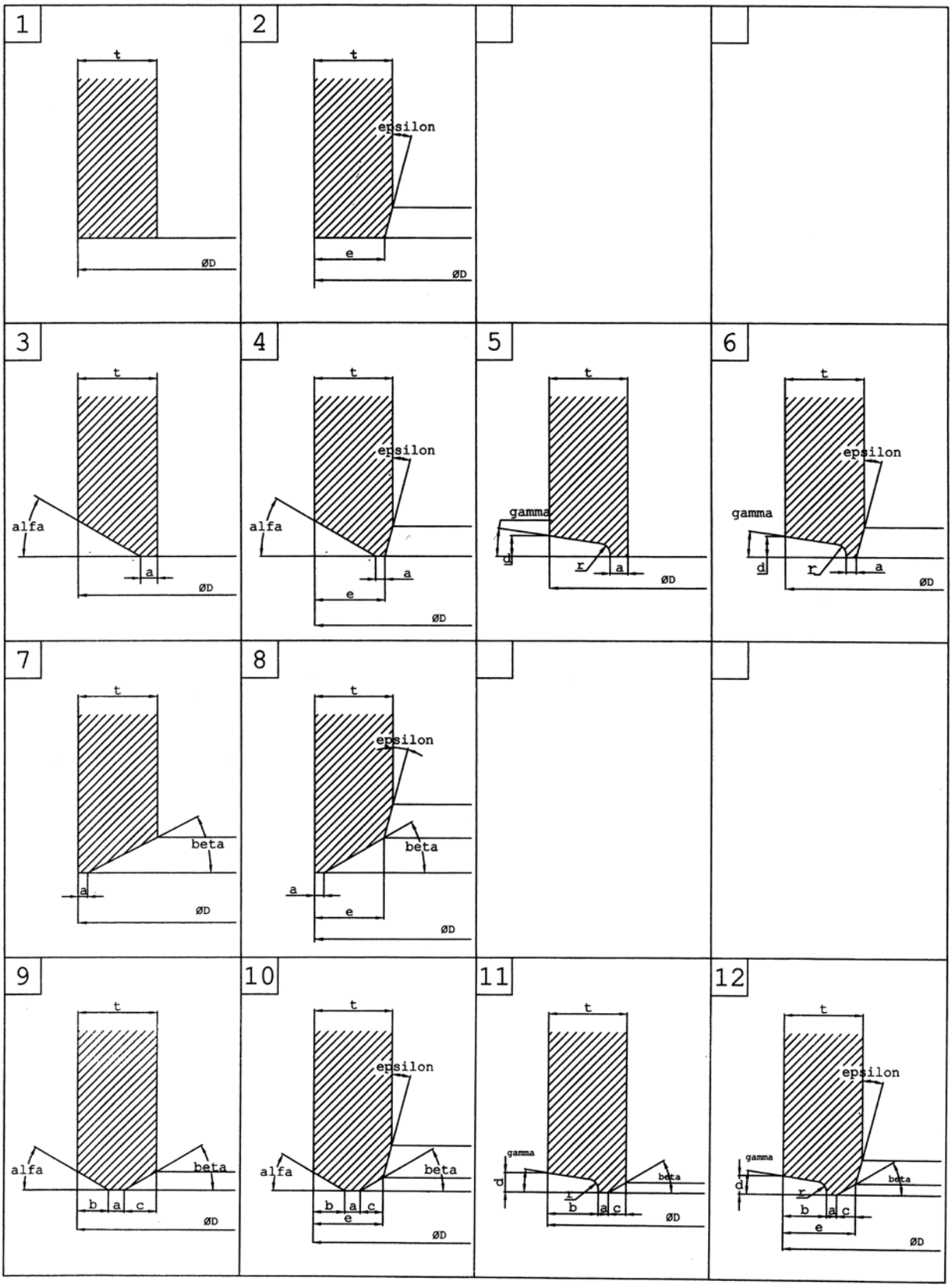
And others.

General

- Unless otherwise ordered, heads are provided with a flange h = 3.5t.
- Heads of 4 mm and thicker are, unless otherwise ordered, bevelled for an external V-seam.

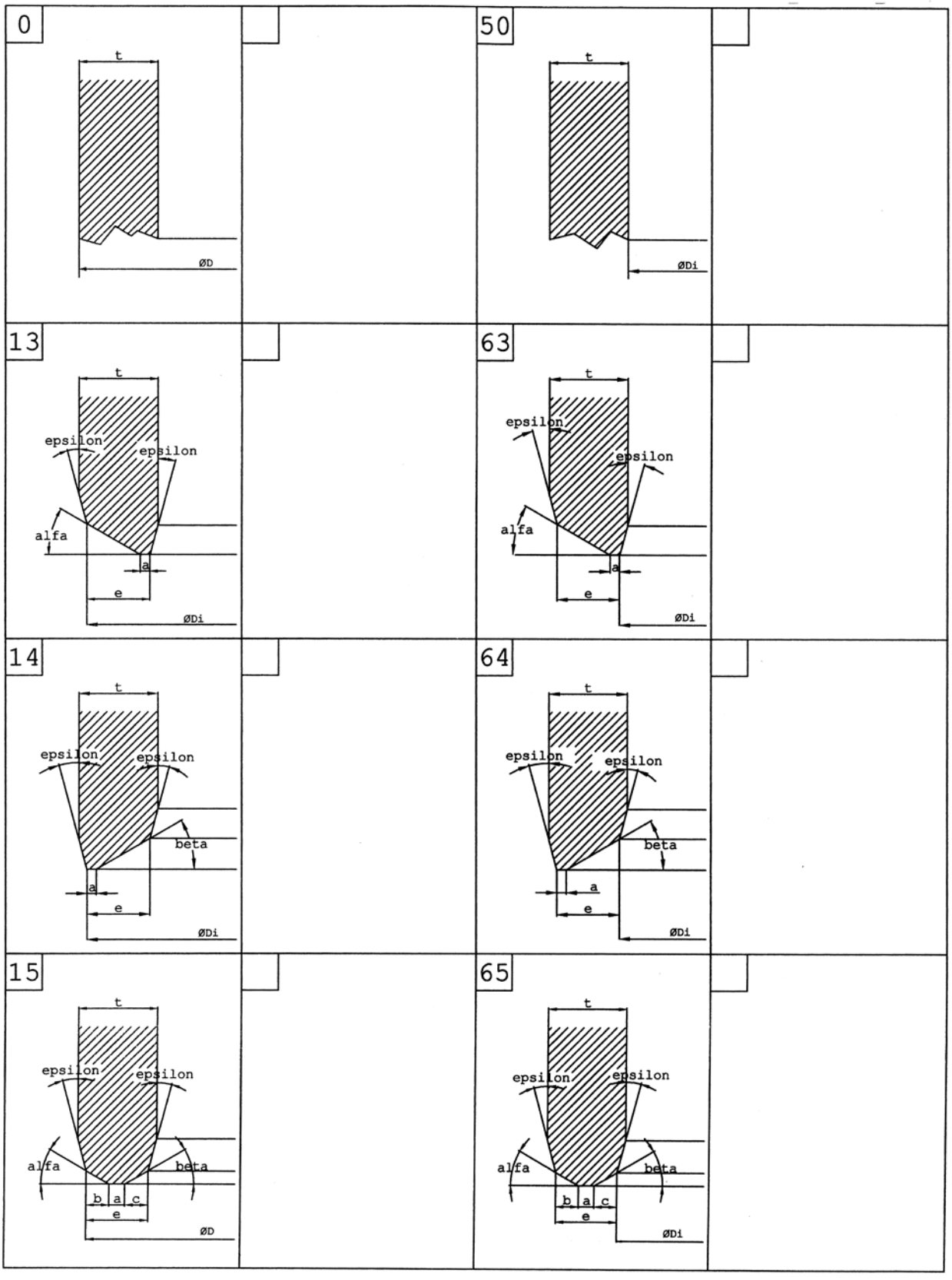
EDGE PREPARATION

OUTSIDE DIMENSION



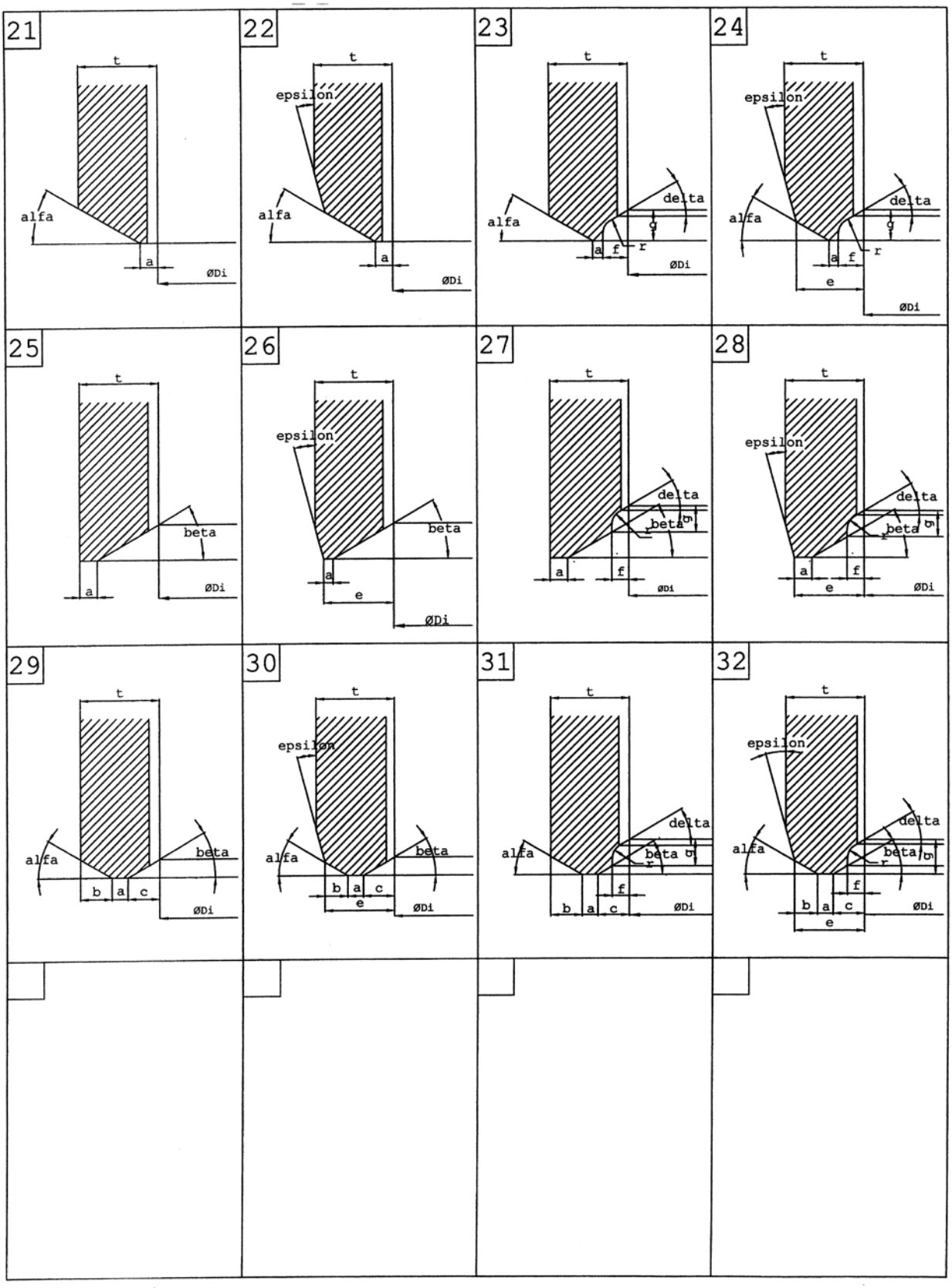
EDGE PREPARATION

IN-OUTSIDE TAPERED



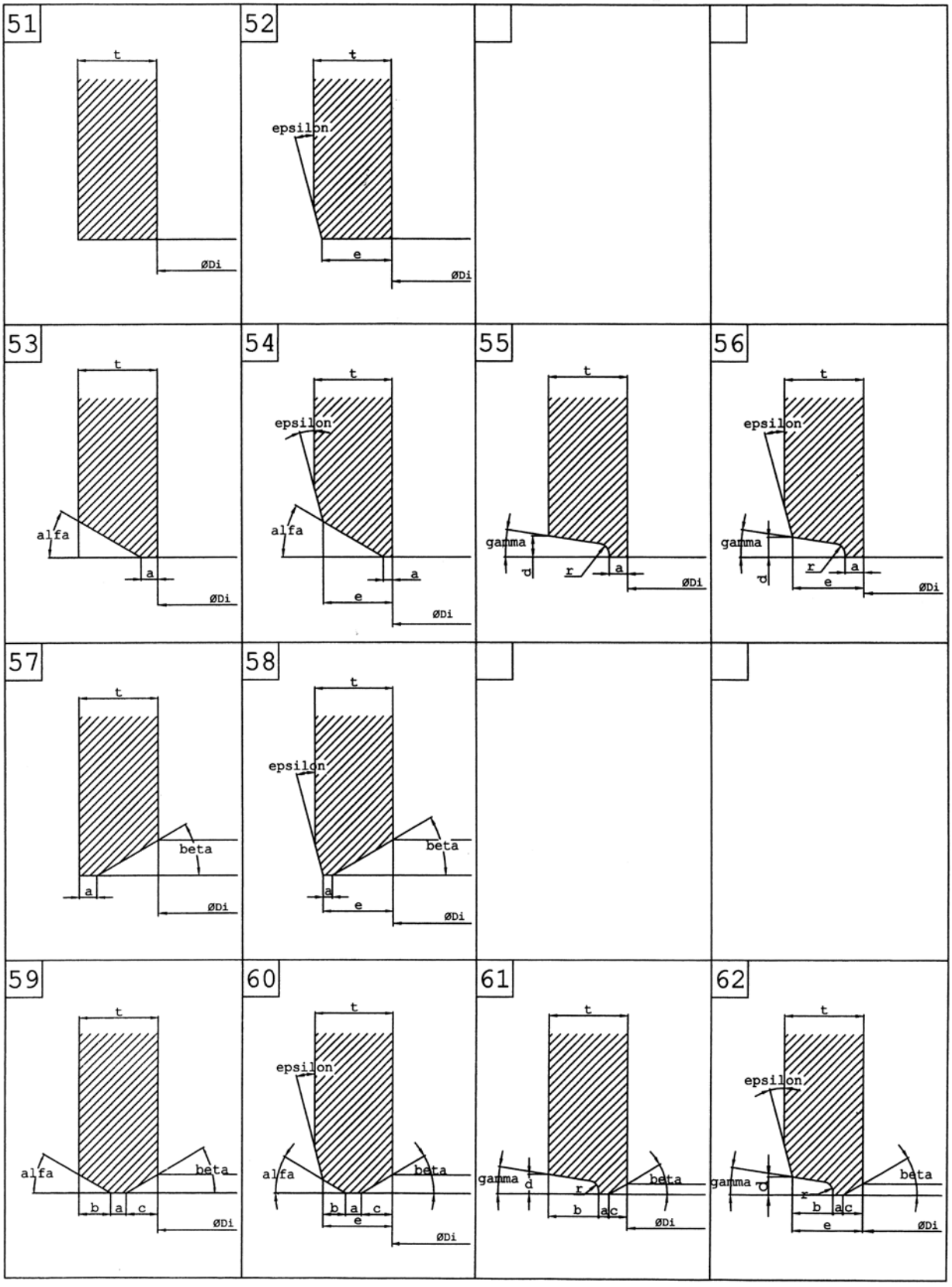
EDGE PREPARATION

CLAD MATERIAL



EDGE PREPARATION

INSIDE DIMENSION



FINISHING OF WELDED JOINTS AND EDGES OF DISCS SUPPLIED BY THE CUSTOMER

Customers supplying their own material are asked to give utmost attention to the following:

1. Do not fit on small pieces at the edge of a disc. Welded joints entirely situated on the flanged part of the vessel head have to be avoided.

2. All welded joints have to be of correct quality and are required to be ground flush on both sides.

3. When grinding, ensure that the grinding lines lie in the length of the weld.
   After grinding polish the welded seam, again in the length of the weld.
   Use grain 120 so that a straight track arises and the grinding marks are eliminated.

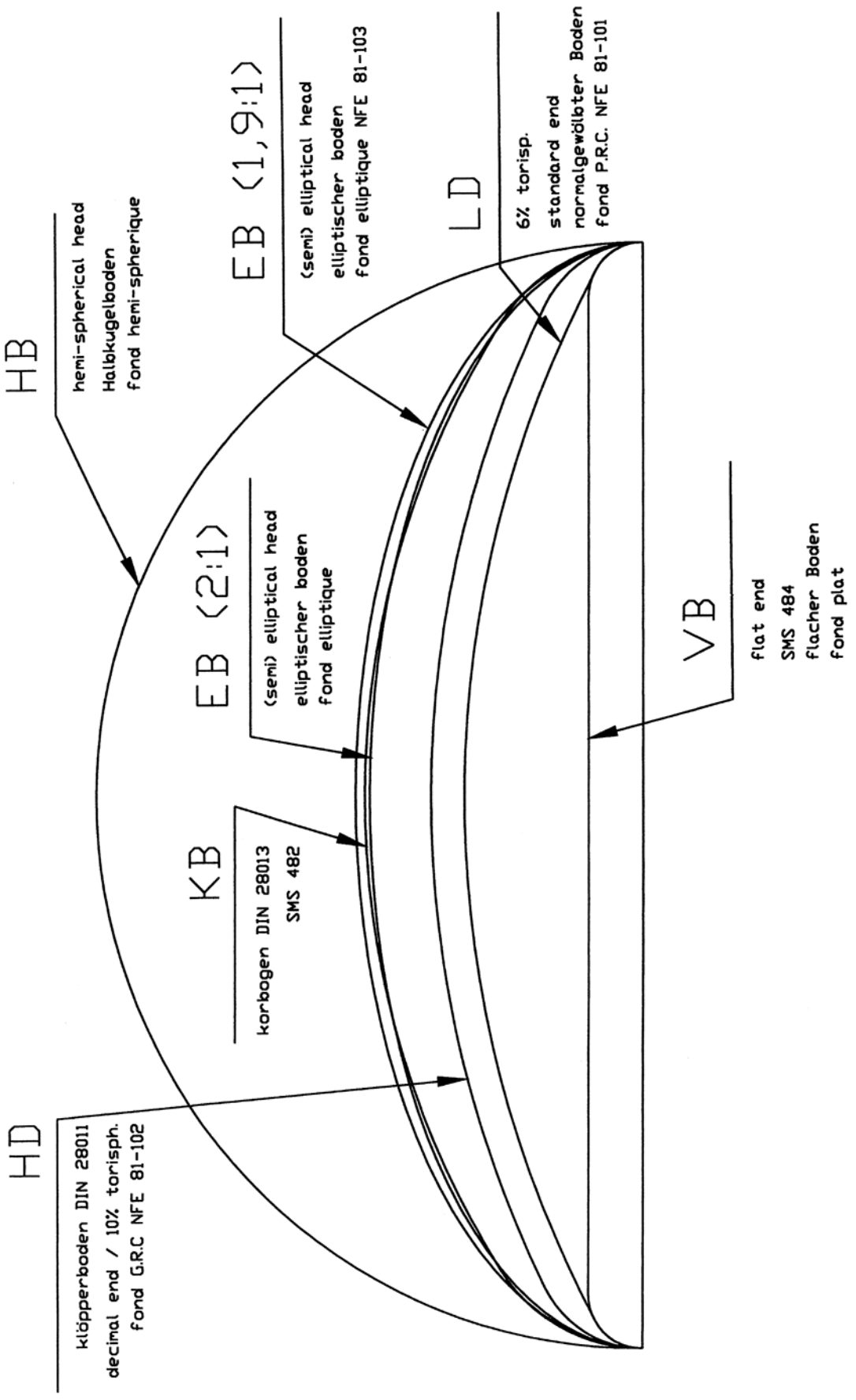
4. All material (discs as well as test pieces) to be marked for easy identification.

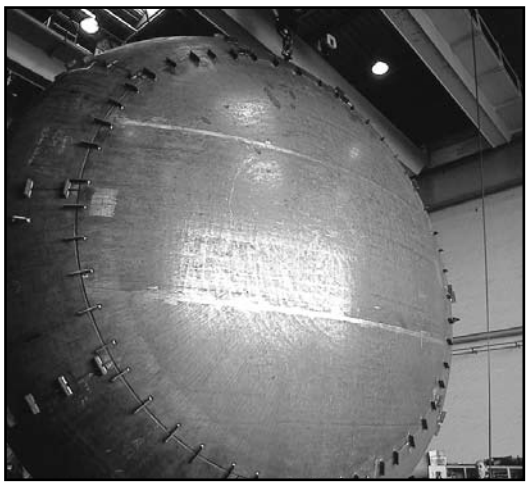
5. Edges of the discs to be ground smooth to prevent notch effect.

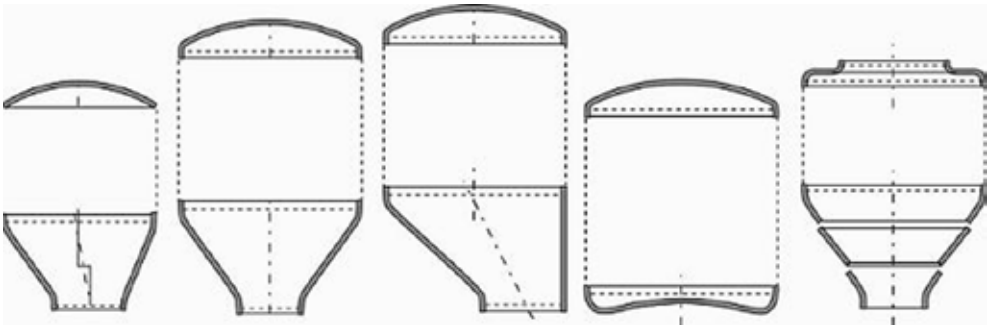
6. **Sizes of discs being supplied, to be advised.**

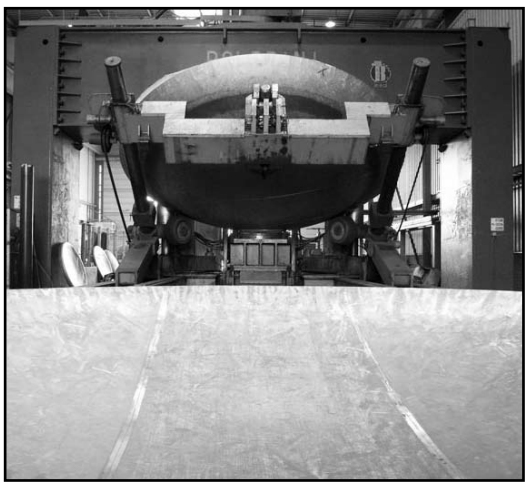
To meet increasing quality requirements and to prevent cracks during forming (and thus avoiding considerable expense and delay) we must insist on a careful compliance with the above mentioned items.

HEAD TYPES


HB
hemi-spherical head
Halbkugelboden
fond hemi-spherique
EB (1,9:1)
(semi) elliptical head
elliptischer boden
fond elliptique NFE 81-103
LD
6% torisp.
standard end
normalgewölbter Boden
fond P.R.C. NFE 81-101
EB (2:1)
(semi) elliptical head
elliptischer boden
fond elliptique
KB
korbogen DIN 28013
SMS 482
HD
klöpperboden DIN 28011
decimal end / 10% torisph.
fond G.R.C NFE 81-102
VB
flat end
SMS 484
flacher Boden
fond plat







PIPE CAPS

(~2:1 RATIO)

$R = 0{,}8.D$

$r = 0{,}154.D$

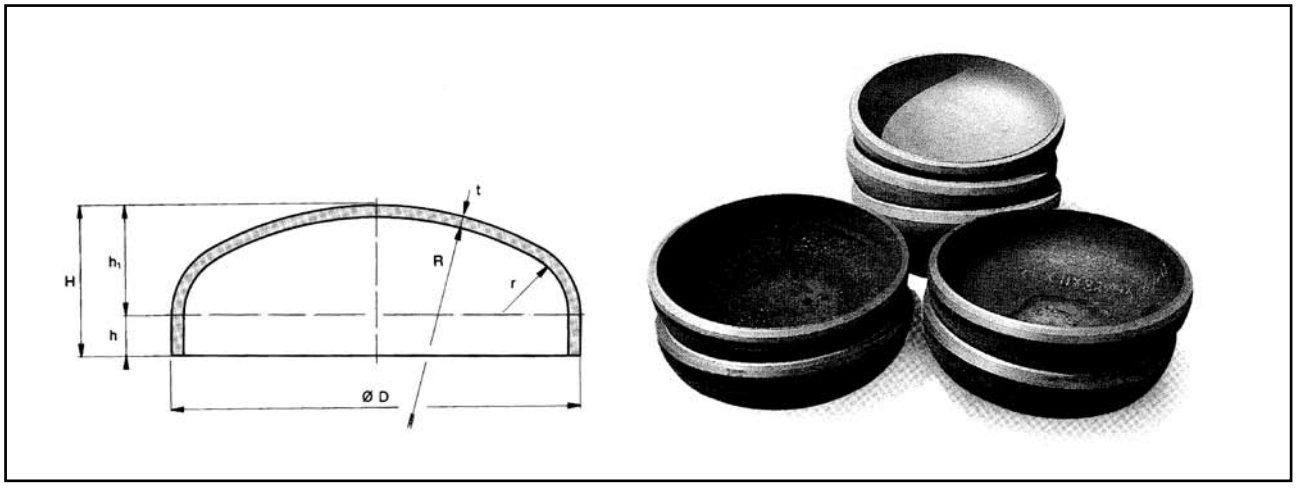
$h = 3{,}5.t$

$h_1 = 0{,}26.D$

$H = 0{,}26.D + h$

D_s(disc dia.) $= 1{,}174.D + 1{,}7.h \quad (1{,}7.h \geqslant 40)$

Net weight (kg) $= 2\pi.D_s^2.t$

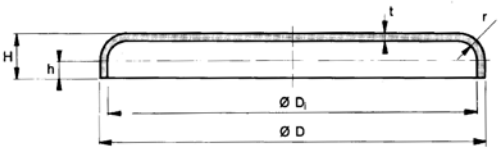


Ø Nom Inches	D (mm)	t (mm)
½"	21,3	3-5
¾"	26,7	3-5
1"	33,5	3-5
1¼	42,2	3-5
1½"	48,3	3-8
2"	60,4	3-12
2½"	76,1	3-15
3	88,9	3-18
3½"	101,6	3-20
4"	114,3	3-25
5"	139,7	3-30
6"	168,4	3-30
8"	219,2	3-35

Ø Nom Inches	D (mm)	t (mm)
10"	273,0	3-40
12"	323,8	3-45
14"	355,6	5-45
16"	406,4	5-50
18"	457,2	5-55
20"	508,0	5-60
22"	558,8	5-65
24"	609,6	5-70
26"	660,0	5-75
30"	762,0	5-80
34"	863,5	5-85
36"	914,4	5-90
42"	1066,8	5-100

All others on request

FLAT HEADS



r = see table (or on request)

h = 20 to 60 mm. (or on request)

H = h + r + t

D_s (disc dia.) = D + r + 2.h (2.h ⩾ 40)
(In the table: D_s is average value)

Capacity = $\frac{\pi}{4} D_i^2.r - 0{,}66.D_i.r^2$ (In the table: D_i = D and h = 0)

Surface (one side) = $\frac{\pi}{4}.D_s^2$

Nett weight (kg) = $2\pi.D_s^2.t$ (D_s in m, t in mm)

Depending on width of available millplates larger ends with one or more welded joints.

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	r (mm)	m (kg/mm)
300	3-10	360	1,6	25	0,8
350	3-10	410	2,4	25	1,1
400	3-10	460	3,0	25	1,3
450	3-10	510	3,8	25	1,6
500	3-10	560	4,7	25	2,0
550	3-20	610	5,7	25	2,3
600	3-20	660	6,8	25	2,8
650	3-20	710	8,0	25	3,2
700	3-20	760	9,3	25	3,6
750	3-20	820	12,8	25	4,2
800	3-30	870	14,6	30	4,7
850	3-30	920	16,5	30	5,3
900	3-30	970	18,5	30	5,9
950	3-30	1020	20,7	30	6,5
1000	3-30	1070	23,0	30	7,2
1050	3-40	1120	25,3	30	7,9
1100	3-40	1180	32,5	35	8,6
1150	3-40	1230	35,5	35	9,4
1200	3-40	1280	38,5	35	10,2
1250	3-40	1330	42,0	35	11,0

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	r (mm)	m (kg/mm)
1300	3-50	1380	45,5	35	11,9
1350	3-50	1430	49,0	35	12,8
1400	3-50	1480	53,0	35	13,7
1450	3-50	1530	64,5	40	14,6
1500	3-50	1580	69,0	40	15,6
1550	3-40	1630	73,5	40	16,7
1600	3-40	1680	78,5	40	17,7
1650	3-40	1730	83,5	40	18,8
1700	3-40	1780	88,5	40	19,9
1750	3-40	1830	94,0	40	21,0
1800	3-30	1880	99,5	40	22,2
1850	3-30	1940	119,0	40	23,5
1900	3-30	1990	125,0	40	24,8
1950	3-30	2040	131,0	40	26,1
2000	3-30	2090	138,0	40	27,4
2050	3-30	2140	145,0	45	28,5
2100	3-30	2190	152,0	45	30,0
2150	3-30	2240	160,0	45	31,5
2200	3-30	2290	168,0	45	33,0
2250	3-30	2340	176,0	45	34,5

FLAT HEADS
(CONTINUED)

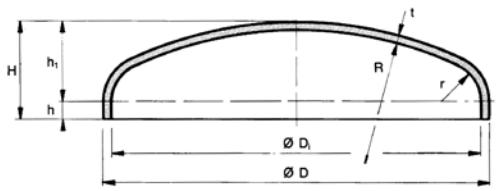
D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	r (mm)	m (kg/mm)
2300	3-30	2400	204	50	36,0
2350	3-30	2450	213	50	37,5
2400	3-30	2500	222	50	39,0
2450	3-30	2550	231	50	41,0
2500	3-30	2600	240	50	42,5
2550	3-30	2650	250	50	44,0
2600	3-30	2700	260	50	46,0
2650	3-30	2750	270	50	47,5
2700	3-30	2800	281	50	49,5
2750	3-30	2850	292	50	51,0
2800	4-30	2900	303	50	53,0
2850	4-30	2950	314	50	54,5
2900	4-30	3000	325	50	56,5
2950	4-30	3050	337	50	58,5
3000	4-30	3100	348	50	60,5
3100	4-30	3200	372	50	64,0
3200	4-30	3300	397	50	68,0
3300	4-30	3400	422	50	73,0
3400	4-30	3500	448	50	77,0
3500	4-30	3600	475	50	81,0

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	r (mm)	m (kg/mm)
3600	5-30	3700	503	50	86
3700	5-30	3800	532	50	91
3800	5-30	3900	561	50	96
3900	5-30	4000	591	50	101
4000	5-30	4100	622	50	106
4500	6-30	4700	1176	50	139
5000	6-30	5200	1454	75	170
5500	6-30	5700	1762	75	204
6000	8-30	6200	2098	75	242
6500	10-30	6700	2465	75	282
7000	10-30	7200	2859	100	328
7500	10-30	7700	3281	100	375
8000	10-30	8200	3733	100	425
8500	10-30	8700	4214	100	474
9000	10-30	9200	4724	100	535
9500	10-30	9700	5263	100	595
10000	10-30	10200	5832	100	657

All others on request

DECIMAL HEADS

KLÖPPERBÖDEN



DETAILS

R	=	D
r	=	0,1.D
h	=	3,5.t (or on request)
h_1	=	0,2.D
H	=	0,2.D + h
D_s (disc dia.)	=	1,12.D + 1,7.h (1,7.h ⩾ 40) (in the table: D_s is average value)
Capacity	=	$0,1.D_i^3$ (in the table: D_i = D and h = 0)
Surface (one side)	=	$\frac{\pi}{4}.D_s^2$
Nett weight (kg)	=	$2\pi.D_s^2.t$ (D_s in m, t in mm)

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
300	3-40	380	2,7	60	0,9
350	3-40	435	4,3	70	1,2
400	3-45	490	6,4	80	1,5
450	3-50	550	9,1	90	1,9
500	3-55	610	12,5	100	2,3
550	3-60	665	16,6	110	2,8
600	3-65	720	21,6	120	3,2
650	3-70	775	27,5	130	3,8
700	3-75	830	34,5	140	4,3
750	3-80	885	42,0	150	4,9
800	3-80	950	51,0	160	5,6
850	3-85	1000	61,0	170	6,3
900	3-90	1060	73,0	180	7,0
950	3-95	1120	86,0	190	7,8
1000	3-100	1180	100,0	200	8,7
1050	3-105	1240	116,0	210	9,6
1100	3-110	1290	134,0	220	10,4
1150	3-115	1350	152,0	230	11,4
1200	3-120	1400	174,0	240	12,3
1250	3-125	1460	196,0	250	13,4
1300	3-130	1520	220,0	260	14,5

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
1350	3-135	1580	246	270	15,6
1400	3-140	1640	275	280	16,8
1450	3-140	1690	305	290	18,0
1500	3-140	1750	337	300	19,2
1550	3-140	1800	375	310	20,4
1600	3-140	1860	410	320	21,6
1650	3-140	1910	450	330	22,9
1700	3-140	1970	490	340	24,3
1750	3-140	2030	535	350	25,8
1800	3-140	2080	580	360	27,1
1850	3-140	2140	630	370	28,7
1900	3-140	2200	685	380	30,4
1950	3-140	2260	740	390	32,0
2000	3-140	2310	800	400	33,5
2050	3-25	2370	860	410	35,2
2100	3-25	2430	925	420	37,0
2150	3-25	2490	995	430	39,0
2200	3-25	2540	1065	440	40,7
2250	3-25	2600	1140	450	42,5
2300	3-25	2660	1215	460	44,3
2350	3-25	2720	1300	470	46,2

DECIMAL HEADS

KLÖPPERBÖDEN (CONTINUED)

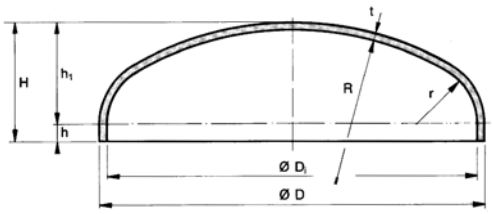
D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
2400	3-25	2770	1380	480	48,0
2450	3-25	2830	1470	490	50,0
2500	3-25	2880	1560	500	52,0
2550	3-25	2940	1660	510	54,0
2600	3-25	3000	1760	520	56,5
2650	3-25	3060	1860	530	59,0
2700	3-25	3110	1970	540	61,0
2750	3-25	3170	2080	550	63,0
2800	3-25	3230	2200	560	65,5
2850	3-25	3290	2320	570	68,0
2900	3-25	3340	2440	580	70,0
2950	3-25	3400	2570	590	72,0
3000	3-25	3450	2700	600	75,0
3050	4-25	3510	2840	610	77,5
3100	4-25	3560	2980	620	80,0
3150	4-25	3620	3130	630	82,5
3200	4-25	3680	3280	640	85,0
3250	4-25	3740	3440	650	87,5
3300	4-25	3790	3600	660	90,0
3350	4-25	3850	3760	670	93,0
3400	4-25	3910	3930	680	96,0

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
3450	4-25	3970	4110	690	99
3500	5-25	4020	4300	700	101
3550	5-25	4080	4480	710	104
3600	5-25	4130	4680	720	107
3650	5-25	4190	4870	730	110
3700	5-25	4240	5070	740	113
3750	5-25	4300	5280	750	116
3800	5-25	4360	5500	760	119
3850	5-25	4420	5710	770	123
3900	5-25	4470	5940	780	126
3950	5-25	4530	6170	790	129
4000	5-25	4590	6400	800	132
4500	6-25	5140	9115	900	165
5000	6-25	5700	12500	1000	204
5500	6-25	6260	16640	1100	246
6000	6-25	6820	21600	1200	292
6500	6-25	7250	26780	1300	330
7000	7-25	7800	33440	1400	383
7500	8-25	8350	41230	1500	438
8000	9-25	8400	50080	1600	500

All others on request

SEMI-ELLIPTICAL HEADS

KORBBOGEN (~2:1 RATIO)



R = 0,8.D

r = 0,154.D

h = 3,5.t (or on request)

h_1 = 0,26.D

H = 0,26.D + h

D_s(disc dia.) = 1,174.D + 1,7.h (1,7.h ⩾ 40)
(in the table: D_s is average value)

Capacity = $0,13.D_i^3$
(in the table: D_i = D and h = 0)

Surface (one side) = $\frac{\pi}{4}.D_s^2$

Nett weight (kg) = $2\pi.D_s^2.t$ (D_s in m, t in mm)

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
300	3-40	400	3,5	78	1,0
350	3-40	460	5,6	91	1,3
400	3-45	520	8,3	104	1,7
450	3-50	580	11,8	117	2,1
500	3-55	640	16,1	130	2,6
550	3-60	700	21,6	143	3,1
600	3-65	760	28,0	156	3,6
650	4-70	820	36,0	169	4,2
700	4-75	875	44,5	182	4,8
750	4-80	935	54,5	195	5,5
800	4-80	995	66,5	208	6,2
850	4-85	1055	79,5	221	7,0
900	4-90	1115	94,0	234	7,8
950	4-95	1170	111,0	247	8,6
1000	5-100	1230	130,0	260	9,5
1050	5-105	1290	150,0	273	10,4
1100	5-110	1350	173,0	286	11,1
1150	5-115	1410	198,0	299	12,5

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
1200	5-120	1470	225,0	312	13,6
1250	5-125	1530	254,0	325	14,7
1300	5-130	1590	285	338	15,9
1350	5-135	1650	320	351	17,1
1400	5-140	1710	356	364	18,4
1450	5-140	1770	395	377	19,7
1500	5-140	1830	438	390	21,0
1550	5-140	1890	483	403	22,5
1600	5-140	1950	532	416	23,9
1650	5-140	2010	585	429	25,4
1700	5-140	2070	640	442	27,0
1750	5-140	2130	700	455	28,5
1800	5-140	2190	760	468	30,0
1850	5-140	2250	825	481	31,5
1900	5-140	2300	890	494	33,0
1950	5-140	2360	965	507	35,0
2000	5-140	2420	1040	520	37,0
2050	5-140	2480	1120	533	38,5

SEMI-ELLIPTICAL HEADS

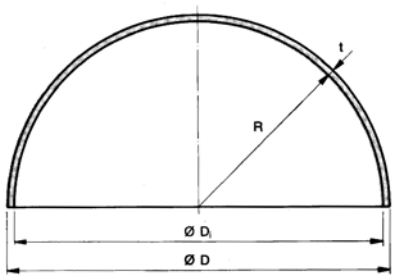
KORBBOGEN (~2:1 RATIO) (CONTINUED)

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
2100	5-140	2540	1200	546	40,5
2150	5-140	2600	1290	559	42,5
2200	5-140	2660	1380	572	44,5
2250	5-140	2720	1480	585	46,5
2300	5-140	2780	1580	598	48,5
2350	5-140	2840	1690	611	51,0
2400	5-140	2900	1800	624	53,0
2450	5-140	2960	1910	637	55,0
2500	5-140	3020	2030	650	57,0
2550	5-140	3080	2150	663	59,0
2600	5-140	3140	2280	676	62,0
2650	5-140	3190	2410	690	64,0
2700	5-140	3250	2550	700	66,5
2750	5-140	3310	2700	715	69,0
2800	5-140	3370	2850	725	71,0
2850	5-140	3430	3000	740	74,0
2900	5-140	3490	3160	755	76,0
2950	5-140	3550	3340	765	79,0

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	h (mm)	m (kg/mm)
3000	5-140	3610	3500	780	82
3100	5-25	3720	3850	805	87
3200	5-25	3840	4260	832	93
3300	5-25	3960	4672	858	99
3400	5-25	4080	5110	884	105
3500	6-25	4200	5574	910	111
3600	6-25	4320	6065	936	117
3700	6-25	4440	6585	962	124
3800	6-25	4560	7133	988	131
3900	6-25	4680	7712	1014	138
4000	6-25	4780	8320	1040	144
4500	6-25	5360	11846	1170	181
5000	6-25	5940	16250	1300	222
5500	6-25	6580	21630	1430	272
6000	6-25	6980	29200	1560	306
6500	7-25	7580	37050	1690	360

All others on request

HEMISPHERICAL HEADS



DETAILS

R = $0,5.D_i$

D_s(disc dia.) = 1,42.D

Capacity = $0,2619.D_i^3$ (in the table: $D_i = D$)

Surface (one side) = $1,57.D^2$

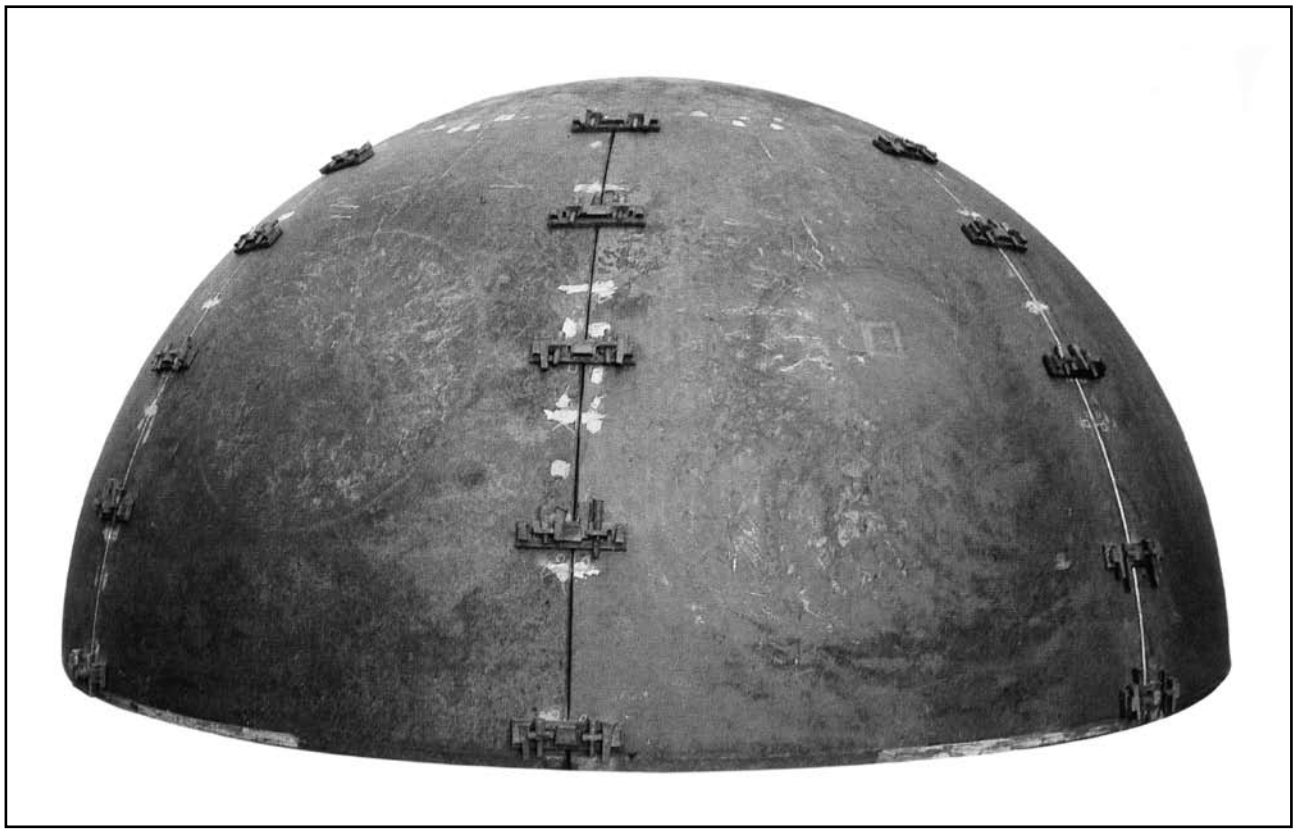
Nett weight (kg) = $1,57.D^2.8.t$ (D in m, t in mm)

Di (mm)	t (mm)	V (10^3 m^3)	m (kg/mm)
One piece head			
100	5-20	0,262	0,13
200	5-30	2,095	0,50
300	5-50	7,07	1,13
400	5-55	16,75	2,01
500	3-60	32,7	3,14
600	3-65	56,4	4,5
700	3-70	89,6	6,2
800	3-75	134	8,0
900	3-80	191	10,2
1000	3-85	262	12,6
1100	3-90	348	15,2
1200	3-90	451	18,2
1300	3-90	575	21,2
1400	3-90	717	24,6
1500	3-90	884	28,3

Di (mm)	t (mm)	V (10^3 m^3)	m (kg/mm)
One piece head			
1600	3-90	1070	32,0
1700	3-90	1285	36,5
Segments and spherical cap			
1800	3-50	1525	40,5
1900	3-50	1790	45,5
2000	3-50	2095	50,0
2100	3-50	2425	55,5
2200	3-50	2790	61,0
2300	3-50	3185	66,5
2400	3-50	3610	72,5
2500	3-50	4090	78
2600	4-50	4600	85
2700	4-50	5150	91
2800	4-50	5740	98
2900	4-50	6380	105

HEMISPHERICAL HEADS

(CONTINUED)



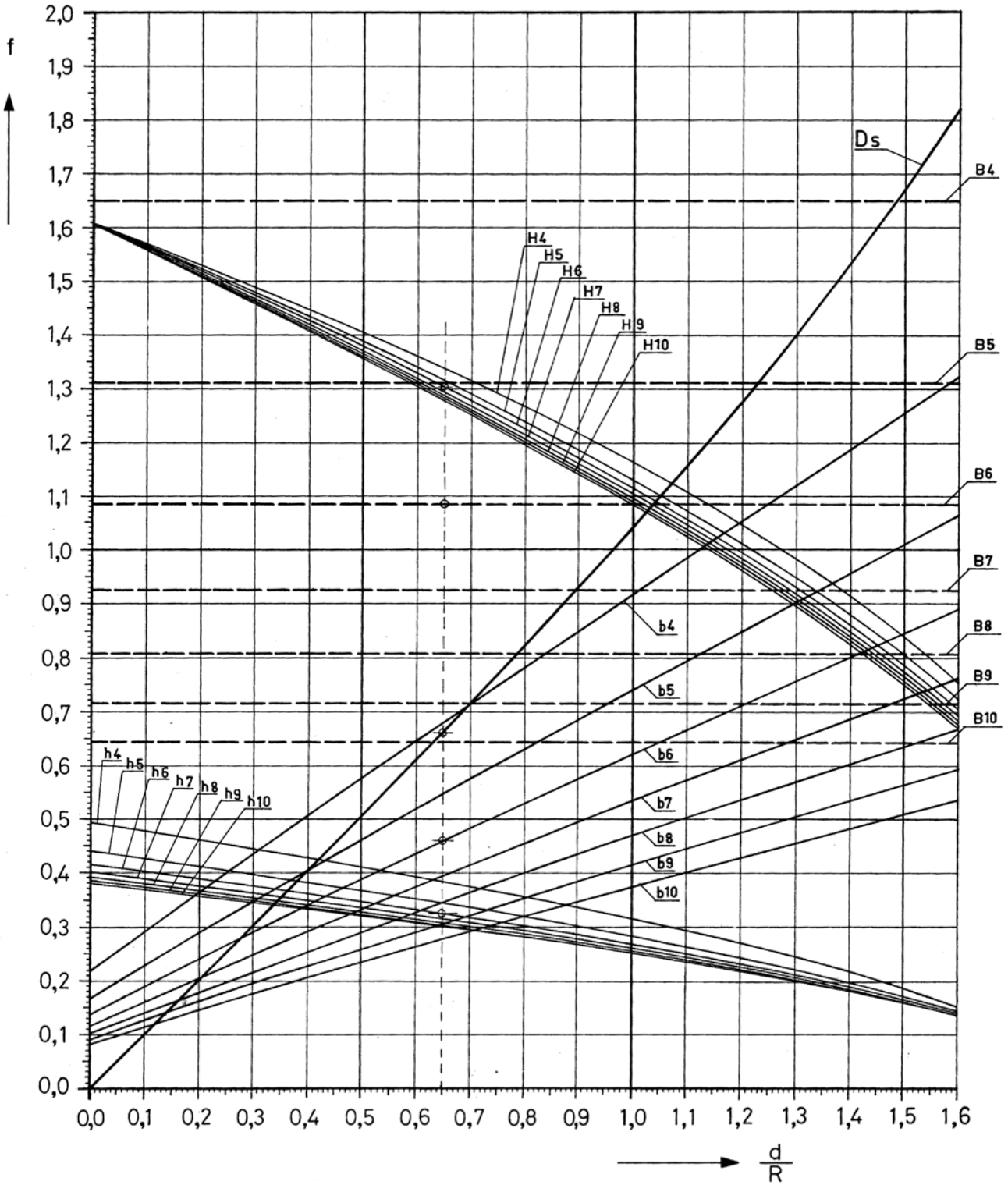
Di (mm)	t (mm)	V (10^3 m^3)	m (kg/mm)
Segments and spherical cap			
3000	5-50	7070	113
3100	5-50	7800	121,00
3200	5-50	8570	129
3300	5-50	9400	137
3400	5-50	10280	145
3500	5-50	11210	154
3600	6-50	12200	163
3700	6-50	13250	172
3800	6-50	14350	181
3900	6-50	15500	191
4000	6-50	16750	201
4100	6-50	18050	211
4200	6-50	19400	222
4300	6-50	20800	232
4400	6-50	22300	243

Di (mm)	t (mm)	V (10^3 m^3)	m (kg/mm)
Segments and spherical cap			
4500	6-50	23800	254
4600	6-50	25500	266,0
4700	6-50	27200	278
4800	6-50	28900	289
4900	6-50	30800	302
5000	6-50	32700	314
5500	7-50	43575	380
6000	8-50	56500	452
6500	9-50	71900	531
7000	10-50	89800	615
7500	12-50	110000	707
8000	12-50	134100	804

Di upto 20.000 mm

All others on request

GRAPH FOR DETERMINATION OF BLANK-DIMENSIONS

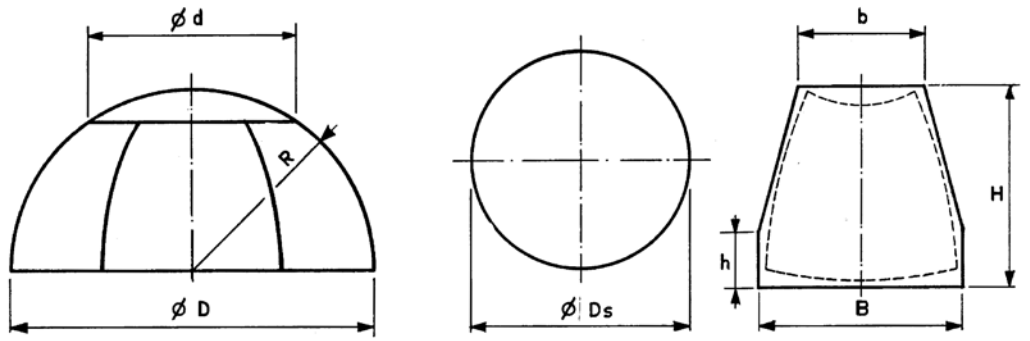


DETERMINATION OF BLANKDIMENSIONS FOR SPHERICAL CAP AND SEGMENTS

Hemispherical ends larger than 1000 mm. in diameter normally are assembled of separately pressed segments and a spherical cap. The segment-blanks are trapezoidal sheets which, after pressing, are cut to the correct dimensions. With the opposite graph a quick determination of the blank-dimensions is possible for hemispherical ends assembled of:

— a spherical cap that conforms to $0 < d/R < 1,6$
— 4 up to 10 segments.

Symbols: B_n, H_n, b_n and h_n are the dimensions of a segment-blank for a hemispherical end with "n" segments (see figure below).



Hemispherical end with cap and "n" segments

Cap blank

Segment blank

Direction for use of the graph. For a hemispherical end the dimensions D, R, d, and the number of segments "n" are known. Firstly the ratio "d/R" is determined. On the vertical of the graph applying to this ratio intersections are found with the D_s-, B_n-, H_n-, b_n- and h_n-curve. On the axis of ordination the factor "f" relating to each intersection is found. Multiply this factors "f" with the known R-value and subjoin the following allowances to determine the blankdimensions.

Allowances. Spherical Cap: normally no final machining or gas-cutting after pressing. No allowance required.
Segments: always trimmed after pressing. Allowance essential.
For size B, H and b: + 40 mm. each
For size h: + 20 mm.

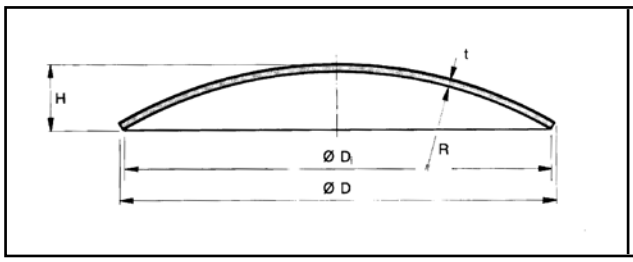
Example. To obtain the blankdimensions for a hemispherical end: D = 2400 mm., R = 1200 mm., d = 780 mm and n = 6. d/R = 780/1200 = 0,65 (see vertical dotted line in the graph). Along this vertical line, from top to bottom, the factors f will be found for H_6:1,305; B_6:1,085; D_s:0,665; b_6:0,460; h_6:0,325.
The blankdimensions, including the allowances wil be:

Spherical Cap: D_s = 0,665 x 1200 + 0 = 798 ≙ 800 mm
Segments : B = 1,085 x 1200 + 40 = 1342 ≙ 1340 mm.
H = 1,305 x 1200 + 40 = 1606 ≙ 1605 mm.
b = 0,460 x 1200 + 40 = 592 ≙ 590 mm.
h = 0,325 x 1200 + 20 = 410 ≙ 410 mm.

Remark. Apart from Ø D the blankdimensions will also depend on the type of material, the sheet thickness, the manufacturing process (hot or cold pressing) and other factors. There are also press-limits on the dimensions of the sheet.

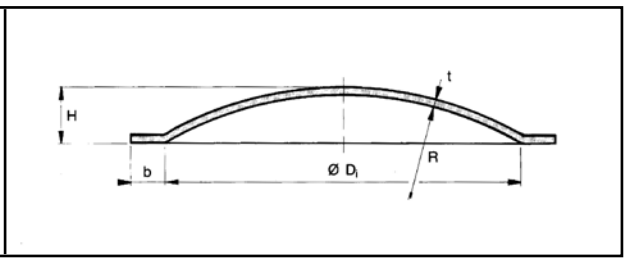
The dimensions found should therefore only be considered as an indication and for a definite fixation of the blanks consultation with the manufacturer is always necessary.

SPHERICAL CAP
DISHED ONLY



R = D (or on request)
H = 0,134.D + t (if R = D)
D_s (disc dia.) = 1,035.D (if R = D)
(see also graph on p. 24)
Capacity = $0{,}054.D_s^3$ (if R = D)
Surface (one side) = $\frac{\pi}{4}.D_s^2$
Nett weight (kg) = $2\pi.D_s^2.t$ (D_s in m, t in mm)

SPHERICAL COVER
DISHED AND FLARED



R = D (or on request)
H = 0,134.D + t (if R = D)
b = 40 ÷ 60 mm (or on request)
D_s (disc dia.) = 1,035.D + 2.b (if R = D)
Capacity = $0{,}054.D^3$ (if R = D)
Surface (one side) = $\frac{\pi}{4}.D_s^2$
Nett weight (kg) = $2\pi.D_s^2.t$ (D_2 in mm, t in mm)

Spherical caps (dished only)

D (mm)	t (mm)	Ds (mm)	V (10^3 m³)	h (mm)	m (kg/mm)
1000	3-80	1035	54,0	140	6,7
1250	3-80	1290	105	174	10,5
1500	3-80	1550	183	208	15,2
1750	3-80	1810	290	242	20,6
2000	3-80	2070	432	277	27
2250	4-80	2325	615	310	34
2500	4-80	2585	845	344	42
2750	4-80	2845	1120	377	51
3000	5-80	3105	1460,0	412	60,5
3250	6-80	3365	1860	447	71,5

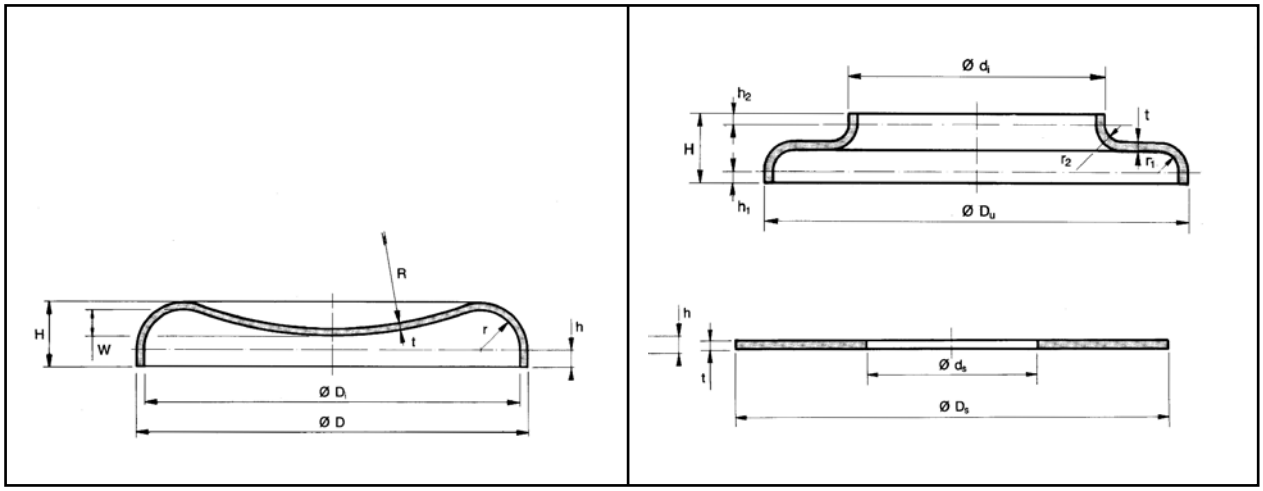
D (mm)	t (mm)	Ds (mm)	V (10^3 m³)	h (mm)	m (kg/mm)
3500	7-80	3620	2320	480	82,5
3750	7-80	3880	2850	514	95
4000	8-80	4140	3460	548	108
4250	8-80	4400	4150	580	122
4500	8-80	4660	4920	614	136

D upto 10.000 mm t upto 80 mm

All others on request

DIFFUSION HEADS EXPANSION JOINTS

DISHED AND REVERSE FLANGED



R	=	D
r	=	see table (or on request)
h	=	20 ÷ 50 mm (or on request)
w	=	$R + r + t - \sqrt{(R+r+t)^2 - (½.D$
D_s (disc dia.)	=	1,02.D + r + 1,7.h (1,7.h ⩾ 40)
Capacity	=	$\frac{\pi}{4} D_i^2.r - 0{,}65.D.r^2 - \pi (R.w^2 - ⅓$ (in the table: h = 0 and t = 0)
Surface (one side)	=	$\frac{\pi}{4} D_s^2$
Nett weight (kg)	=	$2\pi.D_s^2.t$ (D_s in m, t in mm)

$D_{u\text{-}min}$ = 200 mm; $d_{i\text{-}min}$ = 50 mm
$D_{u\text{-}max}$ = 6000 mm; $d_{i\text{-}max}$ = 4000 mm
if $3 \leqslant t \leqslant 10$ mm., then $200 \leqslant D_u \leqslant 4500$ mm
and $50 \leqslant d_i \leqslant 4000$ mm.

BLANKDIMENSIONS

$D_s = D_u + r_1 + 2\,h_1$; $(2\,h_1 \geqslant 40$ mm)
$d_s = d_i - r_2 - 2\,h_2$; $(2\,h_2 \geqslant 40$ mm)

Diffusion heads (dished and reverse flanged)

D (mm)	t (mm)	Ds (mm)	V (10^3 m^3)	r (mm)	w (mm)	m (kg/mm)
1000	4-20	1160	45	90	81	8,4
1100	4-20	1260	50	90	93	9,9
1200	4-20	1365	54	90	106	11,6
1300	4-20	1475	72	100	114	13,6
1400	4-20	1580	76	100	126	15,6
1500	4-20	1690	117	110	106	17,8
1600	4-20	1790	124	110	116	20,0
1700	4-20	1900	129	110	126	22,5
1800	4-20	2010	164	120	132	25,2
1900	4-20	2110	170	120	142	28,0
2000	4-20	2220	179	120	152	31,0

D upto 4.000 mm

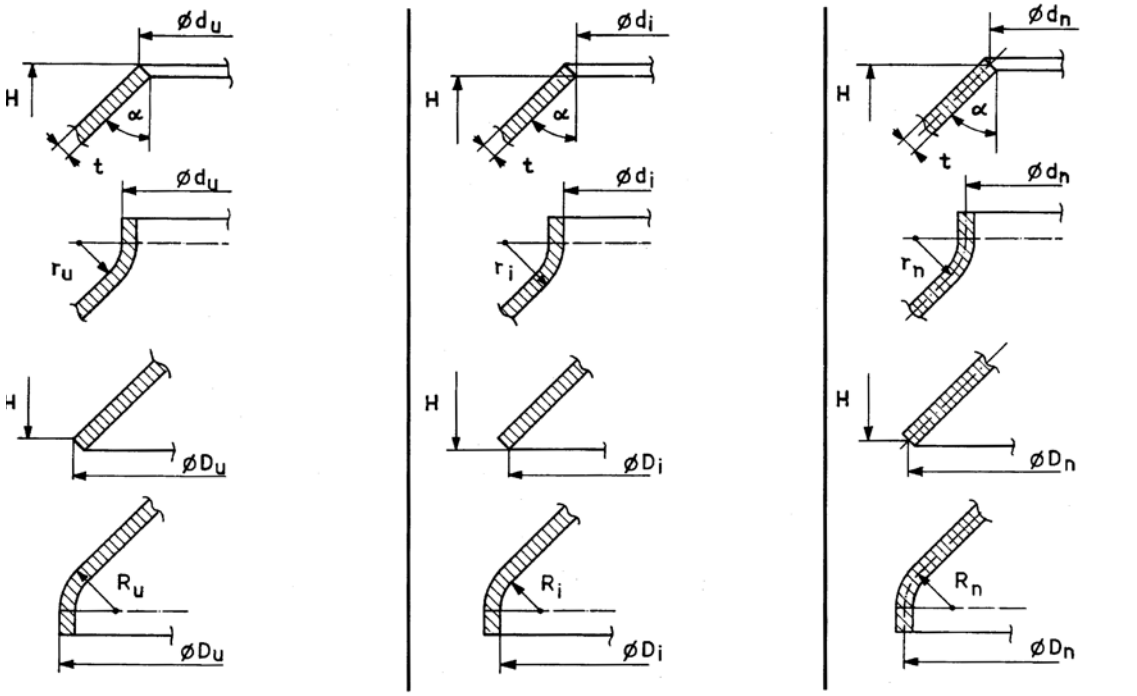
All others on request

CONES

Symbols

α	=	half of included angle	H	=	over-all height
D	=	large dia	h_1	=	height without straight flange parts
d	=	small dia	S	=	unwound slope-line
R	=	inside corner radius at D	R_s	=	blank radius at D
r	=	outside corner radius at d	r_s	=	blank radius at d
H_b	=	straight flange at D	M	=	curved cone surface (one side)
h_b	=	straight flange at d	I	=	capacity without straight flange parts

To obtain an accurate result when using the formulas on page 33 the cone dimensions per item must always be taken from the same point in relation to the sheet thickness; in other words, all external sizes or all internal sizes or all sizes on the neutral line.

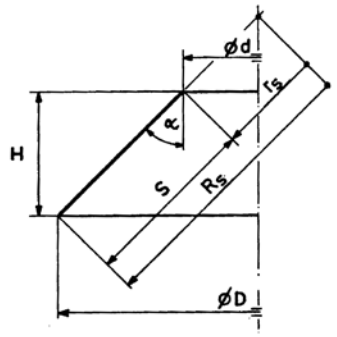
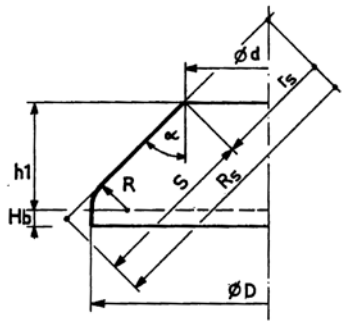
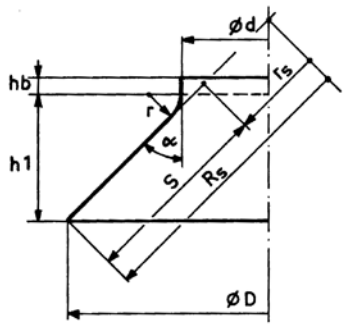
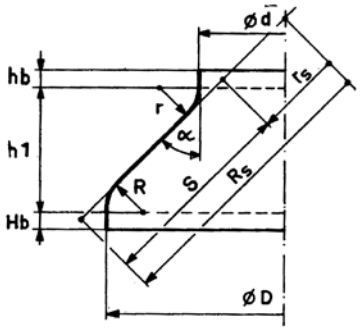


External sizes | Internal sizes | Sizes on the neutral line

For the exact determination of the blank the sizes on the neutral line should be taken. The sheet blank radii found (R_s and r_s) are theoretical. In practice allowances are to be applied to these values.

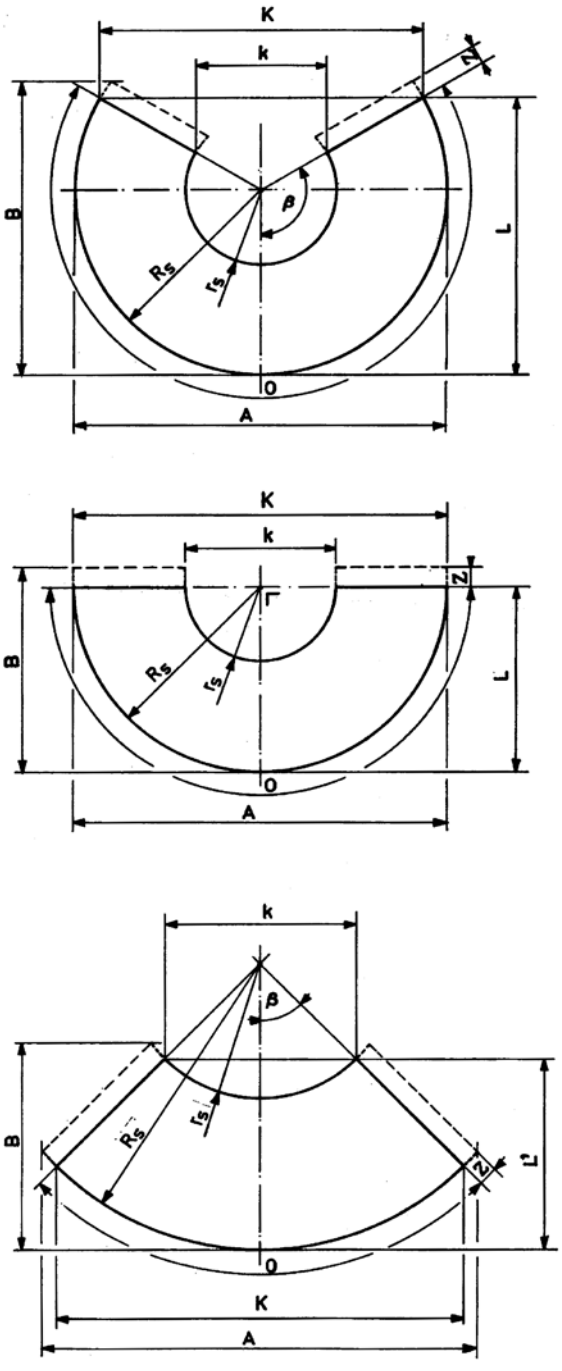
When determining the capacity internal sizes should be taken.
For flanged cones with unknown included angle, first of all the goniometric proportions should be determined.

DETAILS

	Unknown: Over-all height H	Unknown: Half of included angle α
1. Cone without flange. 	$H = \frac{D-d}{2 \text{ tg } \alpha}$; $S = \frac{D-d}{2 \sin \alpha} = R_s - r_s$; $R_s = \frac{D}{2 \sin \alpha}$; $r_s = \frac{d}{2 \sin \alpha}$; $M = \frac{\pi}{4} \cdot \frac{(D^2-d^2)}{\sin \alpha}$; or $M = \pi \sin \alpha \, (R_s^2 - r_s^2)$; $I = \frac{\pi}{24} \cdot \frac{(D^3-d^3)}{\text{tg } \alpha}$;	$S = \sqrt{\left(\frac{D-d}{2}\right)^2 + H^2}$; $R_s = D \cdot \frac{S}{D-d}$; $r_s = d \cdot \frac{S}{D-d}$; $M = \frac{\pi}{2} (D + d) \cdot S$; $I = \frac{\pi}{12} H \frac{(D^3-d^3)}{D-d}$; or $I = \frac{\pi}{12} H (D^2 + D \cdot d + d^2)$; $\sin \alpha = \frac{D-d}{2S}$; $\cos \alpha = \frac{H}{S}$;
2. Cone with flange at D. 	$h1 = \frac{D-d}{2 \text{ tg } \alpha} + R \cdot \text{tg } ½ \alpha$; $S = \frac{D-d}{2 \sin \alpha} + R \left(\frac{\pi \alpha^\circ}{180} - \text{tg } ½\alpha\right) + Hb$; $R_s = \frac{D}{2 \sin \alpha} + R \left(\frac{\pi \alpha^\circ}{180} - \text{tg } ½\alpha\right) + Hb$; $r_s = \frac{d}{2 \sin \alpha} = R_s - S$; $M = \pi \cdot S \, (d + S \sin \alpha)$; or $M = \pi \sin \alpha \, (R_s^2 - r_s^2)$; $I \approx \frac{\pi}{24} \cdot \frac{(D^3-d^3)}{\text{tg } \alpha} + \frac{\pi}{4} \cdot D^2 \cdot R \text{ tg } ½ \alpha$;	$\sin \alpha = \frac{B \sqrt{A^2+B^2-C^2} + A \cdot C}{A^2+B^2}$ $\cos \alpha = \frac{A \sqrt{A^2+B^2-C^2} - B \cdot C}{A^2+B^2}$ Here: $A = h1$ $B = \frac{D-d}{2} - R$; $C = R$ Furthermore: $\text{tg } \alpha = \frac{\sin \alpha}{\cos \alpha}$; $\text{tg } ½ \alpha = \frac{1 - \cos \alpha}{\sin \alpha}$;
3. Cone with flange at d. 	$h1 = \frac{D-d}{2 \text{ tg } \alpha} + r \cdot \text{tg } ½ \alpha$; $S = \frac{D-d}{2 \sin \alpha} + r \left(\frac{\pi \alpha}{180} - \text{tg } ½\alpha\right) + hb$; $R_s = \frac{D}{2 \sin \alpha} = r_s + S$; $r_s = \frac{d}{2 \sin \alpha} - r \left(\frac{\pi \alpha}{180} - \text{tg } ½\alpha\right) - hb$; $M = \pi \cdot S \, (D - S \sin \alpha)$; or $M = \pi \sin \alpha \, (R_s^2 - r_s^2)$; $I \approx \frac{\pi}{24} \cdot \frac{(D^3-d^3)}{\text{tg } \alpha} + \frac{\pi}{4} d^2 \cdot r \text{ tg } ½\alpha$;	$\sin \alpha = \frac{B \sqrt{A^2+B^2-C^2} + A \cdot C}{A^2+B^2}$ $\cos \alpha = \frac{A \sqrt{A^2+B^2-C^2} - B \cdot C}{A^2+B^2}$ Here: $A = h1$; $B = \frac{D-d}{2} - r$; $C = r$; Furthermore: $\text{tg } \alpha = \frac{\sin \alpha}{\cos \alpha}$; $\text{tg } ½\alpha = \frac{1 - \cos \alpha}{\sin \alpha}$;
4. Cone with flanges both at D and d. 	$h1 = \frac{D-d}{2 \text{ tg } \alpha} + (R+r) \text{ tg } ½ \alpha$; $S = \frac{D-d}{2 \sin \alpha} + (R+r) \left(\frac{\pi \alpha}{180} - \text{tg } ½\alpha\right) + Hb + hb$; $S = R_s - r_s$; $R_s = \frac{D}{2 \sin \alpha} + R \left(\frac{\pi \alpha}{180} - \text{tg } ½\alpha\right) + Hb$; $r_s = \frac{d}{2 \sin \alpha} - r \left(\frac{\pi \alpha}{180} - \text{tg } ½\alpha\right) - hb$; $M = \pi \sin \alpha \, (R_s^2 - r_s^2)$; $I \approx \frac{\pi}{24} \cdot \frac{(D^3-d^3)}{\text{tg } \alpha} + \frac{\pi}{4} (D^2 \cdot R + d^2 \cdot r) \text{ tg } ½\alpha$;	$\sin \alpha = \frac{B \sqrt{A^2+B^2-C^2} + A \cdot C}{A^2+B^2}$ $\cos \alpha = \frac{A \sqrt{A^2+B^2-C^2} - B \cdot C}{A^2+B^2}$ Here: $A = h1$; $B = \frac{D-d}{2} - R - r$; $C = R + r$; Furthermore: $\text{tg } \alpha = \frac{\sin \alpha}{\cos \alpha}$ $\text{tg } ½\alpha = \frac{1 - \cos \alpha}{\sin \alpha}$

DETERMINATION OF BLANKDIMENSIONS FOR CONCENTRIC CONES WITH LONGITUDINAL WELD

Assuming known blank radii R_s and r_s (allowances included) and a known value of sin α, the blankdimensions of a cone can be determined with the following formular:



General

α = half of included cone-angle
β = half of blank-angle
Z = bending allowance
M = curved cone - or blank - surface (one side)
G_n = nett weight of cone (kg)
G = density (kg/dm₃)

$\alpha \geqslant 30°$

$\beta° = 180 . \sin \alpha$
$K = R_s\ 2 . \sin \beta$
$k = r_s\ 2 . \sin \beta$
$L = R_s\ [1 + \cos (180 - \beta)]$
$O = R_s\ 2\pi . \sin \alpha$
$M = (R_s^2 - r_s^2) . \pi . \sin \alpha$
$G_n = M . t . \varrho . 10^{-6}$

$A = 2 . R_s$
$B = L + Z . \sin (180 - \beta)$

$\alpha = 35° \rightarrow L = 1{,}229 . R_s$
$\alpha = 40° \rightarrow L = 1{,}434 . R_s$
$\alpha = 45° \rightarrow L = 1{,}606 . R_s$
$\alpha = 50° \rightarrow L = 1{,}742 . R_s$
$\alpha = 60° \rightarrow L = 1{,}913 . R_s$
$\alpha = 70° \rightarrow L = 1{,}982 . R_s$

$\alpha = 30°$

$\beta = 90°$
$K = 2 . R_s$
$k = 2 . r_s$
$L = R_s$
$O = R_s . \pi$
$M = (R_s^2 - r_s^2) . 0{,}5 . \pi$
$G_n = M . t . \varrho . 10^{-6}$

$A = 2 . R_s$
$B = L + Z$

$\alpha \leqslant 30°$

$\beta = 180 . \sin \alpha$
$K = R_s\ 2 . \sin \beta$
$k = r_s\ 2 . \sin \beta$
$L' = R_s - r_s . \cos \beta$
$O = R_s . 2\pi . \sin \alpha$
$M = (R_s^2 - r_s^2)\ \pi . \sin \alpha$
$G_n = M . t . \varrho . 10^{-6}$

$A = K + 2 Z . \cos \beta$
$B = L' + Z . \sin \beta$

WALL THICKNESS GRAPHS

Introduction. For the production of pressure vessels on approval of the Dutch "Dienst voor het Stoomwezen" the design, materials used, fabrication, inspection, testing and operation of pressure vessels, their protective devices and appurtenances has to be in accordance with the specifications of "Stoomwezen", laid down in the manuel "Rules for pressure vessels". The graphs on these pages are determined according to the edition 1973 of this manuel and bring up to date with the latest alterations and supplements (ed. '76-12).

Symbols for quantities used in the graphs.

$R_e(\vartheta_m)$: Yield Point (at ϑ_m °C)
Determinant are the material properties as laid down in the accepted specifications according the Stoomwezen-lists (See "Rules", chapter M).
For metal temperatures $\leqslant$ 50°C. some frequently used values are given in the table.
R_m = tensile strength in N/mm² at ϑ_m = 20°C.
R_e = Yield point in N/mm² at ϑ_m = 20°C.

Material	Rm (N/mm²)	Re (N/mm²)
X5CrNiMo 1812	500 - 700	245
P265GH	400 - 490	255
16Mo3	430 - 520	275
17Mn4	460 - 550	285
St E36	490 - 625	352

z: Strenght Reduction Coefficient
for *openings* (see "Rules", chapter D 0501) and for *welds* (see below).
z_1 (p. 37-40) = strenght reduction coefficient for the knuckle zone of a dished end (see "Rules", chapter D 0501 p. 7 for the boundary of the knuckle zone).
z (p. 41-42) = strength reduction coefficient for cylindrical shells and pipes.

The smallest of the values z to be determined for welds and openings has to be used in the wall thickness equations. The value to be introduced for z or z_1 shall not be more than 1.

z - strength reduction coefficient for *welds* in cylindrical shells and dished ends subjected to internal pressure: From chapter T 0120 destructive testing of welds) and chapter T 0110 (non-destructive testing) has to be determined whether examinations are obligatory and, ifso, to what extent. In general these examinations are essential (This is independent of the introduced z). In a few cases, depending on the technical circumstances, these obligations can be completely or partly neglected. Once it has been determined whether destructive or non-destructive tests must be carried out, the z value to be introduced for fusion welds can be read from the table (see "Rules", chapter D 0201 and D 0203).

Fusion Welds		z_1 / z
Destructive testing (T 0120)	**Non-destructive testing (T 0110)**	
Yes, in so far required	**Yes,** even if not required	**1**
Yes, even if not required	**No,** in so far allowed	**0,8**
No, in so far allowed	**No,** in so far allowed	**0,6**

This table is not applicable to transporttanks or gas cylinders.

Allowances
The calculated wall thickness t is a required minimum. Due to the sheet tolerance, the forming process and the corrosion a reduction of wall thickness can occur. To compensate this thinning the following allowances must be made:

$\triangle t_t$ = Tolerance allowance
(depending on steel rolling mill — see "Rules" chapter D 0101).

$\triangle t_f$ = Forming allowance
(depending on deformation — to be stated by "St. Antonius").

$\triangle t_c$ = Corrosion allowance
(depending on nature and duration of corrosion — to be stated by end-user).

As far as the manufacturer has not indicated special requirements on the construction drawing, initial plate thickness should be at least the calculated wall thickness t increased with:
— for cylinders a tolerance allowance: $\triangle t_t$.
— for ends a tolerance allowance and a forming allowance: $\triangle t_t + t_f$.

The corrosion allowance is generally considered to be superfluous in following cases:
— walls of steel in contact with boiler water, steam, lubricating-oil, fuel-oil etc.
— pressure vessels with an inspection period of six years or longer.
— walls of stainless steel or non-ferrous materials.

When ordering ends always specify thickness required at the thinnest point after forming including a corrosion allowance, if any.

WALL THICKNESS DECIMAL HEADS

(R = D; r = 0,1.D; excess pressure on the inner side).

The graph alongside is determined acording to the formula of Stoomwezen "Rules", chapter D 0203 and is based on the wall thickness calculation for the knuckle zone. This determination mostly applies to the complete contour.

$$t = \frac{p_d \cdot D \cdot c_1 \cdot c_2}{2 \cdot z_1 \cdot f \cdot c_3}$$

t = minimum wall thickness in mm.

p_d = design pressure in N/mm² (in the graph indicated in bar = 0,1 N/mm²); equals mostly the maximum admissible working pressure plus a pressure allowance for differences by flow resistance or by the static head of a liquid.

C_1, C_2, C_3 = factors respectively for shape, stress concentration and correction on design stress ($C_{3max.}$ = 2. See "Rules", chapter D 0203).

D = outside diameter of the end in mm.

Z_1 = strength reduction coefficient (see p. 36).

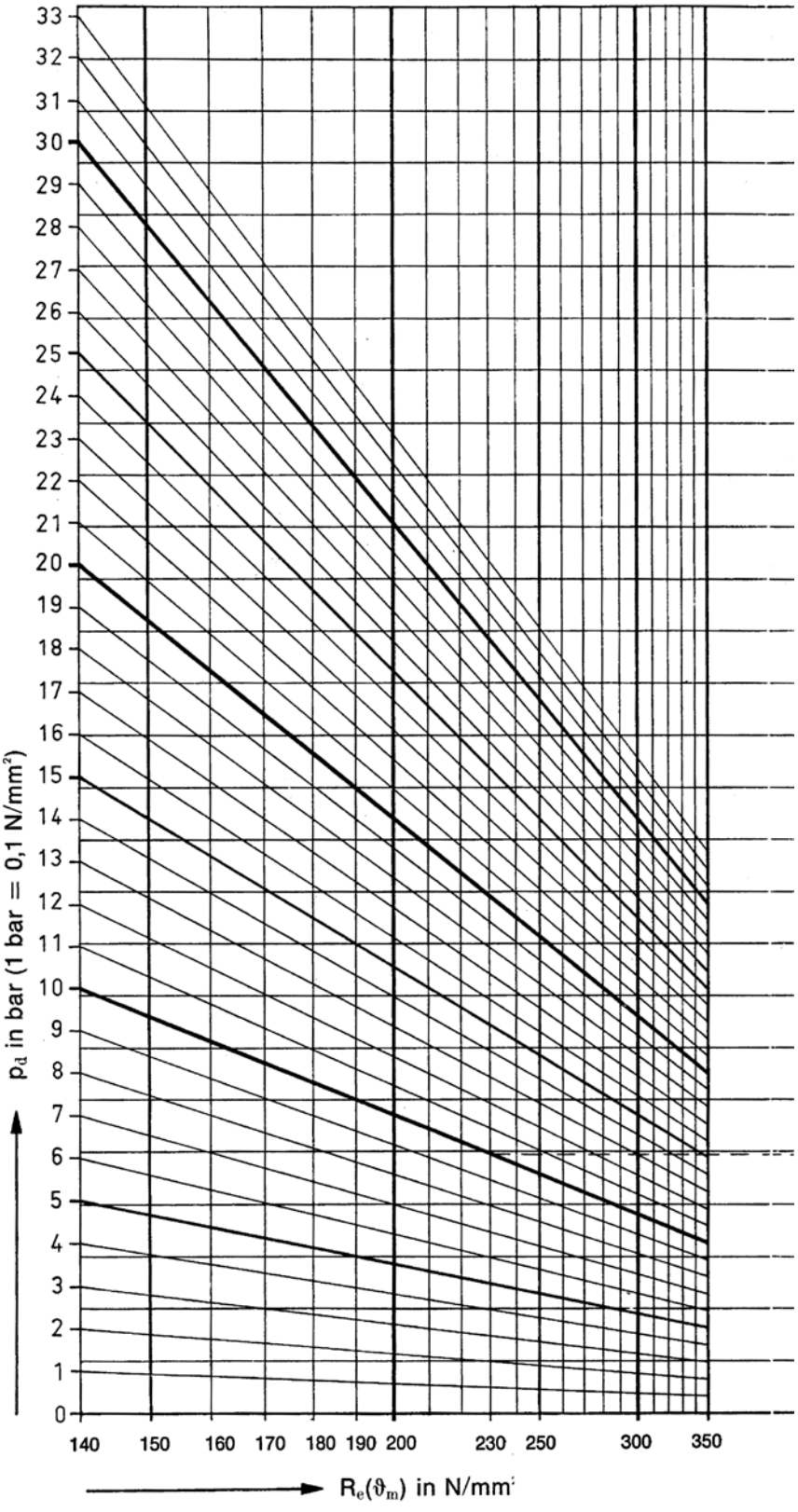
f = design stress in N/mm² = Yield point $R_e(\vartheta_m)$.

If using a quality applying to: $^2/_3$. $R_m < R_e(\vartheta_m)$ or $R_e(\vartheta_m) > 330$ N/mm² (St. E36 and such-like), than the exceptive clause see "Rules", chapter D 0203 p. 11 and D 0107 p. 2) has to be exercised. **Consequently the graph is not applicable for such types of materials.** For convenience we plotted on the axis of the abscissae the yield stress $R_e(\vartheta_m)$.

Use of the graph

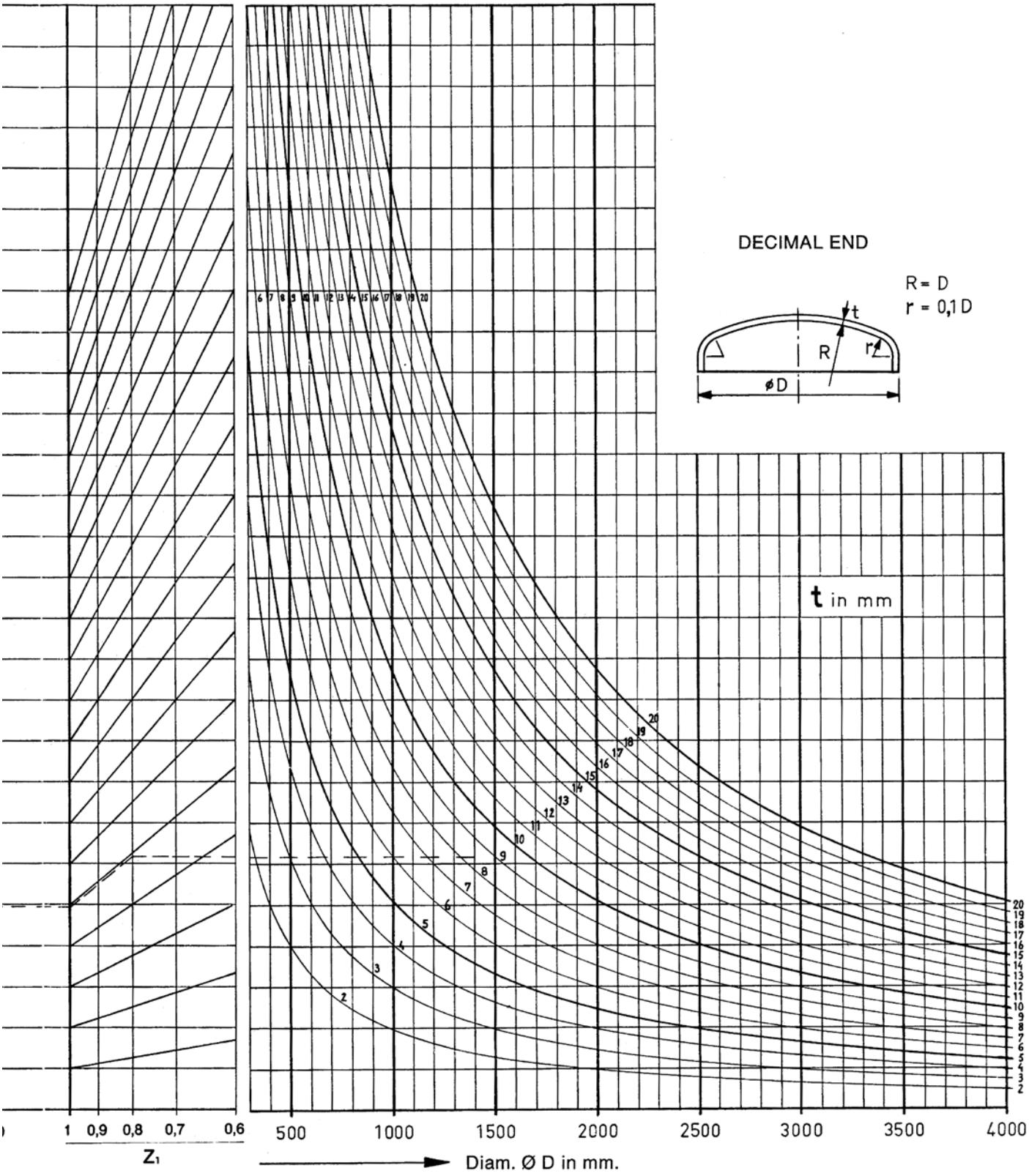
Find, on the left, the intersection of the (slanting) p_d-line and the (vertical) $R_e(\vartheta_m)$-line. Proceed from this point horizontally to the right. Having reached the z_1-area proceed slantingly upwards untill the applicable z_1-line is reached (so, if $z_1 = 1$ there is no rise, if $z_1 = 0{,}6$ the rise is over the entire z_1-area). From this point proceed horizontally again to the relevant diameter D on the right. The value of t is then found.

Example (see dotted line)
Decimal End (R = D; r = 0,1.D)
p_d = 10 bar (= 1 N/mm²); $R_e(\vartheta_m)$ = 230 N/mm²); z_1 = 0,8 and D = 1400 mm.
From this it follows that t = 8,4 mm.
N.B. This t is without any allowance (p. 36)!



WALL THICKNESS DECIMAL HEADS

(CONTINUED)



WALL THICKNESS SEMI-ELLIPTICAL HEADS

(R = 0,8.D; r = 0,154.D; excess pressure on the inner side).

The graph alongside is determined acording to the formula of Stoomwezen "Rules", chapter D 0203 and is based on the wall thickness calculation for the knuckle zone. This determination mostly applies to the complete contour.

$$t = \frac{p_{cl} \cdot D \cdot c_1 \cdot c_2}{2 \cdot z_1 \cdot f \cdot c_3}$$

t = minimum wall thickness in mm.

p_{cl} = design pressure in N/mm² (in the graph indicated in bar = 0,1 N/mm²); equals mostly the maximum admissible working pressure plus a pressure allowance for differences by flow resistance or by the static head of a liquid.

C_1, C_2, C_3 = factors respectively for shape, stress concentration and correction on design stress ($C_{3max.} = 2$. See "Rules", chapter D 0203).

D = outside diameter of the end in mm.

Z_1 = strength reduction coefficient (see p. 36).

f = design stress in N/mm² = Yield point $R_e(\vartheta_m)$.

If using a quality applying to: $^2/_3$. $R_m < R_e(\vartheta_m)$ or $R_e(\vartheta_m) > 330$ N/mm² (St. E 36 and such-like), than the exceptive clause see "Rules", chapter D 0203 p. 11 and D 0107 p. 2) has to be exercised. **Consequently the graph is not applicable for such types of materials.** For convenience we plotted on the axis of the abscissae the yield stress $R_e(\vartheta_m)$.

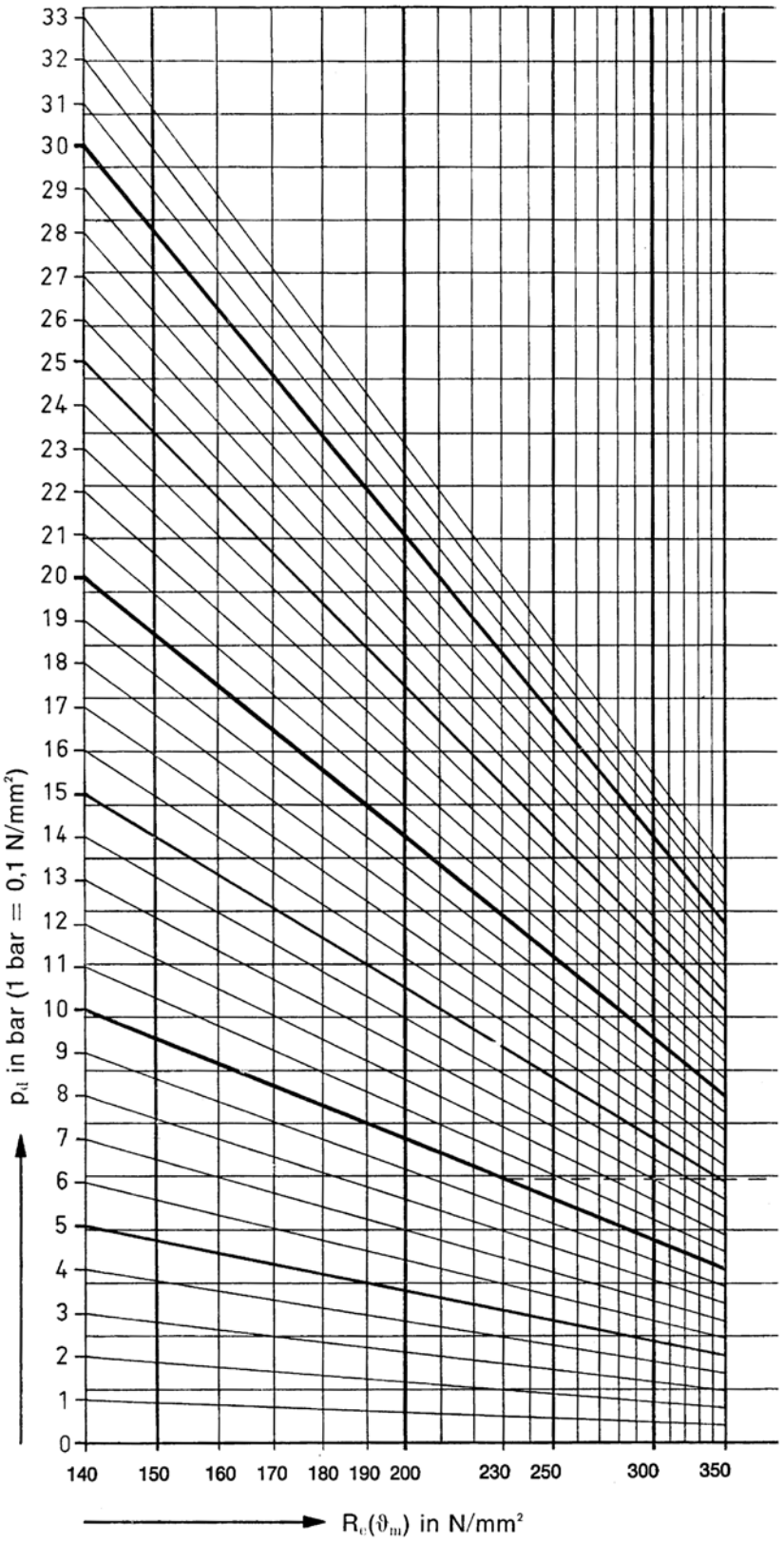
Use of the graph

Find, on the left, the intersection of the (slanting) p_{cl}-line and the (vertical) $R_e(\vartheta_m)$-line. Proceed from this point horizontally to the right. Having reached the z_1-area proceed slantingly upwards untill the applicable z_1-line is reached (so, if $z_1 = 1$ there is no rise, if $z_1 = 0{,}6$ the rise is over the entire z_1-area). From this point proceed horizontally again to the relevant diameter D on the right. The value of t is then found.

Example (see dotted line)
Semi-elleptical End (R = 0,8.D, r = 0,154.D) p_{cl} = 10 bar (= 1 N/mm²); $R_e(\vartheta_m)$ = 230 N/mm²); z_1 = 0,8 and D = 1400 mm.

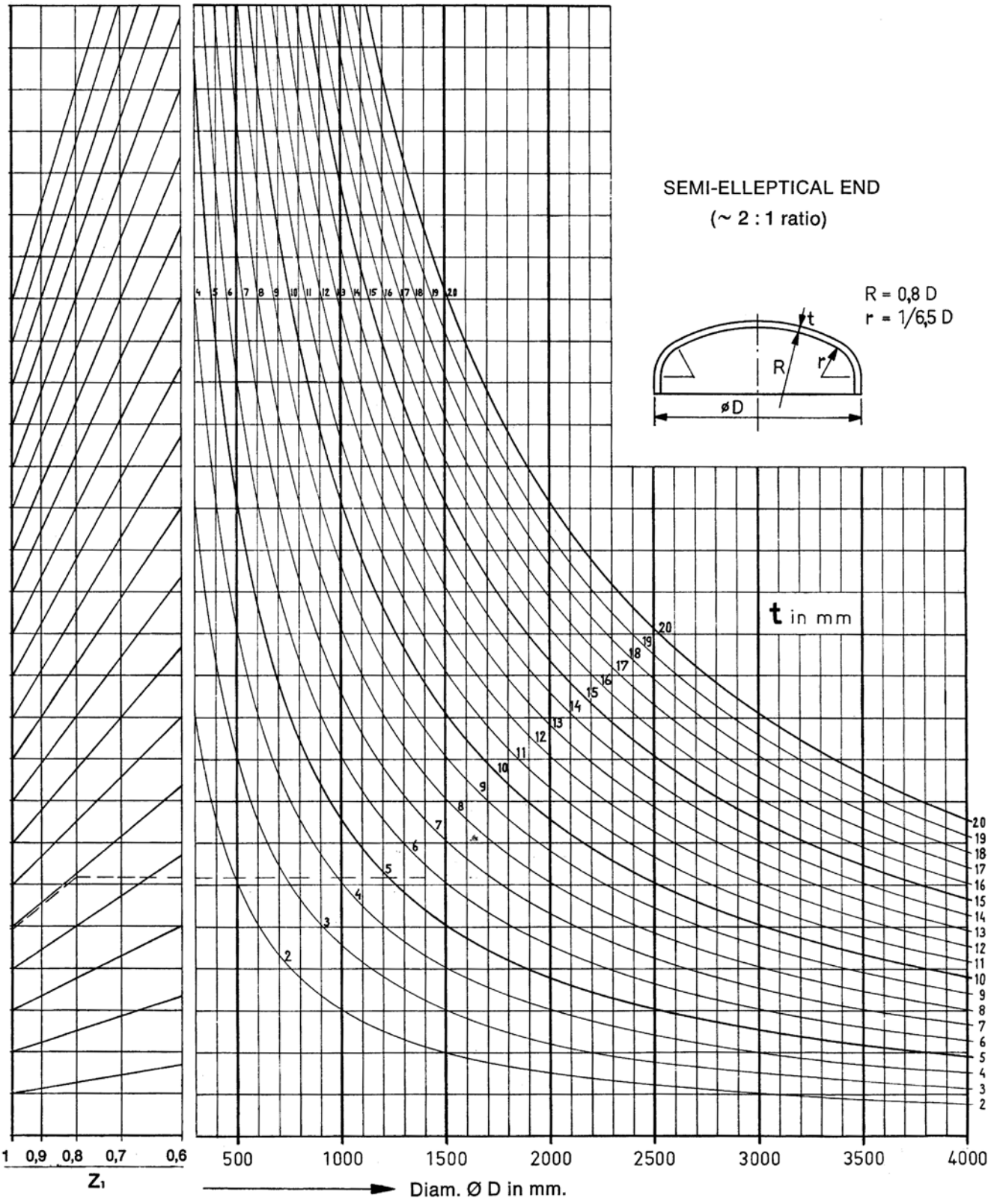
From this it follows that t = 5,7 mm.

N.B. This t is without any allowance (p. 36)!



WALL THICKNESS SEMI-ELLIPTICAL HEADS

(CONTINUED)



COMPANY PROFILE

Market Sectors

The products of ANTONIUS are used in all kind of applications like storage- and transport tanks, pressure- and process vessels and heat exchangers.

Relevant market sectors and industries:

- Oil & Gas
- Offshore
- Chemical- and petrochemical
- Pulp and paper
- Mining
- Cryogenic
- Food, beverage and pharmaceutical
- Water treatment
- Transport and Storage
- Energy
- Art Objects

NDT and DT

NDT:

- RT (X-Ray)
- PT (Dye Penetrant)
- MT (Magnetic Particle)
- UT (Ultrasonic Testing)
- Hardness Testing
- Ferrite Testing
- Ferroxyl and Conductivity

RT, PT, MT and UT can be performed by (Level 2) own or subcontracted certified operators according to EN 473 and/or SNT-TC.

DT: Destructive testing is subcontracted to approved Laboratories.

Quality Assurance

- Manufacturing covered by the ISO-9001/2000 QA-system and PED 97/23
- ISO 9001 Certified by Lloyd's since 1992
- ASME accreditation for S-stamp, U-stamp and U2-stamp since 1997
- AD Merkblatt 2000 and EN 729-2 certified
- Experienced with BS 5882, RCCM-MR or ASME III
- Quality Plans can be submitted

COMPANY PROFILE

(CONTINUED)

Bankers Details

Name bank:	ABN-AMRO Bank N.V.
Address:	P.O. Box 515 5600 AM Eindhoven The Netherlands
Tel number:	(+31) 40 2379499
Fax:	(+31) 40 2440410
Account no.:	57.21.30.325
BIC code:	ABNANL2A
IBAN:	NL97ABNA0572130325

Organisation Information

Trade Chamber Registration Roermond: 13009101
Code number VAT: NL 0049 77 968 B01

Site Area

Shipping address: S. Houbenweg 1, 6051 AL Maasbracht
The Netherlands, Europe

Site area: 40.000 m2
Area covered by workshops: 16.000 m2
Limitations on access to site: none

Distance to border:	•	Belgium 10 km
	•	Germany 10 km
Distance to motorway:	•	500 m
Distance to seaport from own harbour:	•	Rotterdam 150 km
	•	Antwerpen 120 km
Distance to airport:	•	30 km
Distance to railway station:	•	10 km

Production facilities

Plasma (under water) cutting machine:	•	30 x 6.5 m
Autogene/plasma cutting machine:	•	24 x 5.5 m
Disc welding machine:	•	max. Ø 8.600 discs
Cold Pressing:	•	Press 1.100 tons, Ø 10.000 mm discs
	•	Press 800 tons, Ø 9000 mm discs
	•	Press 500 tons, Ø 5000 mm discs
	•	Cones (2 x 250 tons) especially for cone-pressing

COMPANY PROFILE

(CONTINUED)

Hot Pressing:
- Press 250 tons
- Press 500 tons
- Press 1.200 tons

Spinning / Flanging machine:
- Max. Ø 12.000 mm thickness 30 mm
- Max. Ø 5.000 mm thickness 18 mm
- Max. Ø 6.000 mm thickness 16 mm
- Max. Ø 5.500 mm thickness 20 mm

Heat treatment:
- Gas furnace 5 tons (5.600 x 4.250 mm)
- Gas furnace 5 tons (2.600 x 2.170 mm)
- Electric furnace 25 tons (Ø 7.400 mm)
- Electric furnace for test pieces (1.000 x 500 mm)

Welding:
All welding processes covered by:
- WPS
- WPQ
- PQR

according to all relevant design codes:
- SMAW
- SAW
- GTAW
- GMAW
- PAW
- ESW
- FCAW

Weld edge cutting:
- all sizes

Machined weld edges:
- up to Ø 5.500 mm

Pickling:
- Stainless Steel pickling bath Ø 7.200 mm
- Aluminium pickling bath Ø 4.200 mm

Polishing/grinding:
- all sizes up to Ø 12.000 mm

Grit-/ Sandblasting:
- all sizes

DENSITIES

Solid substances (for wood: air dry)	(kg/dm³)				
aluminium	2,6...2,75	ebony (black)	1,25	phosphor	1,8
anthracite	1,5	ebony (red)	0,97	pockwood	1,2...1,4
antimony	6,7	fibre	1,28	porcelain	2,4
asbestos	2,4	fir (pine)	0,37...0,75	poplar	0,4...0,6
asphalt	1,5	gas coke	1,4	potassium	0,86
basalt	3,—	glas (mirror)	2,5	pumice	0,95
beech	0,91...1,16	gold	19,3	red wood	0,35...0,6
bismuth	9,8	granite	2,5...3,05	rubber	0,93
brass	8,1...8,55	graphite	2,25	rubber (hand)	1,15
brick	1,8	gravel	2,5	sand (dry)	1,6
cadmium	8,64	iridium	22,4	sandstone	2,3
calcium carbide	2,96	ivory	1,9	silver	10,5
cast iron	7,2	lead	11,34	sodium	0,98
ceder	0,57	lime sandstone	1,9	steel	7,8
chalk	2,5	limestone	2,6	sulphur	2,—
charcoal	0,4	linden (lime)	0,35...0,6	teak	0,9
chlorinated calcium	2,2	mahogany	0,55...1,05	teak (djati)	0,8
chromium	6,92	magnesium	1,74	tin	7,3
coal	1,4	marble	2,5...2,8	walnut	0,6...0,8
common salt	2,16	mica	2,95	willow	0,5...0,6
concrete (reinforced)	2,4	nickel	8,3...8,9	white metal	7,1
cork	0,24	nickel steel	8,—	wolfram	19,1
copper	8,6...8,93	oak	0,7...1,—	yew	0,56...0,82
deal	0,35...0,6	palm	0,97	zinc	7,2
delta metal	8,6	paraffin	0,89		
diamond	3,51	plaster (cast)	0,97		
duraluminium	2,8	platinum	21,4		

Liquid substances (at 15°C)	(kg/dm³)				
alcohol	0,79	hydrochloric acid (40%)	1,2	petroleum	0,83
ammonium (36%)	0,88	linseed oil	0,94	sea water	1,03
benzene (0 °C)	0,9	mercury (0 °C)	13,6	sulphuric acid (87%)	1,8
coaltar	1,2	napthalene (19 °C)	0,76	terpentine	0,87
ether (20 °C)	0,74	nitric acid (91%)	1,15	water (4 °C)	1,—
glycerine (0 °C)	1,26	petrol (gasoline)	0,69		

Gaseous substances (at O°C and 101,32 k Pa)	(g/l)				
acetylene	1,16	carbon doixide (CO_2)	1,97	ether vapour	3,35
air	1,29	carbon monoxide (CO)	1,26	helium	0,18
alcohol vapour	2,07	chlorine gas	3,13	hydrogen	0,09
ammonia gas	0,77	coal gas	0,50	nitrogen	1,26
argon	1,78			oxygen	1,43

	J	int J	mkg	ft lb	int kWh	IT kcal	BTU	ft³ lb/in²	atm dm³	PSh	HPh	R · grd
1 J	1	$9{,}9981 \cdot 10^{-1}$	$1{,}0197 \cdot 10^{-1}$	$7{,}3756 \cdot 10^{-1}$	$2{,}7772 \cdot 10^{-7}$	$2{,}3884 \cdot 10^{-4}$	$9{,}4782 \cdot 10^{-4}$	$5{,}1220 \cdot 10^{-3}$	$9{,}8692 \cdot 10^{-3}$	$3{,}7767 \cdot 10^{-7}$	$3{,}7251 \cdot 10^{-7}$	$1{,}2027 \cdot 10^{-1}$
1 int J	1,0002	1	$1{,}0199 \cdot 10^{-1}$	$7{,}3770 \cdot 10^{-1}$	$2{,}7778 \cdot 10^{-7}$	$2{,}3889 \cdot 10^{-4}$	$9{,}4800 \cdot 10^{-4}$	$5{,}1229 \cdot 10^{-3}$	$9{,}8711 \cdot 10^{-3}$	$3{,}7774 \cdot 10^{-7}$	$3{,}7258 \cdot 10^{-7}$	$1{,}2029 \cdot 10^{-1}$
1 mkg	9,8066	9,8048	1	7,2330	$2{,}7236 \cdot 10^{-6}$	$2{,}3422 \cdot 10^{-3}$	$9{,}2949 \cdot 10^{-3}$	$5{,}0229 \cdot 10^{-2}$	$9{,}6784 \cdot 10^{-2}$	$3{,}7037 \cdot 10^{-6}$	$3{,}6530 \cdot 10^{-6}$	1,1794
1 ft lb	1,3558	1,3556	$1{,}3825 \cdot 10^{-1}$	1	$3{,}7655 \cdot 10^{-7}$	$3{,}2383 \cdot 10^{-4}$	$1{,}2851 \cdot 10^{-3}$	$6{,}9444 \cdot 10^{-3}$	$1{,}3361 \cdot 10^{-2}$	$5{,}1206 \cdot 10^{-7}$	$5{,}0505 \cdot 10^{-7}$	$1{,}6306 \cdot 10^{-1}$
1 int kWh	$3{,}6007 \cdot 10^{6}$	$3{,}6000 \cdot 10^{6}$	$3{,}6717 \cdot 10^{5}$	$2{,}6557 \cdot 10^{6}$	1	$8{,}6000 \cdot 10^{2}$	$3{,}4128 \cdot 10^{3}$	$1{,}8442 \cdot 10^{4}$	$3{,}5536 \cdot 10^{4}$	1,3599	1,3413	$4{,}3305 \cdot 10^{5}$
1 IT kcal	$4{,}1868 \cdot 10^{3}$	$4{,}1860 \cdot 10^{3}$	$4{,}2694 \cdot 10^{2}$	$3{,}0884 \cdot 10^{3}$	$1{,}1628 \cdot 10^{-3}$	1	3,9684	2,1445 · 10	4,1321 · 10	$1{,}5813 \cdot 10^{-3}$	$1{,}5596 \cdot 10^{-3}$	$5{,}0355 \cdot 10^{2}$
1 BTU	$1{,}0551 \cdot 10^{3}$	$1{,}0549 \cdot 10^{3}$	$1{,}0759 \cdot 10^{2}$	$7{,}7817 \cdot 10^{2}$	$2{,}9302 \cdot 10^{-4}$	$2{,}5199 \cdot 10^{-1}$	1	5,4040	1,0413 · 10	$3{,}9847 \cdot 10^{-4}$	$3{,}9302 \cdot 10^{-4}$	$1{,}2689 \cdot 10^{2}$
1 ft³ lb/in²	$1{,}9524 \cdot 10^{2}$	$1{,}9520 \cdot 10^{2}$	$1{,}9909 \cdot 10$	$1{,}4400 \cdot 10^{2}$	$5{,}4223 \cdot 10^{-5}$	$4{,}6631 \cdot 10^{-2}$	$1{,}8505 \cdot 10^{-1}$	1	1,9268	$7{,}3736 \cdot 10^{-5}$	$7{,}2727 \cdot 10^{-5}$	2,3481 · 10
1 atm dm³	1,0132 · 10²	1,0131 · 10²	1,0332 · 10	7,4734 · 10	$2{,}8140 \cdot 10^{-5}$	$2{,}4201 \cdot 10^{-2}$	$9{,}6038 \cdot 10^{-2}$	$5{,}1898 \cdot 10^{-1}$	1	$3{,}8268 \cdot 10^{-5}$	$3{,}7744 \cdot 10^{-5}$	1,2186 · 10
1 PSh	$2{,}6478 \cdot 10^{6}$	$2{,}6473 \cdot 10^{6}$	$2{,}7000 \cdot 10^{5}$	$1{,}9529 \cdot 10^{6}$	$7{,}3536 \cdot 10^{-1}$	$6{,}3241 \cdot 10^{2}$	$2{,}5096 \cdot 10^{3}$	$1{,}3562 \cdot 10^{4}$	$2{,}6132 \cdot 10^{4}$	1	$9{,}8632 \cdot 10^{-1}$	$3{,}1845 \cdot 10^{5}$
1 HPh	$2{,}6845 \cdot 10^{6}$	$2{,}6840 \cdot 10^{6}$	$2{,}7374 \cdot 10^{5}$	$1{,}9800 \cdot 10^{6}$	$7{,}4556 \cdot 10^{-1}$	$6{,}4118 \cdot 10^{2}$	$2{,}5444 \cdot 10^{3}$	$1{,}3750 \cdot 10^{4}$	$2{,}6494 \cdot 10^{4}$	1,0139	1	$3{,}2287 \cdot 10^{5}$
1 R · grd	8,3147	8,3131	$8{,}4786 \cdot 10^{-1}$	6,1326	$2{,}3092 \cdot 10^{-6}$	$1{,}9859 \cdot 10^{-3}$	$7{,}8808 \cdot 10^{-3}$	$4{,}2588 \cdot 10^{-2}$	$8{,}2050 \cdot 10^{-2}$	$3{,}1402 \cdot 10^{-6}$	$3{,}0973 \cdot 10^{-6}$	1

	int kW	PS	HP
1 erg/sec	$9{,}9981 \cdot 10^{-11}$	$1{,}3596 \cdot 10^{-10}$	$1{,}3410 \cdot 10^{-10}$
1 int J/sec	$1{,}0000 \cdot 10^{-3}$	$1{,}3599 \cdot 10^{-3}$	$1{,}3413 \cdot 10^{-3}$
1 mkg/sec	$9{,}8048 \cdot 10^{-3}$	$1{,}3333 \cdot 10^{-2}$	$1{,}3151 \cdot 10^{-2}$
1 ft lb/sec	$1{,}3556 \cdot 10^{-3}$	$1{,}8434 \cdot 10^{-3}$	$1{,}8182 \cdot 10^{-3}$
1 int kW	1	1,3599	1,3413
1 IT kcal/sec	4,1860	5,6925	5,6147
1 BTU/sec	1,0549	1,4345	1,4149
1 ft³ lb/in²h	$5{,}4223 \cdot 10^{-5}$	$7{,}3736 \cdot 10^{-5}$	$7{,}2727 \cdot 10^{-5}$
1 atm dm³/h	$2{,}8140 \cdot 10^{-5}$	$3{,}8268 \cdot 10^{-5}$	$3{,}7744 \cdot 10^{-5}$
1 PS	$7{,}3536 \cdot 10^{-1}$	1	$9{,}8632 \cdot 10^{-1}$
1 HP	$7{,}4556 \cdot 10^{-1}$	1,0139	1
1 R grd/h	$2{,}3092 \cdot 10^{-6}$	$3{,}1402 \cdot 10^{-6}$	$3{,}0973 \cdot 10^{-6}$

1 lb/in	$= 1{,}7858 \cdot 10^{-1}$	kg/cm
1 lb/ft	$= 1{,}4882$	kg/m
1 lb/yd	$= 4{,}9606 \cdot 10^{-1}$	kg/m
1 lb/cu in	$= 2{,}7680 \cdot 10^{-2}$	kg/cm³
1 lb/cu ft	$= 1{,}6019 \cdot 10$	kg/m³
1 lb/cu yd	$= 5{,}9328 \cdot 10^{-1}$	kg/m³
1 oz/cu in	$= 1{,}7300$	g/cm³
1 oz/cu ft	$= 1{,}0012$	kg/m³
1 lb/imp gal	$= 9{,}9779 \cdot 10^{-2}$	kg/dm³
1 lb/US gal	$= 1{,}1983 \cdot 10^{-1}$	kg/dm³
1 lb/pint	$= 7{,}9823 \cdot 10^{-1}$	kg/dm³
1 lb/min	$= 2{,}7216 \cdot 10$	kg/h
1 lb/sec	$= 1{,}6229$	t/h

1 HK	$= 0{,}886$ IK	$= 0{,}903$ cd	
1 cd	$= 0{,}981$ IK	$= 1{,}107$ HK	
1 IK	$= 1{,}019$ cd	$= 1{,}128$ HK	
1 bougie décimale		$= 1{,}12$ HK	
1 sperm candle		$= 1{,}14$ HK	
1 pentan candle		$= 1{,}11$ HK	
1 carcel		$= 10{,}75$ HK	
1 VK		$= 1{,}20$ HK	
1 sb		$= \pi \cdot 10^{4}$	asb
1 la		$= 10^{4}$	asb
1 m la		$= 10^{-3}$	la
1 ft la		$= 10{,}764$	asb
1 ft cd		$= 10{,}764$	lx
1 ph		$= 10^{4}$	lx
1 lx		$= 1$	lm/m²

1 BTU	$=$	0,2520 IT kcal
1 BTU/lb	$=$	0,5555 IT kcal/kg
1 BTU/°F	$=$	0,4536 IT kcal/°C
1 BTU/lb °F	$=$	1,0000 IT kcal/kg °C
1 BTU/ft °F	$=$	1,4884 IT kcal/m °C
1 BTU/in °F	$=$	17,858 IT kcal/m °C
1 BTU/sq ft °F	$=$	4,8824 IT kcal/m² °C
1 BTU/sq in °F	$=$	703,07 IT kcal/m² °C
1 BTU/sq ft	$=$	2,7124 IT kcal/m²
1 BTU/in	$=$	9,9211 IT kcal/m

T_K $= t_C + 273{,}15 = {}^{5}/_{9}\ T_{Rank}$

$T_{Rank} = t_F + 459{,}67 = {}^{9}/_{5}\ T_K$

$t_C = {}^{5}/_{9}\ (t_F - 32) = T_K - 273{,}15$

$t_F = {}^{9}/_{5}\ t_C + 32 = T_{Rank} - 459{,}67$

1 in	= 2,5400	cm	**1 sq in**	= 6,4516	cm^2	**1 gal**	= 4	qt	**1 naut mile/h**	= 0,5144	m/sec	**1 in Hg**	= $3{,}3421 \cdot 10^{-2}$	atm
1 ft	= 0,3048	m	1 sq ft	= 9,2903	dm^2	1 qt	= 2	pt	1 stat mile/h	= 0,4470	m/sec	1 in H_2O	= $2{,}4583 \cdot 10^{-3}$	atm
1 yd	= 0,9144	m	1 sq yd	= 0,8361	m^2	1 imp gal	= 277,42	cu in	1 ft/sec	= 1,0973	km/h	1 lb/sq in	= $6{,}8046 \cdot 10^{-2}$	atm
1 fathom	= 1,8288	m	1 acre	= 40,4684	a	1 US gal	= 231,00	cu in	1 stat mile/h	= 1,4666	ft/sec	1 in Hg	= $3{,}4532 \cdot 10^{-2}$	at
1 stat mile	= 1,6093	km	1 sq mile	= 2,5899	km^2	1 imp bu	= 8	imp gal				1 in H_2O	= $2{,}5400 \cdot 10^{-3}$	at
1 naut mile	= 1,8532	km	1 acre	= 4840	sq yd	1 US bu	= 9,3092	US gal	**1 sq yd/min**	= 50,1675	m^2/h	1 lb/sq in	= $7{,}0307 \cdot 10^{-2}$	at
1 int mile	= 1,8520	km				**1 oz**	= 28,3495	g	1 sq ft/min	= 5,5742	m^2/h	1 in Hg	= $3{,}3864 \cdot 10^{-2}$	bar
1 toise (Paris)	= 1,9390	m	**1 cu in**	= 16,3871	cm^3	1 lb	= 0,4536	kg	1 sq in/sec	= 2,3226	m^2/h	1 in H_2O	= $2{,}4909 \cdot 10^{-3}$	bar
1 ligne (Paris)	= 2,2558	mm	1 cu ft	= 28,3167	dm^3	1 cwt	= 50,8024	kg	1 sq yd/min	= 1,3934	am^2/sec	1 lb/sq in	= $6{,}8948 \cdot 10^{-2}$	bar
1 ft	= 12	in	1 cu yd	= 0,7646	m^3	1 ton	= 1,0160	t	1 sq ft/min	= 15,4838	cm^2/sec	1 Torr	= $1{,}3158 \cdot 10^{-3}$	atm
1 yd	= 3	ft	1 pint	= 0,5683	dm^3	1 sh cwt	= 45,3592	kg	1 sq in/min	= 0,1075	cm^2/sec	1 atm	= 1,03323	kg/cm^2
1 fathom	= 2	yd	1 imp gal	= 4,5460	dm^3	1 sh ton	= 0,9072	t	1 im gal/min	= 0,2700	m^3/h	1 at	= 1,0000	kg/cm^2
1 stat mile	= 1760	yd	1 US gal	= 3,7854	dm^3	**1 sh ton**	= 2000	lb	1 US gal/min	= 0,2271	m^3/h	1 at	= 0,9678	atm
1 naut mile	= 2026,7	yd	1 US qt	= 0,9463	dm^3	1 ton	= 2240	lb				1 bar	= 1,01972	kg/cm^2
												1 br atm	= 30	in Hg

SI-UNITS

Heat, Work, Energy — Si-unit: Joule or kW.h

	kcal	kpm	kWh	J Nm Ws
kcal	1	427	$1{,}16 \cdot 10^{-3}$	$4{,}19 \cdot 10^{3}$
kpm	$2{,}34 \cdot 10^{-3}$	1	$2{,}72 \cdot 10^{-6}$	9,81
kWh	860	$3{,}67 \cdot 10^{5}$	1	$3{,}6 \cdot 10^{6}$
J Nm Ws	$2{,}39 \cdot 10^{-4}$	0,102	$2{,}78 \cdot 10^{-7}$	1

Impact Energy — Si-unit: Joule

Type of Test specimen*)		$\frac{kpm}{cm^2}$	kpm	J
DVM-type (cross section 0,7 cm^2)	kpm/cm^2	1	0,7	6,864
	J	0,1457	0,102	1
Charpy-V (cross section, 0,8 cm^2)	kpm/cm^2	1	0,8	7,8453
	J	0,1275	0,102	1
Charpy-U (cross section 0,5 cm^2)	kpm/cm^2	1	0,5	4,90332
	J	0,2039	0,102	1

*) Since the impact energy is no longer indicated per cm^2, the type of test specimen has to be stated.

Force — Si-unit: Newton

	kp	J/cm	N
kp	1	$9{,}81 \cdot 10^{2}$	9,81
J/cm	10,2	1	100
N	0,102	0,01	1

The exact reduction factor is: 1 kp = 9,80665 N

Mechanical Stress (tensile strength) — Si-unit: Newton/mm^2

	kp/mm^2	kp/cm^2	N/mm^2
kp/mm^2	1	100	9,81
kp/cm^2	0,01	1	$9{,}81 \cdot 10^{-2}$
N/mm^2	0,102	10,2	1

Pressure — Si-unit: Pascal or Bar, Newton/mm^2*

	at	Torr	mm WS	bar	N/mm^2	Pa
at (1 at = 1 kp/cm^2)	1	736	10^4	0,981	$9{,}81 \cdot 10^{-2}$	$9{,}81 \cdot 10^4$
Torr (1 Torr = 1 mm Hg)	$1{,}36 \cdot 10^{-3}$	1	13,6	$1{,}333 \cdot 10^{-3}$	$1{,}33 \cdot 10^{-4}$	133,3
mm WS (1 mm WS = 1 kp/m^2)	10^{-4}	$7{,}36 \cdot 10^{-2}$	1	$9{,}81 \cdot 10^{-5}$	$9{,}81 \cdot 10^{-6}$	9,81
bar (1 bar = 0,1 MPa)	1,02	750	$1{,}02 \cdot 10^4$	1	0,1	10^5
N/mm^2 (1 N/mm^2 = 10 bar)	10,2	7500	$1{,}02 \cdot 10^5$	10	1	10^6
Pa (1 Pa = 1 N/m^2)	$1{,}02 \cdot 10^{-5}$	$7{,}5 \cdot 10^{-3}$	0,102	10^{-5}	10^{-6}	1

*) Recommended unit for the steel industry.

General Terms and Conditions of Delivery of ANTONIUS Vesselheads B.V. Filed with the Chamber of Commerce of Venlo on 30 August 2005 under number 13009101

Article 1 General

1. Where these General Terms and Conditions of Delivery are a part of offers for and agreements on the performance of deliveries and/or services by the Contractor, all provisions of these terms and conditions apply between the parties excepting where stipulated otherwise explicitly and in writing. Reference by the Client to the Client's own terms and conditions of purchasing, contracting, or any other terms and conditions is not accepted by the Contractor.

2. In these terms and conditions of delivery, the following term is defined as follows: - product: goods, as well as services, such as maintenance, consulting and inspection. These terms and conditions of delivery also use the following terms and definitions: - the Contractor: any party referring to these terms and conditions of delivery in its offer;
- the Client: the party to which the aforementioned offer is directed;
- service: the contracting of work.

Article 2 Offer

1. Any offer issued by the Contractor is non-obligational.

2. All offers are based on the performance of the contract by the Contractor under normal circumstances and during normal business hours.

Article 3 Contract

1. If the contract is concluded in writing, it becomes effective either on the date of signing of the contract by the Contractor or on the date that the Contractor sends the written order confirmation.

2. Extra work is considered as anything delivered and/or installed by the Contractor, in consultation with the Client, whether or not set out in writing, during the performance of the contract above and beyond the amounts explicitly set out in the contract or order confirmation, or any performance by the Contractor above and beyond the activities explicitly set out in the contract or order confirmation.

3. Verbal commitments by and arrangements made with subordinates of the Contractor are not binding on the Contractor excepting and insofar as confirmed by Contractor in writing.

Article 4 Price

1. The prices indicated by Client are exclusive of turnover tax and other governmental levies to which the sale and delivery are subject, and based on delivery ex factory, in accordance with the incoterms valid on the date of the offer, excepting insofar as stipulated otherwise in these terms and conditions. 'Factory' is defined as the business premises of the Contractor.

2. If after the date of conclusion of the contact, one or more of the cost-price factors is subject to change (even if such change takes place as a result of predictable factors), the Contractor is authorized to increase the agreed price accordingly.

3. The contract includes the Contractor's authority to separately invoice extra work performed by the Contractor as soon as the amounts to be invoiced for this extra work are known to the Contractor. For the calculation of extra work, the rules stated in paragraphs 1 and 2 of this article apply accordingly.

4. Unless otherwise agreed, cost estimates and plans will not be invoiced separately. If the Contractor must make new drawings, calculations, descriptions, models, tools or the like in the event of reorders, costs will be charged.

5. Packaging is not included in the price, and will be charged separately. Packaging will not be taken back.

6. Costs of loading and unloading and of transport of raw materials, semi-manufactured products, models, tools and other goods provided by the Client are not included in the price and will be charged separately. The costs paid in this regard by the Contractor are considered as an advance against the costs to be paid by the Client.

7. If the Contractor has accepted the installation of the product, the price is calculated including installation and commercial delivery of the product at the location specified in the offer, and including all costs, excepting costs not included in the price pursuant to the preceding paragraphs or costs referred to in Article 7.
Costs incurred due to inclement weather will be charged on.

Article 5 Drawings, calculations, descriptions, models, tools, etc.

1. Information stated in catalogues, images, drawings, dimension and weight specifications and the like are only binding if and insofar as explicitly set out in a contract signed by the parties or an order confirmation signed by the Contractor.

2. The offer issued by the Contractor, as well the drawings, calculations, software, descriptions, models, tools and the like provided by the Contractor, remain the property of the Contractor, regardless of whether costs were charged for any such materials. The client reserves exclusively all information encompassed in these materials or underlying the manufacturing and construction, methods, products and the like, even if costs have been charged for this information. The Client warrants that other than in the performance of the contract, this information will not be copied, notified to third parties, or used without the written permission of the Contractor.

Article 6 Delivery period

1. The delivery period commences from whichever of the following moments is latest:

a) the date of conclusion of the contract;

b) the date of receipt by the Contractor of the documents, data, permits, etc. required for the performance of the contract;

c) the date of the fulfillment of the formalities required for the commencement of the work;
or week.

d) the date of receipt by the Contractor of the amount that, pursuant to the contract, must be paid in advance for the commencement of the work.
If a delivery date or week is agreed, the delivery period is made up of the period between the date of conclusion of the contract and the delivery date or week.

2. The delivery term is based on the working conditions applicable at the time of concluding the contract and on the timely delivery of the materials ordered by the Contractor for the performance of the work. If delays beyond the control of the Contractor arise as a result of changes in these working conditions or because materials ordered for the performance of the work are not delivered in time, the delivery period will be extended insofar as necessary.

3. For the purposes of the delivery period, the product is deemed delivered when it is ready for approval (if approval at the Contractor's company is agreed) or (in all other cases) shipment, all after the Client has been informed in writing thereof and without prejudice to the Contractor's obligation to fulfill any assembly/installation obligations.

4. Without prejudice to the other provisions in these terms and conditions in regard to the extension of the delivery period, the delivery period will be extended by the duration of the delay arising on the part of the Contractor as a result of the Client's failure to meet any obligation under the contract or to provide the cooperation required for the purposes of the performance of the Contract.

5. Excepting cases of gross negligence on the part of the Contractor, the delivery period being exceeded does not entitle the Client to full or partial dissolution of the contract. Exceeding the delivery period, for any reason whatsoever, does not entitle the Client to perform any work for the performance of the contract, or to have such work performed, without judicial authorization.

6. A contractual penalty set on the exceeding of the delivery period must be deemed to come in place of any Client entitlement to damages. Such a penalty is not incurred if the exceeding of the delivery period is the result of force majeure, or if no specific contractual penalty clause has been stipulated.

Article 7 Assembly/installation

1. The Client is responsible to the Contractor for the correct and timely performance of all constructions, measures and/or conditions required for the setup of the product to be assembled and/or the correct functioning of the product in the assembled state, excepting if and insofar as that performance is performed by or on behalf of the Contractor according to or due to information provided by and/or drawings produced by Contractor.

2. Without prejudice to the provisions of paragraph 1, the Client will ensure, at its own expense and risk, that:

a) as soon as the product is at the place it is to be installed, the Contractor's personnel may commence their activities and continue to perform them during normal business hours, and further, if deemed necessary by the Contractor, outside of normal business hours, so long as the Contractor notifies the Client thereof in advance;

b) there are suitable accommodations and/or all facilities required by governmental regulations, the contract and custom available to the Contractor's personnel;

c) the access roads to the setup location are suitable for the transportation required;

d) the designated setup location is suitable for storage and assembly;

e) the requisite secure storage places for material, tools and other goods are present;

f) the required auxiliaries, support equipment, supplies and resources (including fuel, oil and lubricants, cleaning supplies and other housekeeping materials, gas, water, electricity, power, compressed air, heating, lighting, etc.), and the standard measurement and testing equipment for the Client's operations are available to the Contractor, in advance and at no cost, at the correct location;

g) all necessary safety and preventative measures are taken and will be maintained, and all measures to meet all applicable governmental regulations for the purposes of the assembly/installation have been taken and will be maintained;

h) upon commencement of and during the assembly, the shipped products will be present at the correct location.

3. Damages and costs arising from conditions in this article not being met or not been met in a timely manner will be borne by the Client.

4. Article 6 applies accordingly to the assembly/installation period.

Article 8 Approval and acceptance testing

1. The Client will approve the product no later than 14 days after delivery as referred to in Article 6, paragraph 3, or (if assembly/installation is agreed) within no more than 14 days after the assembly/installation. If this period expires without a written and detailed statement of well-founded complaints, the product is considered to be accepted.

2. If an acceptance test is agreed, then after receipt or assembly/installation, the Client will give the Contractor the opportunity to conduct the necessary tests, as well as make such improvements and modifications deemed necessary by the Contractor. The acceptance test will be held immediately after the request of the Contractor to that effect in the presence of the Client. If the acceptance test is conducted without a specified and well-founded complaint, or if the Client does not meet the obligations set out above, the product is considered to have been accepted. possible.

3. For the acceptance test and for any other tests, the Client will provide to the Contractor the required facilities, including those referred to in Article 7, paragraph 2, under (f), as well as adequate amounts of representative samples of any material to be processed/consumed, so that the circumstances of use of the product envisioned by the parties can be duplicated as closely as possible. If the Client does not meet this obligation, the last sentence of paragraph 2 applies.

4. In the event of minor failings, particularly those having little or no effect on the envisioned use of the product, the product will be deemed to be accepted despite these failings. The Contractor will nonetheless remedy such failings as quickly as possible.

5. Without prejudice to the Contractor's obligation to fulfill its guarantee obligations, acceptance in accordance with the preceding paragraphs excludes any claims by the Client in regard to any failing in the Contractor's performance.

Article 9 Transfer of risk and ownership

1. Immediately after the product is deemed delivered within the definition of Article 6, paragraph 3, the Client bears the risk for all direct and indirect damages that may be caused to or by this product, excepting insofar as ascribable to gross negligence on the part of the Contractor. If after being notified of default, the Client remains in default of the purchase of the product, the Contractor will be authorized to invoice the Client for the costs of storage of the product.

2. Without prejudice to the provisions of the preceding paragraph and of Article 6, paragraph 3, the ownership of the product transfers to the Client only when all amounts owed by the Client to the Contractor for deliveries or activities, including interest and costs, are paid in full to the Contractor.

3. As needed, the Contractor will be entitled to have unimpeded access to the product. The Client will grant the Contractor all cooperation in order to enable the Contractor to exercise the retention of title referred to in paragraph 2 by repossessing the product, including any disassembly required.

Article 10 Payment

1. Unless otherwise agreed, payment of the agreed price will be made in two instalments: one-third, no later than seven days after the conclusion of the contract; two-thirds no later than 14 days after delivery pursuant to Article 6, paragraph 2.

2. Payment for extra work will be effected as soon as invoiced to the Client.

3. All payments must be effected without any deduction or settlement, either at the Contractor's office or by transfer to an account designated by the Contractor.

4. If the Client does not pay within the agreed term, Client is considered to be in default by operation of law, and the Contractor is entitled, without any notification of default being required, to charge Client interest of 3 points above the average statutory interest scheme applicable in the Netherlands, and further all judicial and extra-judicial costs for the collection of its claim.

Article 11 Guarantee

1. Without prejudice to the restrictions set out below, the Contractor warrants both the soundness of the product it delivers as well as the quality of the material used and/or delivered in conjunction with the product, insofar as relating to failings in the product delivered not observable upon approval/acceptance testing, of which the Client demonstrates that they arose within six months after the delivery pursuant to Article 6, paragraph 3, exclusively or predominately as a direct consequence of an error in the construction used by the client or as a result of faulty processing or the use of poor material.

2. Paragraph 1 applies accordingly to approval/acceptance testing upon hidden failures caused entirely or primarily by improper assembly/installation by the Contractor. If the product is assembled/installed by the Contractor, the 6-month guarantee period referred to in paragraph 1 commences on the day that the assembly/installation by the Contractor is complete, with the proviso that in that case the guarantee period ends in any event once 12 months have passed after delivery in accordance with Article 6, paragraph 3.

3. Failings covered by the guarantee referred to in paragraphs 1 and 2 will be remedied by the Contractor either by repair or replacement of the faulty part, which may or may not be done at the Contractor's place of business, or the Contractor may send a replacement part to the Client; the choice of method is at the Contractor's discretion. All costs exceeding the sole obligation as described in the preceding sentence, including but not limited to transport costs, travel and accommodation costs and costs of disassembly and assembly, will be borne by the Client.

4. Under no circumstances does the guarantee cover failings that are fully or partially the result of:

a) the failure to observe operation and maintenance instructions, or use of the product in a manner other than the intended normal use;

b) normal wear-and-tear

c) assembly/installation or repair by third parties, including the Client;

d) the application of any governmental provision concerning the nature or quality of the materials used;

e) used materials/goods applied in the product in consultation with the Client;

f) materials or goods provided by the Client to the Contractor for incorporation into the product;

g) materials, goods, methods and constructions, insofar as used at the explicit instruction of the Client, as well as materials and goods provided by or on behalf of the Client;

h) parts obtained by the Contractor from third parties, insofar as the third party does not extend a guarantee to the Contractor.

5. If the Client does not meet any obligation under the contract concluded with the Contractor, or does not do so properly or in a timely manner, the Contractor is not held to any guarantee, of any title whatsoever, in regard to that contract. If the Client proceeds to disassemble, repair or perform other work on the product, whether by the Client itself or by third parties on the Client's behalf, without the prior written permission of the Contractor, all guarantee claims are voided.

6. Complaints on failings must be made in writing as quickly as possible after the discovery of the failing, but no later than 14 days after the expiry of the guarantee period. Exceeding this term voids all claims against the Contractor in regard to such failings. Claims at law not filed within 1 year after timely written complaint on the failing in question are null and void.

7. If the Contractor replaces parts as part of the fulfilment of its guarantee obligations, the replaced parts/products become the property of the Contractor.

8. Unless otherwise agreed, guarantees on any repair or revision work or other services performed by the Contractor are only on the soundness of the performance of the work charged, and such for a period of 6 months. This guarantee comprises the sole obligation of the Contractor to, in the event of unsound work, perform the work again insofar as unsound. In such cases, the second sentence of paragraph 3 applies accordingly.

9. No guarantee is given on the inspections and other similar activities performed by the Contractor.

10. Alleged non-fulfilment by the Contractor of its guarantee obligations does not discharge the Client from the obligations it bears under any contract concluded with the Contractor.

Article 12 Liability

1. Liability of the Contractor is limited to the fulfilment of the guarantee obligations described in Article 11 of these terms and conditions.

2. Excepting in the event of gross negligence on the part of the Contractor and excepting the provisions of paragraph 1, all liability on the part of the Contractor, such as for loss of profit, other indirect damages and damages resulting from liability to third parties, is excluded.

3. The Contractor is therefore also not liable for:
- violation of patents, licenses or other rights of third parties as a result of the use of information provided by or on behalf of the Client;
- damage or loss, due to any cause whatsoever, of raw materials, semi-manufactured products, models, tools and other property provided by the Client.

4. If the Contractor does provide any support and assistance (of any nature whatsoever) in the assembly of the product without being contractually charged with the assembly of the product, this support and assistance is at the Client's own risk.

5. The Client is obliged to indemnify/compensate the Contractor for all claims of third parties for the reimbursement of damages for which liability on the part of the Contractor in the relationship with the Client is excluded in these terms and conditions.

Article 13 Force majeure

In these General Terms and Conditions of Delivery, force majeure is defined as any circumstance outside the control of the Contractor (even if this could have been foreseen at the time of concluding the contract) that permanently or temporarily prevents fulfilment of the contract, as well as, insofar as not already included therein: war, threat of war, civil war, insurgency, strike, lockout, transport difficulties, fire and other severe disruptions in the business of the Contractor or its vendors.

Article 14 Suspension and dissolution

1. In the event of prevention of the performance of the contract as a result of force majeure, the Contractor is authorized, without judicial intervention, to either suspend performance of the contract for a period not exceeding 6 months, or to dissolve the contract in full or in part, without being obliged to compensate any damages.
During the suspension, the Contractor is authorized to opt for either performance or full or partial dissolution of the contract. At the end of the suspension the Contractor is obliged to elect either performance or full or partial dissolution of the contract.

2. Both in the case of suspension and dissolution pursuant to paragraph 1, the Contractor is authorized to demand immediate payment for the raw materials, materials, parts and other goods reserved, taken into processing and manufactured by the Contractor for the purposes of the performance of the contract, this for the reasonable value of these items. In the event of dissolution pursuant to paragraph 1, after payment of the amount due pursuant to the preceding sentence, the Client is obliged to take the goods referred to in that sentence, failing which the Contractor is authorized to have these goods stored at the Client's expense or to sell them on the Client's behalf.

3. If the Client does not fulfill any obligation resting on it under the contract concluded with the Contractor or any related contract, or does not do so properly or in a timely manner, or if there are good grounds to fear that the Client is or will be unable to fulfill its contractual obligations towards the Contractor, as well as in the event of bankruptcy, suspension of payments, closure, liquidation or partial transfer (whether or not as collateral) of the Client's business, including the transfer of a significant portion of its claims, the Contractor is authorized to, without notice of default and without judicial intervention, either suspend the performance of each of these contracts for a period not exceeding 6 months or to dissolve these contracts in full or in part, without being obliged to compensate any damages or being held to any guarantee and without prejudice to the Contractor's further rights. During the suspension, the Contractor authorized to opt for either performance or full or partial dissolution of the contract. At the end of the suspension the Contractor is obliged to elect either performance or full or partial dissolution of the suspended contract(s).

4. In the event of suspension pursuant to paragraph 3, the agreed price is immediately exigible, with deduction of the instalments already paid and of the costs saved by the Contractor as a result of the suspension, and the Contractor is authorized to have the raw materials, materials, parts and other goods reserved, taken into processing and manufactured by the Contractor for the purposes of the performance of the contract stored at the expense and risk of the Client. In the event of dissolution pursuant to paragraph 3, the agreed price is (if no prior suspension has taken place) immediately exigible, with deduction of the instalments already paid and of the costs saved by the Contractor as a result of the suspension, and the Client is obliged to pay the amount referred to above and to take the goods included therein, failing which the Contractor is authorized to have these goods stored at the expense and risk of the Client or to sell them on behalf of the Client.

5. The Client is not authorized to demand the dissolution of the contract with retroactive effect.

Article 15 Disputes

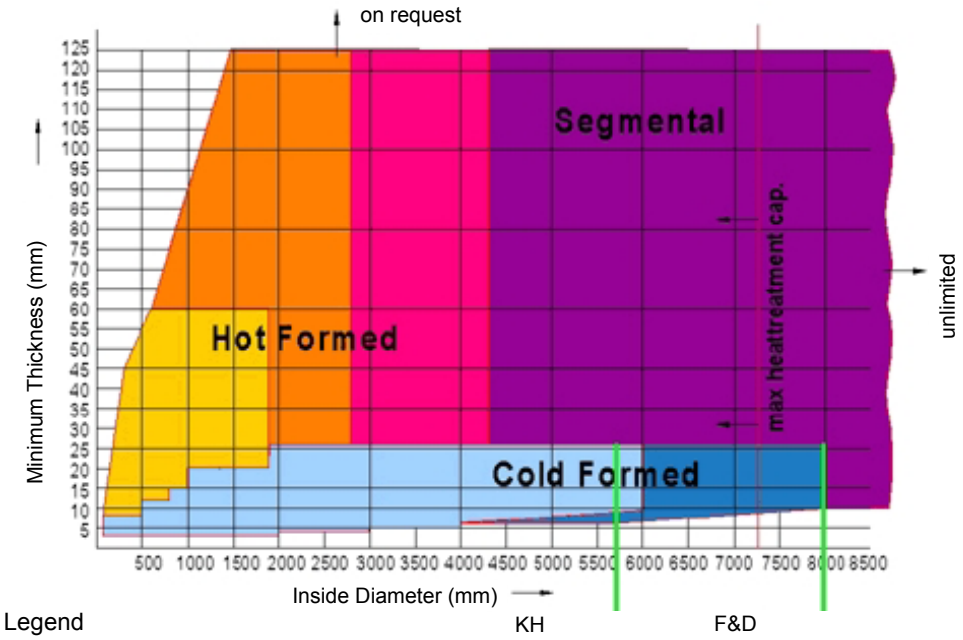
1. Barring the applicability of paragraph 2 of this article, and without prejudice to the option to request provisional measures in preliminary relief proceedings before the President of the competent District Court, all disputes that may arise as a result of a contract to which these terms and conditions of delivery apply in full or in part, or as a result of further agreements following from such a contract, will be adjudicated by an arbitration tribunal, to the exclusion of the normal court. This arbitration tribunal will be appointed in accordance with the articles of the *Stichting Raad van Arbitrage voor Metaalnijverheid en –Handel* (Arbitration Board for the Metals Engineering and Trade Foundation), with its registered office in The Hague, and will arbitrate in observance of the articles of that Board.

2. Insofar as the disputes referred to in the preceding paragraph are, pursuant to the rules of Dutch civil procedural law, within the absolute competence of the subdistrict court, only the competent subdistrict court will be able to adjudicate the dispute.

Article 16 Applicable law

All contracts to which these conditions apply in whole or in part are subject to the law of the Netherlands as applicable to the Kingdom in Europe.

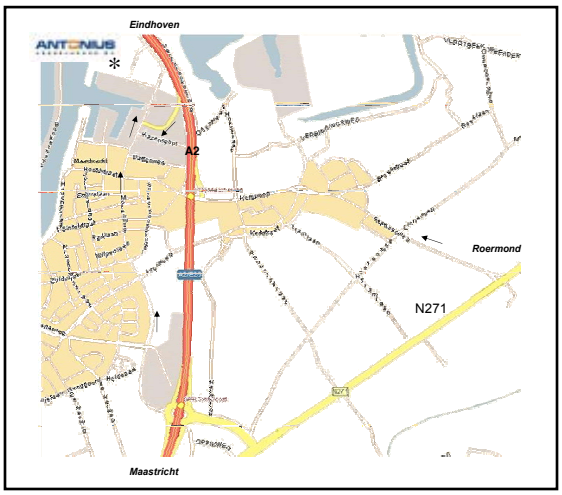
SCOPE OF SUPPLY



Legend

	one piece heads : F&D, HH, EH, KH		segmental heads from crown plate and petals
	one piece heads exept HH		cold formed heads : F&D, EH, KH
	one request : F&D, EH, KH : 1900 < HH < 3600		cold F&D heads only
EH	2 : 1 elliptical heads, semi elliptical haed	F&D	10 % torispherical Flanged & Dished head
KH	Korfbogen Head	HH	Hemispherical Head

ROUTE DESCRIPTION



From Eindhoven:

Motorway A2 Direction Maastricht
- Exit 43 Maasbracht
- End Right (Brouwersstraat)
- 1st Street Left (Brouwersstraat)
- Straight on - directly on to the ANTONIUS facilities.

From Maastricht:

Motorway A2 Direction Eindhoven
- Exit 44 Maasbracht
- Direction Maasbracht
- 2 x Roundabout straight on
- You are now on the Brouwersstraat
- 2th Street Left (Brouwersstraat)
- Straight on
- directly onto the ANTONIUS facilities.

From Roermond:

Direction to Sittard / Maastricht (N271)
- After (Build up area, town) Linne, at 2th trafficlight Right (Stationsstraat)
- Straight on to roundabout (1,5 km)
- Right on to the Brouwersstraat
- 2th Street Left (Brouwersstraat)
- Straight on
- directly onto the ANTONIUS facilities.

ANTONIUS VESSELHEADS BV





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