1 General

1.1 Application

B-Pumps are suitable for water supply schemes, irrigation schemes, lowering of ground water level and dewatering of mines, quarries, construction sites and sea water applications. These are particularly suitable for narrow bore holes. Minimum bore hole sizes required ranges from 150mm to 600mm.

1.2 Operating data

Capacity up to	2600 m^3/hr
Total head up to	160 m
Speed up to	3500 RPM
Temperature up to	105°C
Suspended Depth up to	120 m

1.3 Design

Main pump parts are the Pump Bowl Assembly, Column Pipe Assembly, and Discharge Head Assembly. Bowl Assembly consists of single or multistage radially split, interchangeable intermediate bowls. Column Pipe Assembly consists of interchangeable lengths of the column pipes and variable setting depth. Discharge head assembly consists of discharge head with packed stuffing zone/mechanical seal and thrust bearing arrangement (in case of solid shaft drive only).

1.4 Designation

B 10 B / 7

- Pump Series — B
- Minimum bore-hole, size (inches) — 10
- Impeller Type, Series — B
- Number of Stages — 7

1.5 Types of Impellers

Specific Speed for Impeller Type B,	nq ≈ 54
Specific Speed for Impeller Type D,	nq ≈ 74
Specific Speed for Impeller Type F,	nq ≈ 82

1.6 Discharge Head Executions

VN = Above Floor Discharge

VU = Below Floor Discharge

1.7 Drive Types Available

V1 = Electric motor Type V1 (Flanged Mounted)

ET = Vertical Hollow Shaft Motor (VHS)

KT = Hollow Shaft Gear Head

EK = Hollow Shaft Motor with Hollow Shaft Gear Head (Combination Drive)

RT = Belt Head Drive – Diesel Engine via flat belt

B-PUMP

Contents List

List of Tables & Illustrations

1.8 Steps for Preparing a B-Pump Offer

1.8.1 Operating Data

1	Considering Capacity, Dynamic Head & rpm given by the customer check for the required pump by consulting the family curve at the given speed (See 1.9 Selection Chart)
2	Select the pump with maximum efficiency.
3	Check the max. number of stages of the selected pump. Reduce the efficiency if required as per the pump curve. On the basis of number of stages.
4	Calculate the approximate pump input by using the formulae (Q*H*density*g/(1000*Eff. From curve/100)) for kW (Q*H/(367*Eff. From curve/100)) for kW or [Q*H/(273*Eff. From curve/100)] for hP; can be used if the density of the medium is 1000 kg/m^3
5	A- Determine the head loss (m) in column pipe (see 3.8.5.4.7, Figure 14 and 3.8.5.4.9, Figure 16). In case of Shaft Enclosing Tube Arrangement see 3.8.5.4.11, Figure 18.
6	B- For Friction Losses in Discharge Head, see 3.8.3.3, Figure 11
7	C- Calculate the head loss (m) due to suction strainer &/or foot valve from 3.10.2.1, Figure 20
8	Adding A, B & C in the pump head will give the bowl assembly head
9	Calculate the Pump efficiency using the relation (pump head / bowl head) * Bowl Efficiency
10	Calculate the bowl power input from the above mentioned formulae but using bowl assembly head
11	Calc. the drive rating after adding the following factors into pump input up to 7.5 kW (10hp) — Approx. 20% from 7.5 KW to 40 Kw (53hp) — Approx. 15% from 40 kW onwards — Approx. 10%
12	Note the NPSH required from the graph of the required pump
13	If the required speed of customer is not that of the pump curve then use the following relations to calculate the new values of Q, H, Power & NPSH required Q2 = (N2 / N1) * Q1 H2 = (N2 / N1)^2 * H1 P2 = (N2 / N1)^3 * P1 NPSH2 = (N2 / N1)^2 * NPSH1
14	Material combination as per type series booklet of B-Pump
15	Coating for Sea water use Special Epoxy coating 450 microns

1.8.2 Dimensional Details

16	Installation Depth/Pump Length/Setting Depth or Sump Depth / Pit Depth as given by customer	
17	Minimum clearance between suction strainer / foot valve & pit/sump floor = dia of the suction strainer.	
18	Dia / Length of Suction Strainer as per product Introduction booklet	
19	Dia / Length of Bowl Assembly as per product Introduction booklet	
20	Dia of column Pipe as per product Introduction booklet	
21	Length of Column Pip =	(Pump Length - Foot Valve length - Suction Strainer Length - Bowl Assy. Length) (Sump Depth - Clearance - Foot Valve length - Suction Strainer Length - Bowl Assy. Length)
22	Dia of Discharge Head Nozzle = Dia of column pipe	
23	Dia of Column Shaft is calculated on the basis of Pump input, rpm & material of shaft	
24	Note the Minimum Submergence of center line of first stage impeller from the product introduction booklet of B-Pump	

1.8.3 Execution Details

25	Pump Execution	Flanged / Threaded
26	Performance Testing	ISO 9906
27	Material / Pressure Test	EN 10204 (2.1 / 2.2),..
28	Delivery Flange Standard	BSTable10,EN1092ASME
29	Discharge Above / Below Floor	

1.8.4 Scope of Supply

30	01 No. B…. Pump comprising of:
	Flanged/Threaded Bowl Assembly B…...
	Flanged/Threaded Column Assembly
	Dis. Head Assy (V1/ET/KT/EK/RT, as per Product Introduction Booklet)
	Motor Stool & Thrust bearing Arrangement (only for V1 Design)
31	01 No. Suction Strainer
32	01 No. Foot Valve
33	01 Set of Erection Clamps (04 halves)
34	01 No. Mechanical Seal
35	01 No. Shaft Enclosing Tube Arrangement

1.9 Selection Chart

1.9.1 50 Hz

1.9.1.1 2900 RPM

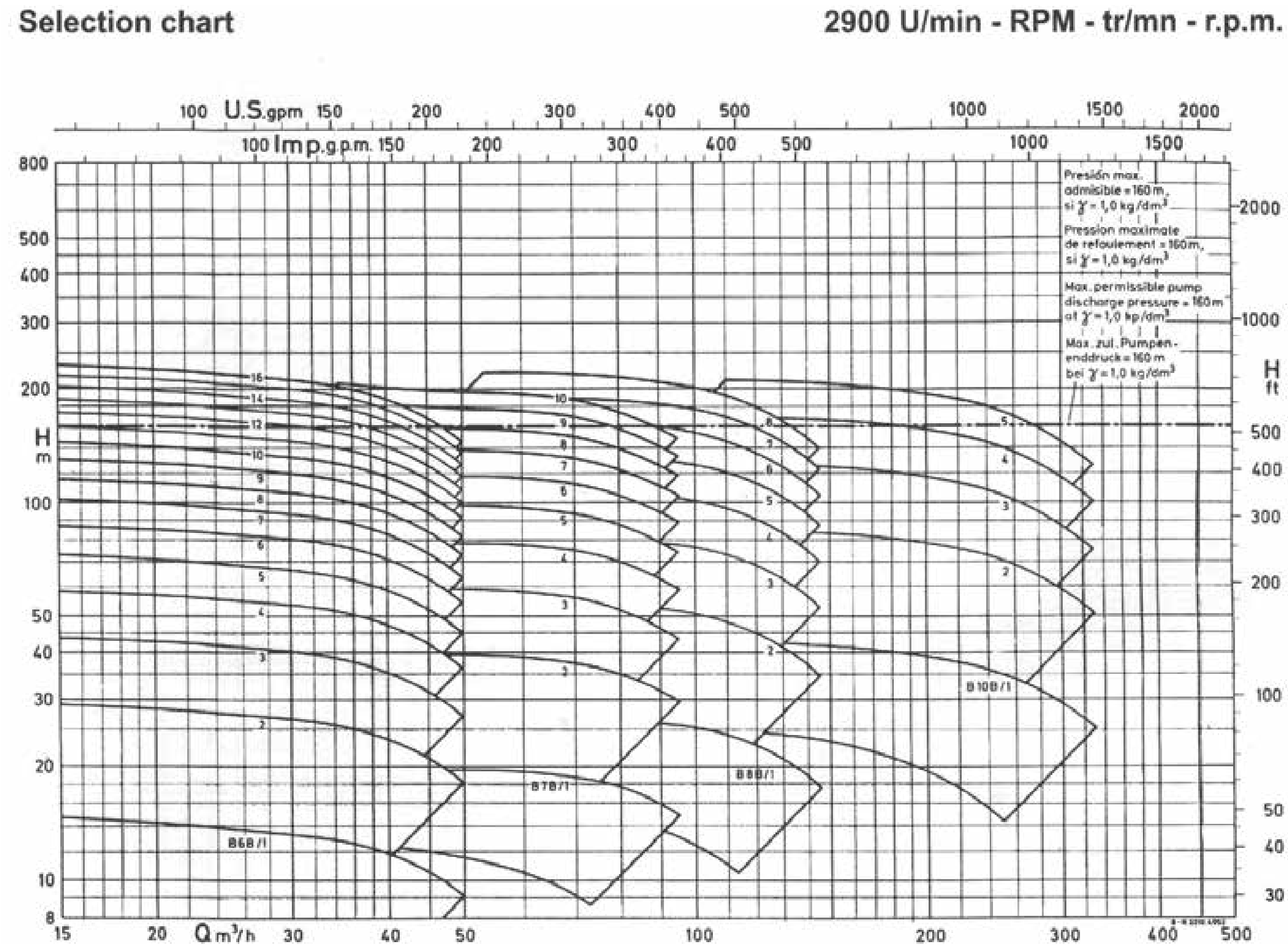


Illustration 1: Family Curves - B Type Impeller at 2900 RPM

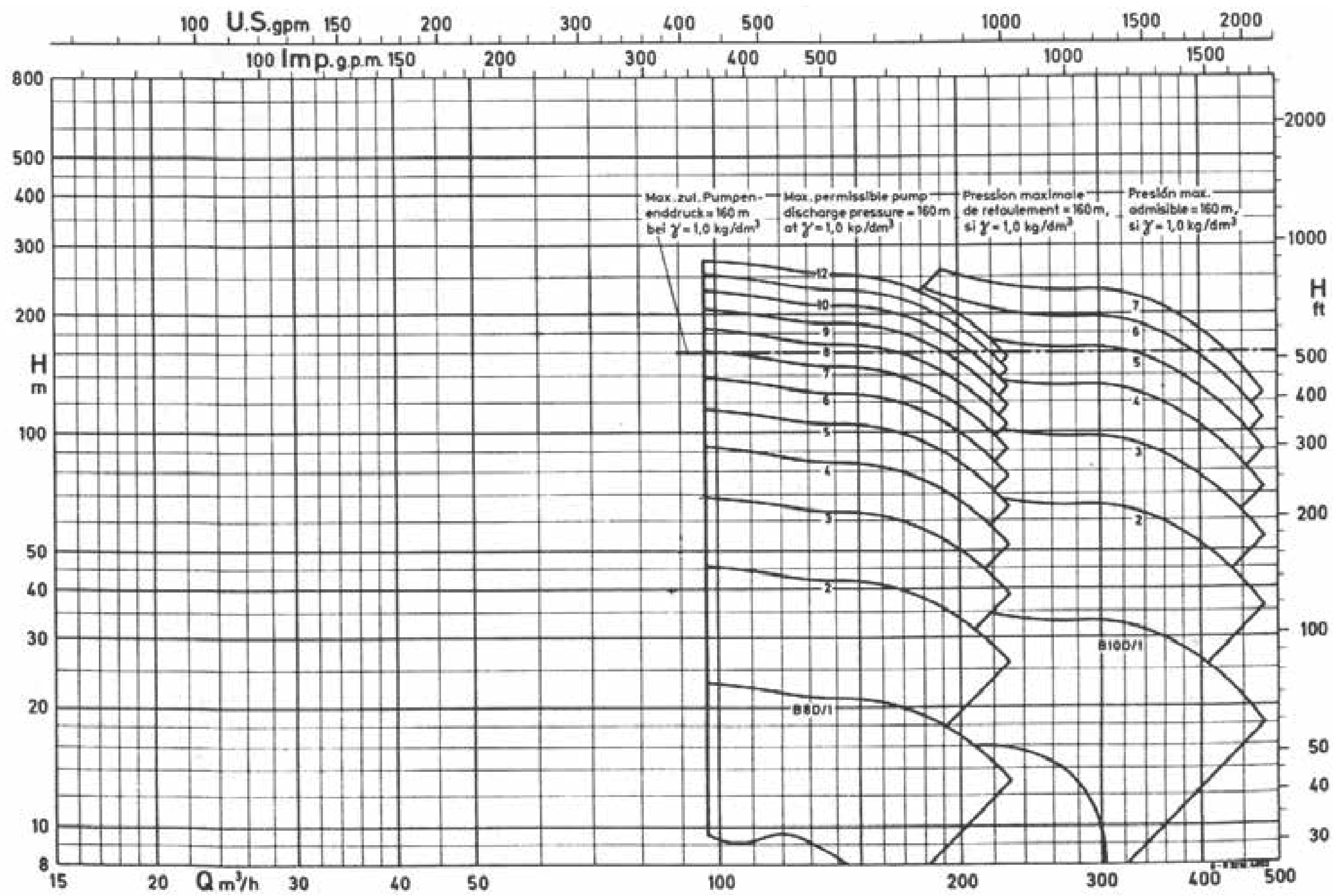


Illustration 2: Family Curves - D Type Impeller at 2900 RPM

1.9.1.2 1450 RPM

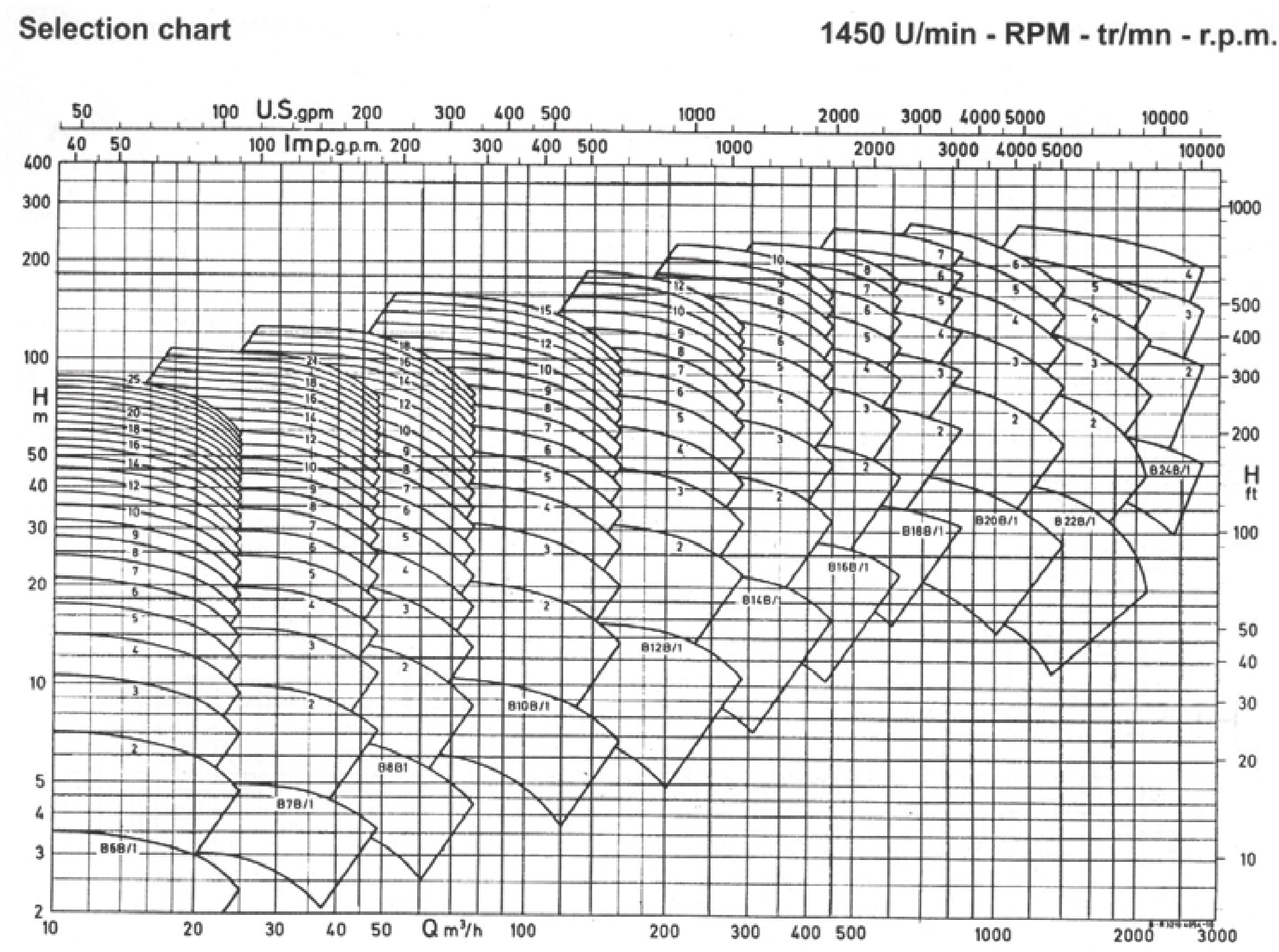


Illustration 3: Family Curves - B Type Impeller at 1450 RPM

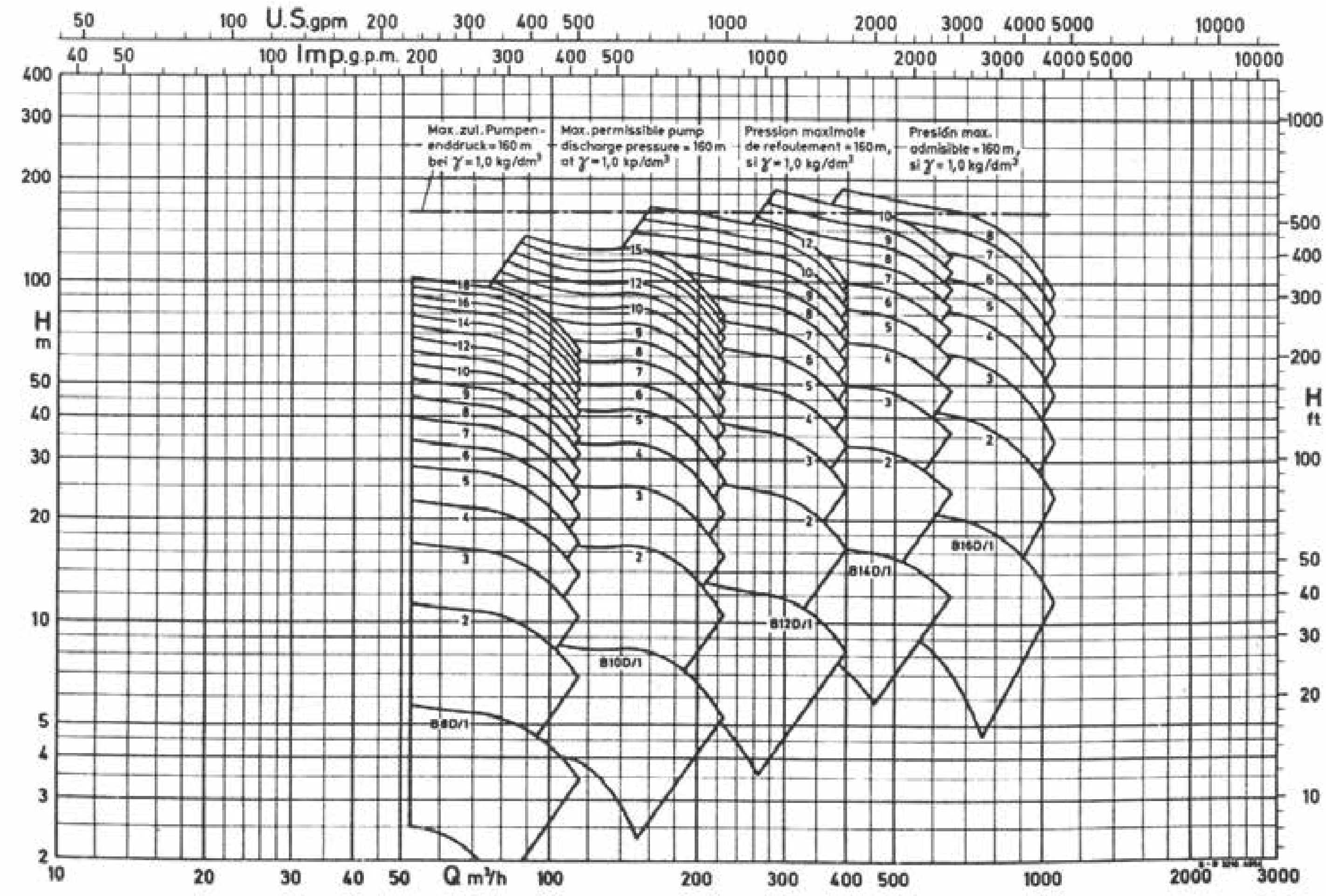


Illustration 4: Family Curves - D Type Impeller at 1450 RPM

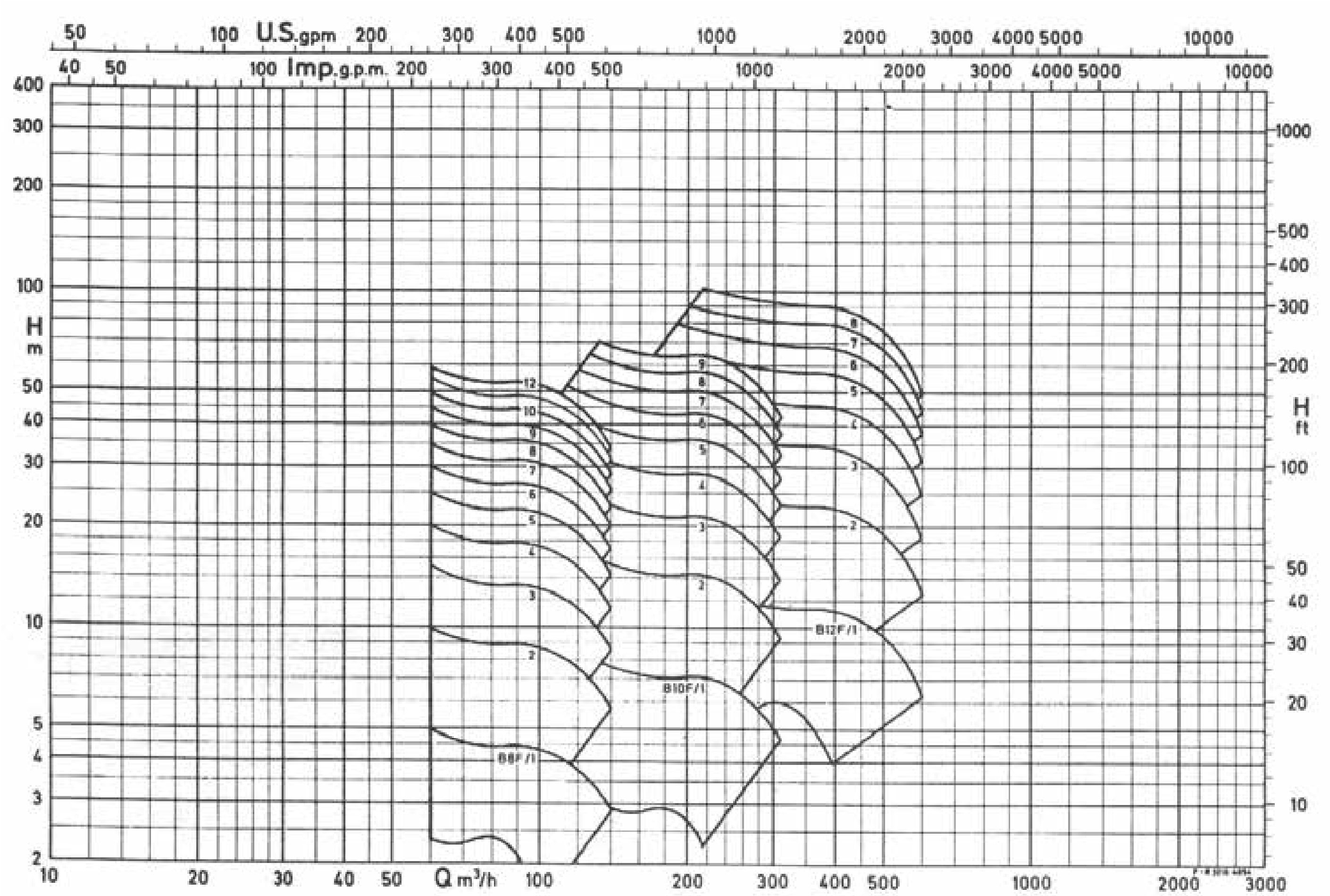


Illustration 5: Family Curves - F Type Impeller for 1450 RPM

1.9.1.3 980 RPM

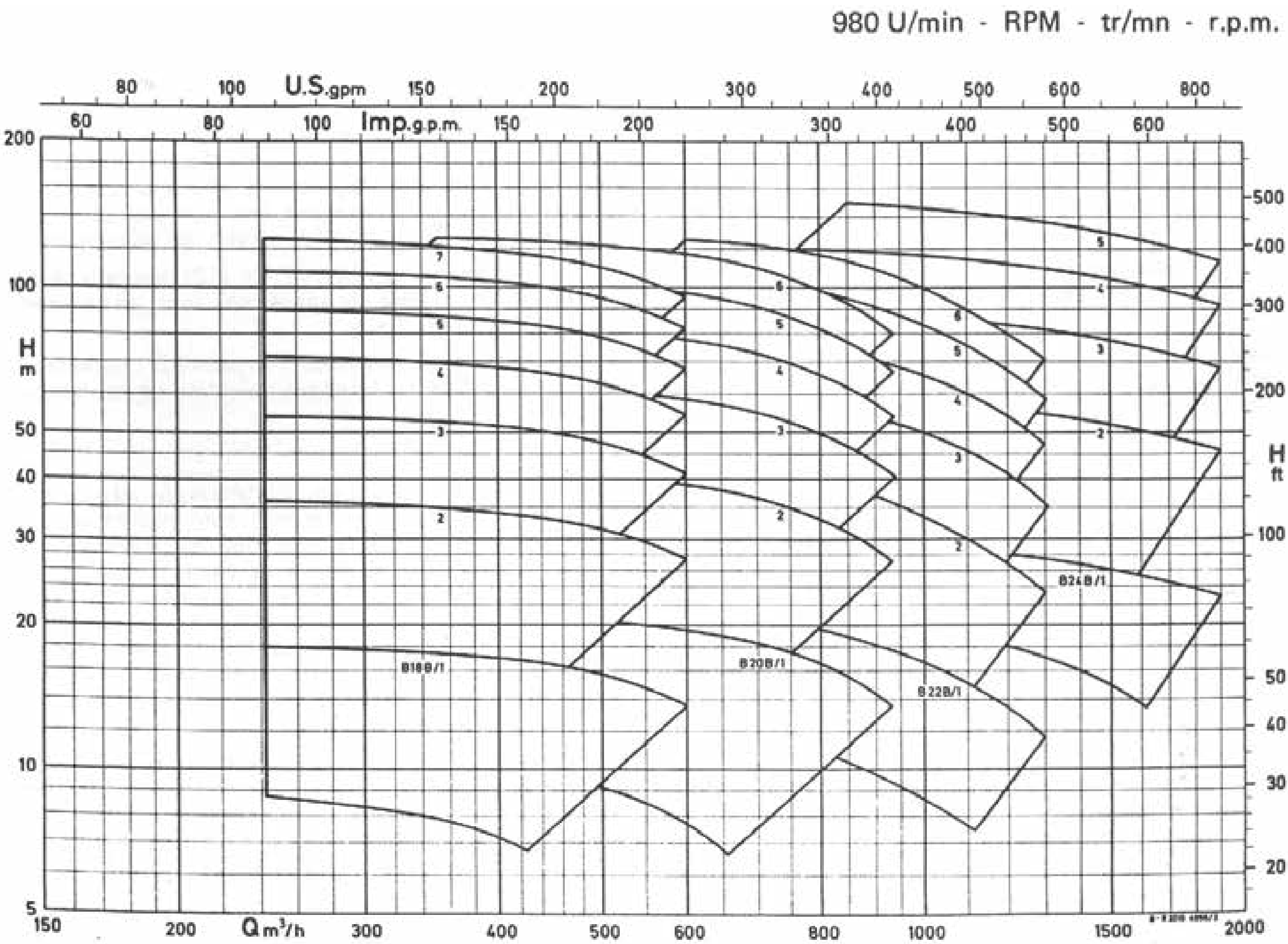


Illustration 6: Family Curves - B Type Impeller for 980 RPM

1.9.2 60 Hz

1.9.2.1 3480, 1740 RPM

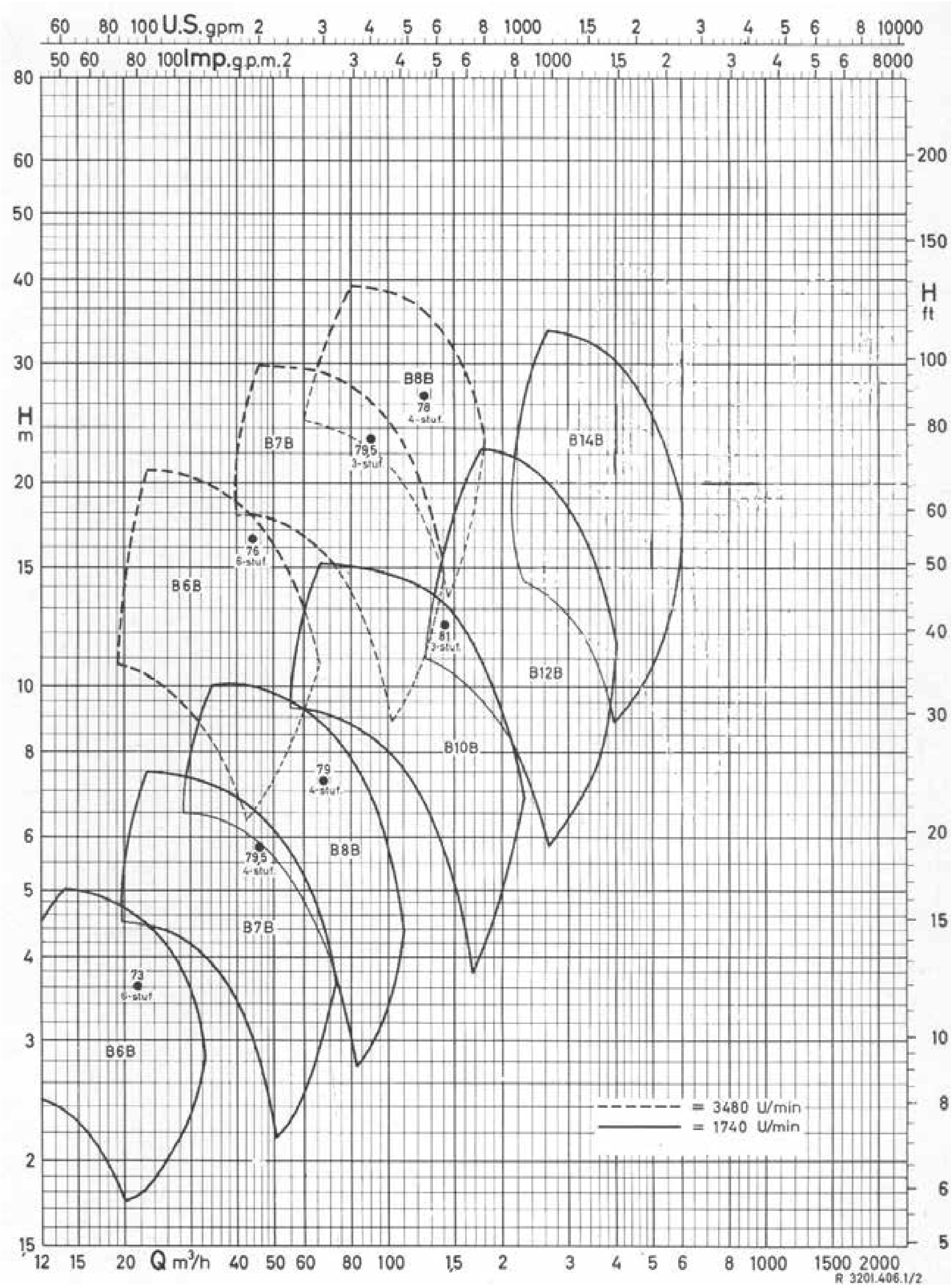


Illustration 7: Family Curves - B Type Impeller for 3480 & 1740 RPM

1.10 Material of Construction

Part #	Part designation	Cast iron	Tin Bronze	GGG-NiCr Nb 202		Duplex
Bowl Assembly (B6-B16)		GG	BZ	D2-01	D2-02	1.4517
106	Suction Piece/Casing	GG-25	G Cusn-10	GGG-NiCr Nb 20 2 (Ni Resist D2)		1.4517
107	Discharge Piece/Casing					
112	Intermediate Bowl/Pump Bowl					
502	Wear Ring / Casing Wear Ring	GG-25	Pb Sn BZ-15		1.4408	Casing wear Ring NA
230 & 503	Impeller	G Cu Sn-10				1.4517
545.1 & .3	Bearing Sleeve / Brg. Bush (Suc & Dis piece)	Pb Sn BZ-15				1.4462
211	Pump Shaft	1.4021	1.4571 / AISI 316			1.4462
545.2	Rubber Bearing	Steel / Rubber Lined		Bronze/Rub. Lined	SS / Rub. Lined	Non Metallic Bearing (Thordon)
	Pump Shaft Coupling (Screwed/Threaded)	1.4021	1.4571 / AISI 316			1.4462
	Fasteners	A2/ 6.8 *	A4			1.4462

Table 1: Material Possibilities for the Bowl Assembly (B6-B16)
*On demand or as per requirement

Part #	Part designation	Cast iron	Tin Bronze		D2	Duplex
Bowl Assembly (B18-B24)		GG	BZ-01	BZ-02	D2-03	1.4517
106	Suction Piece/Casing	GG-25	G Cu Sn-10		GGG-NiCrNb20 2 (Ni Resist D2)	1.4517
107	Discharge Piece/Casing					
112	Intermediate Bowl/Pump Bowl					
502	Wear Ring / Casing Wear Ring	GG-25	Pb Sn BZ-15	1.4408		1.4517
230 & 503	Impeller & Wear Ring	G CuSn-10				
545.1 & .3	Bearing Sleeve / Brg. Bush (Suc & Dis piece)	Pb Sn BZ-15				
211	Pump Shaft	1.4021	1.4571 / AISI 316			1.4462
545.2	Rubber Bearing	Steel/Rub.Lined	Bronze/Rub.Lined	SS/Rubber		Non Metallic Bearing (Thordon)
852	Pump Shaft Coupling (Screwed/Threaded)	1.4021	1.4401 / AISI 316		1.4571	1.4462
	Fasteners	A4				1.4462

Table 2: Material Possibilities for the Bowl Assembly (B18-B24)

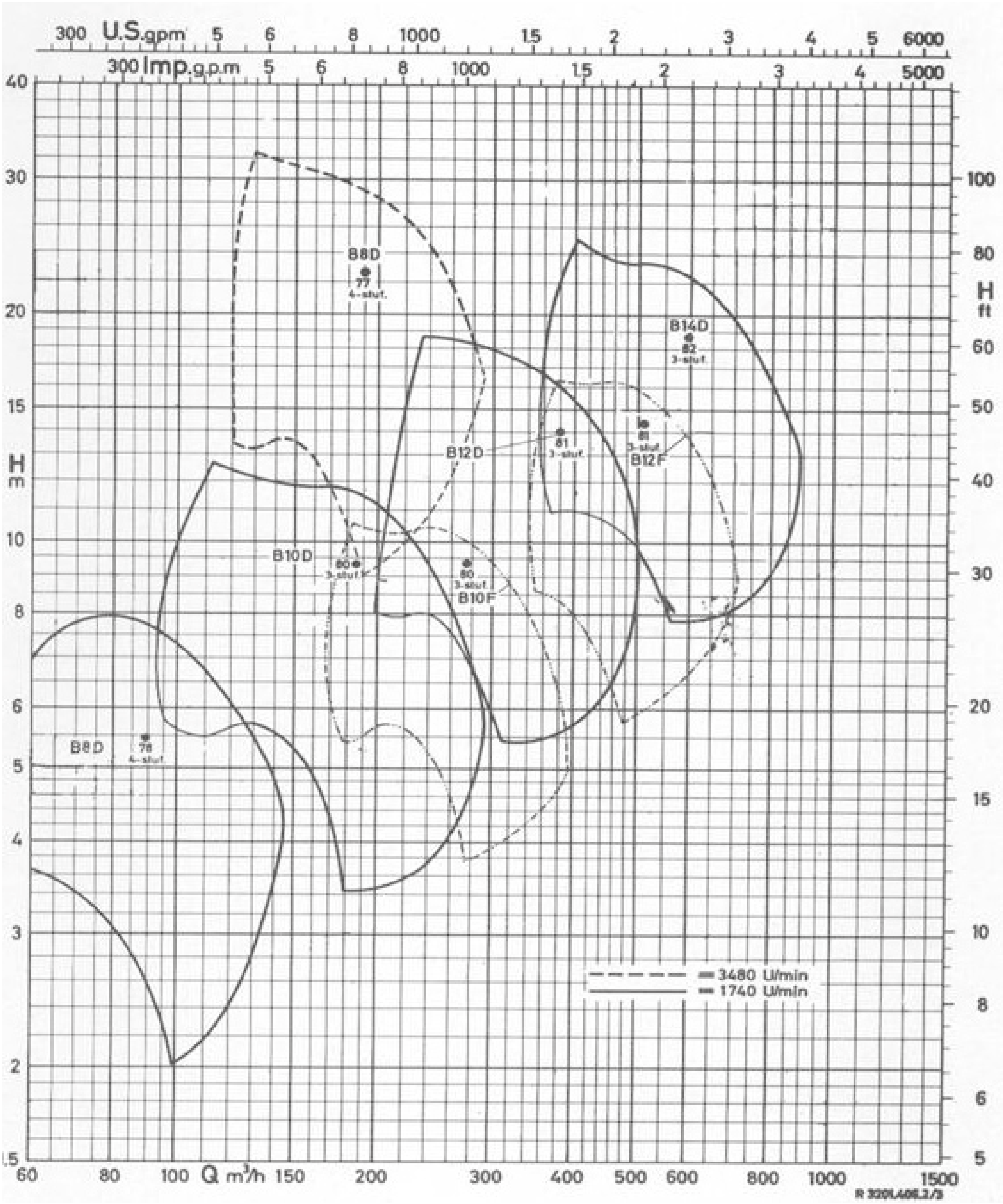


Illustration 8: Family Curves - D & F Type Impeller for 3480 & 1740 RPM

1.11 Pump Dimensions

<table>
<tr><th colspan="2">Impeller Type</th><th>B</th><th>B</th><th>B</th><th>D</th><th>B</th><th>D</th><th>F</th><th>B</th><th>D</th><th>F</th><th>B</th><th>D</th><th>D</th><th>B</th><th>B</th><th>B</th><th>B</th></tr>
<tr><th colspan="2">Size</th><th>6</th><th>7</th><th>8</th><th>8</th><th>10</th><th>10</th><th>10</th><th>12</th><th>12</th><th>12</th><th>14</th><th>14</th><th>16</th><th>18</th><th>20</th><th>22</th><th>24</th></tr>
<tr><td rowspan="7">Bowl Assembly</td><td>Length of one Stage for Flanged Execution</td><td>380</td><td>445</td><td colspan="2">480</td><td colspan="2">535</td><td>630</td><td colspan="2">580</td><td>745</td><td colspan="2">610 *</td><td>690</td><td>890</td><td>955</td><td>1050</td><td>1050</td></tr>
<tr><td>Length of one Stage for Threaded Execution</td><td>435</td><td>500</td><td colspan="2">535</td><td colspan="2">590</td><td>675</td><td colspan="2">625</td><td>745</td><td colspan="2">655</td><td>735</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Length of each Additional Stage</td><td>100</td><td>120</td><td colspan="2">140</td><td colspan="2">165</td><td>250</td><td colspan="2">200</td><td>300</td><td colspan="2">235</td><td>270</td><td>300</td><td>335</td><td>400</td><td>410</td></tr>
<tr><td>Max no. of Stages at 1450 rpm</td><td>25</td><td>21</td><td colspan="2">18</td><td colspan="2">15</td><td>9</td><td colspan="2">12</td><td>8</td><td colspan="2">10</td><td>8</td><td>7</td><td>6</td><td>5</td><td>3</td></tr>
<tr><td>Max length - flanged execution</td><td>2780</td><td>2845</td><td colspan="2">2860</td><td colspan="2">2845</td><td>2630</td><td colspan="2">2780</td><td>2845</td><td colspan="2">2725</td><td>2580</td><td>2690</td><td>2630</td><td>2650</td><td>2700</td></tr>
<tr><td>Max length - Threaded Execution</td><td>2825</td><td>2890</td><td colspan="2">2905</td><td colspan="2">2890</td><td>2675</td><td colspan="2">2825</td><td>2845</td><td colspan="2">2770</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Diameter</td><td>140</td><td>165</td><td colspan="2">190</td><td colspan="3">240</td><td colspan="3">290</td><td colspan="2">338</td><td>390</td><td>430</td><td>472</td><td>560</td><td>600</td></tr>
<tr><td rowspan="2">Suction Strainer Length</td><td>Threaded</td><td colspan="2">190</td><td colspan="2">230</td><td colspan="3">260</td><td colspan="2">295</td><td colspan="3">340</td><td>355</td><td rowspan="2">540</td><td>---</td><td colspan="2">722</td></tr>
<tr><td>Flanged</td><td colspan="2">235</td><td colspan="2">275</td><td colspan="3">315</td><td colspan="2">310</td><td colspan="3">390</td><td>470</td><td>650</td><td colspan="2">730</td></tr>
<tr><td colspan="2">Column Pipe Dia (inch)</td><td colspan="2">3”,4”</td><td>4”,5”</td><td colspan="2">5”, 6”</td><td>6”, 7”</td><td>7”</td><td>7”, 8”</td><td>8”, 10”</td><td>10”</td><td>8”, 10”</td><td>10”</td><td>10”,12”</td><td>12”,14”</td><td>14”,16”</td><td>16”,18”</td><td>18”,20”</td></tr>
<tr><td colspan="2">Minimum Submergence of 1st Impeller</td><td colspan="2">300</td><td colspan="2">350</td><td colspan="3">400</td><td colspan="6">450</td><td colspan="4">500</td></tr>
<tr><td colspan="2">Suction Strainer Dia (inch)</td><td colspan="2">4”</td><td colspan="2">5”</td><td colspan="3">6”</td><td colspan="2">7”</td><td colspan="3">8”</td><td>10”</td><td>12”</td><td>14”</td><td colspan="2">16”</td></tr>
<tr><td colspan="2">Length of Foot Valve</td><td colspan="2">135</td><td colspan="2">165</td><td colspan="3">185</td><td colspan="2">270</td><td colspan="3">365</td><td>410</td><td>490</td><td>560</td><td colspan="2">630</td></tr>
<tr><td colspan="2">Min. Clearance B/w Suction strainer & Floor</td><td colspan="2">100</td><td colspan="2">125</td><td colspan="3">150</td><td colspan="2">175</td><td colspan="3">200</td><td>250</td><td>300</td><td>350</td><td colspan="2">400</td></tr>
</table>

Table 6: Various Dimensions of the pump

All dimensions in mm.

*) For B14 length of single stage in case of shaft enclosing tube arrangement is (220+235+230) = 685 mm

2 Pump Data

2.1 Capacity Limitations

2.1.1 Pump media

Clean	Contaminated	Viscous/combustible
Well water Drinking water Cooling water Condensate Sea water Salty water	river water brackish leach	oils

2.1.2 Capacity

Q_{opt}	Capacity at best efficiency point
Q_{min}	0.55 Q_{opt}(B6-B16),0.65 Q_{opt}(B18-B24)
Q_{max}	1.35 Qopt

Table 7: Minimum and Maximum capacity

2.1.3 Total Head Pressure

Pump Head H = $H_t + H_D$

H_t = Head under ground level

H_D = Head above ground level

H_t = $H_{geo1} + H_{w1}$

H_D = $H_{geo2} + H_{w2} + 10 \times (P_2 – P_1)/\gamma$

H_{geo1} = Geodetic head (Static Head) from water level to pump ground

H_{geo2} = Geodetic head from pump ground to the center of delivery nozzle

H_{w1} = Frictional Losses in (an estimation can be 5% of H_t):

- Suction Strainer
- Suction pipe
- Rising Main
- Discharge Head

H_{w2} = Friction losses in Delivery Line

P_2 = Pressure on the water level from delivery side

P_1 = Pressure on water level from the suction side

γ = Specific gravity in kg/dm^3

As estimation pumping H $_{w1}$ can be assumed 5% from H_t

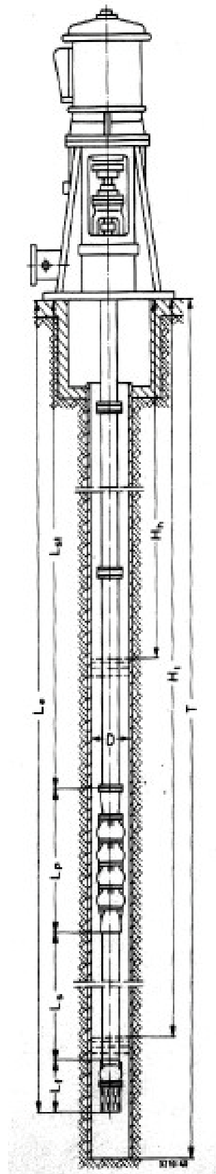


Figure 1: Schematic Diagram

2.1.3.1 Maximum pump pressure at outlet nozzle

In all pump types and material variants the pump pressure P_e maximum at Q=0 should not exceed the value of 16 bar. In case of pumped media with specific gravity γ less than 1 Kg/dm^3, the final pressure during hydraulic trial run with water should not exceed maximum admissible test pressure. If the values in Table 8 are exceeded, then the pump can be tested only with reduced speed.

Part	Max Test Pressure	Max Inlet Pressure	Temperature
Suction Casing Guide Vane Casing Stuffing Box Casing Discharge Casing Column Pipe	6" & 7" = 19.6 bar / 20 kg/cm^2 8" to 24" = 24.5 bar / 25 kg/cm^2	10 bar	0^oC to 105^oC
Cool Water Chamber	10 kg/cm^2		

Table 8: Pressure & Temperature Limitations

2.1.3.2 Test Pressure with Water

The test pressure is normally 1.5 times that of the operational pressure. The pressure test is done with cold water.

2.1.4 Testing Standards

Testing can be performed as per following standard: ISO 9906 Class L

> Note: ISO 9906 Class L has replaced the following Standards
> 1.ANSI – Hydraulic Institute Standard 2.BS 5316 Part 1 & 2
> 3.ISO 3555 Class B 4. ISO 2548 Class C
> 5. DIN 1944 / III, II, I (with negative tolerance)

2.1.5 Maximum Speed

The following speed limits must be considered:

1. Pump Size (Table 9)
2. Length of the column pipe set, categorized according to the diameter of the shaft (Table 10)
3. Angular Contact Ball Bearing (Table 11)

The lowest of the above mentioned speeds is then valid for the complete pump.

2.1.5.1 Determination of Pump Size

Pump size		6	7	8	10	12	14	16	18	20	22	24
Impeller Type	B+D	3600			3000	1800			1500			
	F	1800										

Table 9: Maximum rotational speed of pump in RPM

2.1.5.2 Length of Column Set

Column Set Length in mm		Diameter of Shaft						
		20	25	30	35	45	60	70
Top Column Pipe	300*	3600			3000	1800		
	400**							
	600							
	900							
	1200							
Intermediate Column Pipe	3050	2200				1800		
	1525	1800						
	1800					1800		
	2000	3600			3000			

Table 10: Selection of column length according to pump operational speed in RPM.

* below DN 350, ** above DN 350

Note: For shaft diameter greater than 70, consult design office.

2.1.5.3 Angular Contact Ball Bearing (V1 arrangement)

Brg. BUA Type	7306	7307	7308	7309	7310	7311	7312	7313	7314	7315	7316
N Max. RPM	8000	7500	6700	6000	5300	4800	4500	4300	3800	3600	3400
Brg. BUA Type	7317	7318	7319	7320	7322	7324	7326	7328	7330	7332	7338
N Max. RPM	3200	3000	2800	2600	2200	1900	1800	1700	1600	1600	1200

Table 11: Bearing size according to pump operational speed in RPM.

2.1.6 Shaft Rating/Selection

1. Pump shaft according to Table 12
2. Intermediate shaft according to Table 13

If the material other than specified in the Table 12 & Table 13 are required then P/n permissible can be converted according to Table 14.

2.1.6.1 Maximum Shaft Rating – Pump Shaft

Pump size		6	7	8	10	12
Pump Shaft Material 1)		X 20 Cr 13V / 1.4021.05 / Z 1220				
P/n	Thread Coupling	0.0185	0.0372	0.0675	0.093	0.25
	Cone Coupling			0.039	0.072	0.152

Pump size		14	16	18	20	22	24
Pump Shaft Material 1)		X 20 Cr 13V/ 1.4021.05 / Z 1220					
P/n	Thread Coupling / Cone Coupling	0.386	0.719	1.073	1.325		1.853

Table 12: P/n maximum for the pump shaft

1) Material for normal type/ model, for other material the P/n values are to be converted with the conversion factor (Table 14).

2.1.6.2 Maximum Shaft Rating – Intermediate Shaft

Shaft diameter in mm	Type of load		Threaded Coupling, 1.4021	Cone Coupling 1), 1.4021
			Intermediate Shaft 2)	
			St 50 SH	St 50 SH
20	P/n max.	Kg	0.0085	-
	Pax.max.		2000	-
25	P/n max.	Kg	0.0171	-
	Pax.max.		3000	-
30	P/n max.	Kg	0.031	0.018
	Pax.max.		4500	4500
35	P/n max.	Kg	0.043	0.033
	Pax.max.		6000	5500
45	P/n max.	Kg	0.114	0.070
	Pax.max.		10000	7500
60	P/n max.	Kg	0.286	0.184
	Pax.max.		18000	14000
70	P/n max.	Kg	-	0.291
	Pax.max.		-	20000

Table 13: P/n max for intermediate shaft and maximum axial stress of the intermediate coupling.

1) Switching Frequency see 3.8.2.1.1 Page 3-10

2) Normal material, for other material the value to be converted according to Table 14.

DIN Designation	Material Number	WSZ	Conversion Factor f, Basic material 1)	
			St 50 SH ≤70 Ø	MSt 60-2 >70 Ø
St 50 SH/	1.5031 SH	Z0334	1.0	
C45 N/	1.0503.01	0696		
X20 Cr13V/1.4021	1.4021.05	1220	2.18	1.85
X10 CrNiMoTi 1810	1.4571	1300	0.81	0.69
X2crNiMoN225	1.4462	1647	1.55	1.3

An example for conversion from Standard Material is:

Normal Material of Intermediate Shaft	= St 50 SH
Shaft Diameter	= 35 mm
Cone Coupling P/n_{max}	= 0.033
New Material of intermediate shaft	= 1.4507
Conversion Factor	=2.18

2.1.6.3 Selection of Flexible Coupling

Type	**S0**	**S1**	**S1A**	**2BN**	**3BN**	**4BN**	**5BN**
P/n max	0.0012	0.0052	0.009	0.024	0.05	0.127	0.224
n max	8350	5550	4450	4500	3500	2900	2200

Table 15: P/n max for flexible coupling, Type of construction according to HS 173, Material GG

P = Prime Mover rating (kW)

n = revolution (RPM)

In case of gear drive, of more than 5 – 20 switching in an hour the determined P/n value is to be increased by 20%. However in case of gear drive, up to 40 switching in an hour the determined P/n value is to be increased by 30%.

2.1.7 Max. Number of Stages

Pump Size	**RPM**	**6**	**7**	**8**		**10**			**12**			**14**		**16**	**18**	**20**	**22**	**24**
Type		**B**	**B**	**B**	**D**	**B**	**D**	**F**	**B**	**D**	**F**	**B**	**D**	**D**	**B**	**B**	**B**	**B**
	1450	25	21	18		15		9	12		8	10		8	7	6	5	
	2900	16	10	8	12	5	7											
	1750	25	21	18		15		9	12		8	10		8	7	6	5	
	3500	12	9	6	10													

Table 16: Maximum Number of Stages

For maximum permissible limits of test pressure, see Table 8.

In Table 16, the maximum number of stages mentioned does not provide information over the performance limitation through the admissible shaft rating. Compare Maximum Speed see 2.1.5 Page 2-2

2.1.8 Special Limits

2.1.8.1 Maximum Installation Depth

The maximum possible installation depth depending on the intermediate shaft or on the rising main diameter can be seen from the Table 48 & Table 49, Page 3-14.

2.1.8.1.1 Checking of Installation Depth due to Axial Play (Tolerance).

Elongation in the pump can be due to:

1. Stationary parts (pump casing and column pipe) through
   a. Own weight,
   b. Axial force, resulting from delivery pressure (P_e) multiplied with the cross-section of the column Pipe (F_{NW}).
2. Rotating parts (pump, intermediate, and drive shafts) through
   a. Own weight
   b. The axial thrust (P_{max})

The elongation, which arises from own weight, should not be considered, because it occurs while the pump is at stand still and can be adjusted by the impeller automatically.

During operation, the elongation difference between the fixed and rotating parts is calculated by the following formula.

If the value is positive, the impeller must be adjusted higher and if the value is negative it must be adjusted lower accordingly.

$\Delta\angle$ $= L \times (\Delta\angle_w - \Delta\angle_{st})$

$= L \times \{(P_{ax} / (F_w \times E_w)) - ((P_e \times F_{NW})/(F_{st} \times E_{st}))\}$

L (mm) Pump installation depth up to bottom edge of the suction casing

E_w (kg/cm^2) Elasticity modulus of the shaft material

E_{st} (kg/cm^2) Elasticity modulus of the pipe material

P_{ax} (kg) Axial thrust (Hydraulic component) as per Figure 6 & Figure 7 Page 3-4.

F_w (cm^2) Cross section of the shaft (Table 18)

P_e (kg/cm^2) Delivery pressure measured at Discharge casing

F_{NW} (cm^2) Pressure impacted area of the column pipe (Table 17)

F_{st} (cm^2) Cross section of the column pipe (Table 17)

Figure 2can also used instead of this formula.

Rising Main Dia	80 3"	100 4"	125 5"	150 6"	175 7"	200 8"	250 10"	300 12"	350 14"	400 16"	500 20"
F_{NW} (cm^2)	52	78	122	176	254	325	509	722	971	1260	1950
F_{st} (cm^2)	9.6	13.1	16.2	21.8	32	41	51.6	69	90.5	122	184

Table 17: Cross section of the Column pipe in cm^2.

Intermediate shaft (mm) dia	20	25	30	35	40	45	60	70	80	90	100	110
F_w (cm^2)	3.1	4.9	7.1	9.6	12.6	15.9	28.3	38.5	50.3	63.6	78.5	95

Table 18: Cross-section of shaft in cm^2.

DIN Terminology	Material	WSZ #	Coefficient of Elasticity kg/cm^2 E_w
M St 60-2	1.0542.6	0361	$2.1x10^6$
X22 Cr Ni 17	1.4057	1364	$2.1x10^6$
X20 Cr 13 V	1.4021.05	1220	$2.1x10^6$
X10 Cr Ni Mo Ti 1810	1.4571	1300	$2.3x10^6$
X2Cr Ni Mo N 225	1.4462	1647	$2.03x10^6$

Table 19:Coefficient of elasticity of Shaft Material

The axial play of the pump determines the maximal permissible extension difference (Table 20) and maximum installation depth of the pump. The measurement of the depth with reference to the axial play is required to be carried out in case of column pipe and shaft of steel at more than a certain length L_o (Table 20). In case of material of shaft with a different co-efficient of elasticity (e.g. bronze, E = 2.1x106 kg/cm^2) a recalculation is always required

Pump Size	6	7	8	10	12	14 [1]	16	18	20	22	24
Δ Permissible length(mm) [2]	5		7		6	10		16			
L_o (M)	30		40			50					

Table 20: Permissible difference in extension

1) B14D: Δ permissible length = 5 mm

2) In case of switched off rotor the Δ permissible length can be greater (any questions may be directed to the design office).

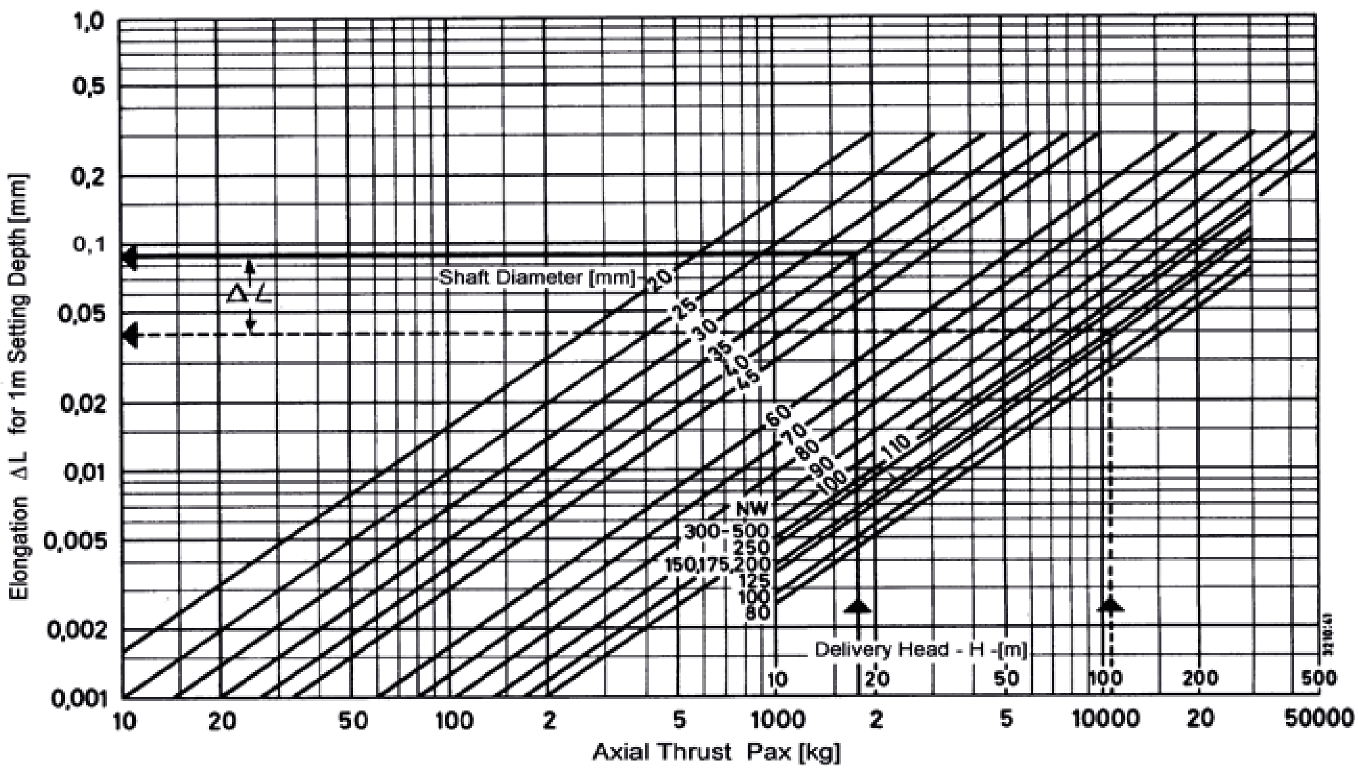


Figure 2: Extension difference between shaft and column pipe.

(valid only for materials with a co-efficient of elasticity less than 2.1x106 kg/cm^2)

2.1.8.2 Maximum Solid Contents

If the flow medium contains sand or other solids, the pump parts as well as column shaft and shaft bearings are subjected to premature wear and tear depending upon the content type and grain size of the solids. In Table 21 the impurities are divided into three groups. According to the level of the impurities/suspensions the column bearing design is to be fixed, as well as the guarantee for specific parts of the pumps is to be limited or even refused. In the choice of the material, special consideration is to be given to the stability against wear and tear. Whenever there is contamination, the smallest revolution should be chosen.

Group	Degree of impurity	Solid Contents				Bearing [1]			Guarantee Limitations
		Ppm	Volume %	Weight %	Grain [2]	Rising Main	Suction Casing	Discharge Casing	
I	Slight	25	<0.001	<0.002	Max 0.5 mm	Unprotected			No (exception natural wear and tear)
II	Moderate	25-250	0.001 to 0.01	0.0025 to 0.025		Protected	Unprotected		Liquid lubricated bearing, casing wear ring inter stage bush
III	Considerable	> 250	>0.01	>0.025		Protected	Unprotected		Complete pump body

Table 21: Admissible contamination

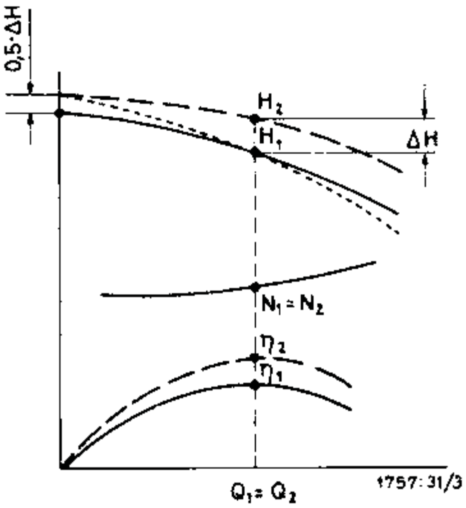
1). Outside lubrication see 3.6.2.1, Page 3-7

2). Sharp edged Quartz (Silica) is more dangerous than rounded or soft minerals. Similarly those solids which are smaller than the bearing play or throttle gap are more detrimental to the life span of the bearings than those which are larger and cannot enter the gaps because of their size.

2.1.8.3 Tolerance – Impeller / Casing Wear Ring

The gap between impeller skirt and the casing wear ring are dependent on the operational temperature and the pumping media. With the increase in the gap the head (H) and efficiency (η) are changed (see Figure 3).

Casing Wear Rings are provided only on Suction Side. A tolerance of 0.3mm is taken in the impeller diameter while plotting the efficiency and head given in the selection charts.



Index 1 = Operating data with enlarged running clearance (tolerance)

Index 2 = Operating data without enlarged running clearance (tolerance) = Design data for index 1

Figure 3: Change of Q/H characteristic curve as well as efficiency curve by enlarging running clearances.

2.1.8.4 Drop of efficiency (η) and the Head (H) by Increased Tolerance

If the operational condition demands increased play, then the resulting efficiency drops and the associated head (H) drop should be taken into account during designing the pump. The correction factor for the efficiency drop in the field of optimum efficiency should be used from Table 22. As the pumps have been provided with a casing wear ring on the suction side, the clearance gap enlargement has a very minor effect. Both the factors listed in the Table 22 can therefore be used for all practical purposes.

Case Wear Ring	**Tolerance 0.3<s≤0.5mm**	
Size	6" – 12"	14" – 24"
Correction Factor f	0.95	0.98

Table 22: Correction Factor f

According to Q-H Curve, the correction factor reaches the value 1.0 against capacity. The 0-point lies in the field between 0-point without clearance gap enlargement and a point which lie lower than 0.5 x ΔH (see Figure 3).

2.1.8.4.1 Impeller neck Diameter (Inlet)

Various specifications prescribe certain tolerance dependent from impeller neck diameters. In Table 23 the diameters for individuals pump size are given.

Pump Size	**6**	**7**	**8**		**10**			**12**			**14**		**16**		**18**	**20**	**22**	**24**
	B	**B**	**B**	**D**	**B**	**D**	**F**	**B**	**D**	**F**	**B**	**D**	**B**	**D**	**B**	**B**	**B**	**B**
Impeller Ø	75	90	105	120	135	150	160	160	180	190	180	210	210	240	240	260	320	330

Table 23: Impeller Neck Diameters (mm)

2.2 Start

2.2.1 Starting Torque

The initial breakaway torque amounts to approximately 15% from rated moment. In Figure 4 the approximate running at start is shown

I. With open gate valve

II. Against closed gate valve – Impeller type "B"

III. Against closed gate valve – Impeller type "D" and "F" shown.

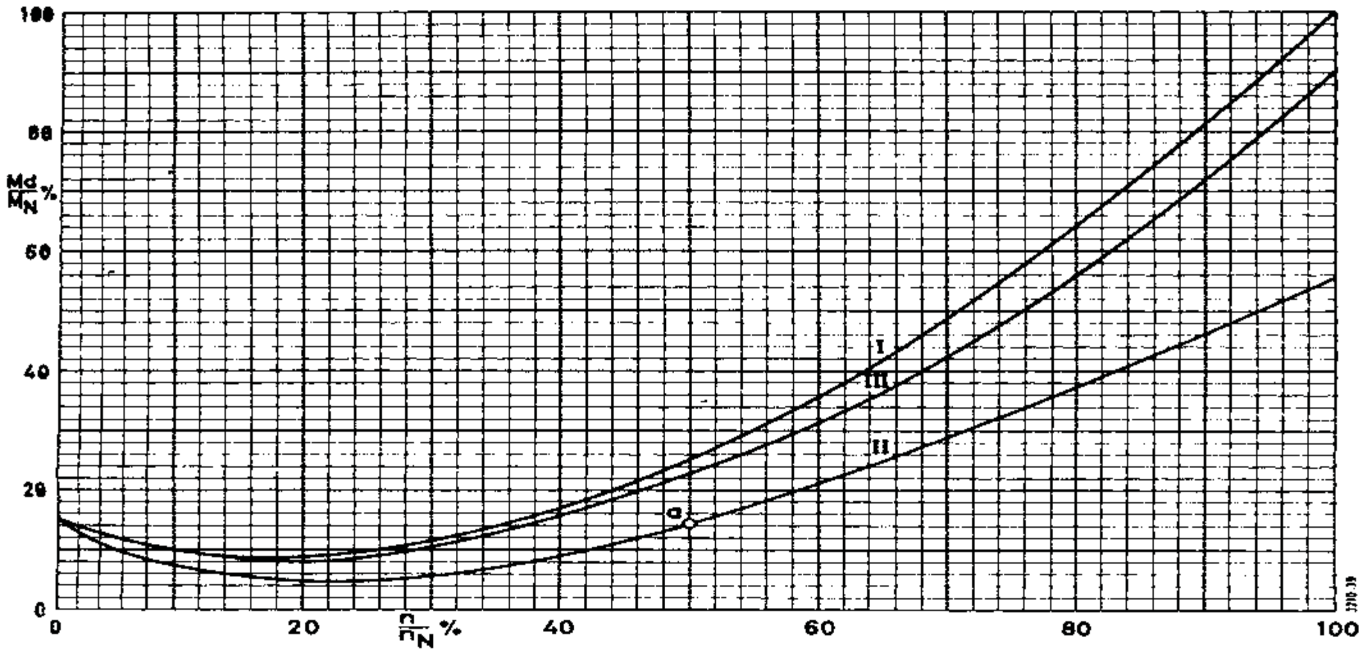


Figure 4: Starting Torque Curve

2.2.2 Torque M_d

The torque can be calculated with this formula

M_d	=	9549 x P/n, where:
P	=	Power requirement at the shaft (motor rating) in kW
n	=	Revolutions of the pump rpm
9549	=	Constant

The motor suppliers can be provided with sheet 1063.48 for pumps with impeller of high speed 'B' and with sheet BT 2752 for pumps with impeller of high speed 'D' and 'F'; which gives detail for the torque curve in practice with sufficient exactness.

2.2.3 Moment of inertia/ Gyration

The total moment of inertia of the complete pump can be calculated in the following manner:

GD^2 TOTAL	=	GD^2 PUMP + n x GD^2 intermediate shaft + GD^2 driving shaft + GD^2 coupling
N	=	number of standard column pipe sets.

2.2.3.1 Pump Bowl Assembly

Pump filled with water																		
Pump Size	**6**	**7**	**8**		**10**			**12**			**14**		**16**		**18**	**20**	**22**	**24**
Impeller Type	**B**	**B**	**B**	**D**	**B**	**D**	**F**	**B**	**D**	**F**	**B**	**D**	**B**	**D**	**B**	**B**	**B**	**B**
Stages 1	0.006	0.012	0.025	0.035	0.072	0.073	0.074	0.17	0.18	0.19	0.34	0.37	0.65	0.68	1.2	1.8	2.9	4.8
2	0.011	0.023	0.045	0.06	0.134	0.136	0.138	0.32	0.34	0.36	0.64	0.69	1.2	1.26	2.2	3.4	5.5	9.3
3	0.016	0.034	0.065	0.085	0.196	0.199	0.202	0.47	0.5	0.53	0.94	1.01	1.75	1.84	3.2	5	8.1	13.8
4	0.021	0.045	0.085	0.11	0.258	0.262	0.266	0.62	0.66	0.7	1.24	1.33	2.3	2.42	4.2	6.6	10.7	18.3
5	0.026	0.056	0.105	0.135	0.32	0.325	0.33	0.77	0.82	0.87	1.54	1.65	2.85	3	5.2	8.2	13.3	22.8
6	0.031	0.067	0.125	0.16	0.382	0.388	0.394	0.92	0.98	1.04	1.84	1.97	3.4	3.58	6.2	9.8		
7	0.036	0.078	0.145	0.185	0.444	0.451	0.458	1.07	1.14	1.21	2.14	2.29	3.95	4.16	7.2			
8	0.041	0.089	0.165	0.21	0.506	0.514	0.522	1.22	1.3	1.38	2.44	2.61	4.5	4.74				
9	0.046	0.1	0.185	0.235	0.568	0.577	0.586	1.37	1.46		2.74	2.93						
10	0.051	0.111	0.205	0.26	0.63	0.64		1.52	1.62		3.04	3.25						
11	0.056	0.122	0.225	0.285	0.692	0.703		1.67	1.78									
12	0.061	0.133	0.245	0.31	0.754	0.766		1.82	1.94									
13	0.066	0.144	0.265	0.335	0.816	0.829												
14	0.071	0.155	0.285	0.36	0.878	0.892												
15	0.076	0.166	0.305	0.385	0.94	0.955												
16	0.081	0.177	0.325	0.41														
17	0.086	0.188	0.345	0.435														
18	0.091	0.199	0.365	0.46														
19	0.096	0.21																
20	0.101	0.221																
21	0.106	0.232																
22	0.111																	
23	0.116																	
24	0.121																	
25	0.126																	

Table 24: Pump Moment of Inertia GD^2 in kgm^2.

2.2.3.2 Intermediate and Driving Shaft

Shaft		**Drive/Top shaft**				**Intermediate Shaft**		
Length of the pipe (mm)		**300**	**600**	**900**	**1200**	**1525**	**2000**	**3050**
Shaft – ø (mm)	20	0.0025	0.0028	0.0032	0.0035	0.0009	0.0011	0.00136
	25	0.0028	0.0031	0.0035	0.0038	0.0031	0.0036	0.0049
	30	0.0047	0.0054	0.0062	0.0069	0.0057	0.0083	0.094
	35	0.0064	0.0079	0.0094	0.0109	0.101	0.0125	0.0164
	45	0.0181	0.022	0.0259	0.0298	0.0252		0.0439
	60	0.066	0.078	0.090	0.102			0.147
	70	0.135	0.157	0.180	0.202			0.303

Table 25: Moment of inertia GD^2 in kgm^2 of intermediate and drive shaft.

2.2.3.3 Flexible Coupling

Size	**S0**	**S1**	**S1a**	**2BN**	**3BN**	**4BN**	**5BN**
GD^2 (kgm^2)	0.0010	0.0033	0.0094	0.0214	0.0428	0.1292	0.3625

Table 26: Moment of inertia GD^2 for flexible coupling, according to HS 173.

For other types of coupling, moment of inertia can be taken from the respective manufacturer's catalogue.

2.3 NPSH of the Pump (H_H) & NPSH of the plant (H_{HA})

Every impeller has its own flow pattern. The Q dependent NPSH (H_H) value can be taken from the characteristic curves. This value must be minimum at the exit from the plant so that vaporization of the pumped fluid (cavitation) in the impeller is avoided.

$H_{HA} > H_H$

The (H_H) values on the characteristic curve have been constructed on a 3% head drop and should be applied to the upper edge of the first impeller's vane. It also contains a safety margin, which must not be deducted, as it takes into consideration casting inaccuracies and head losses in the pump.

External safety margin should also be considered in addition to this.

The minimum submergence is the minimum water level over the lower edge of the suction casing for starting the pump and is marked through the measurement "B" in the Table 27.

<table>
<tr><th>Pump Size</th><th>6</th><th>7</th><th colspan="2">8</th><th colspan="3">10</th><th colspan="3">12</th><th colspan="2">14</th><th colspan="2">16</th><th>18</th><th>20</th><th>22</th><th>24</th></tr>
<tr><td>Impeller Type</td><td>B</td><td>B</td><td>B</td><td>D</td><td>B</td><td>D</td><td>F</td><td>B</td><td>D</td><td>F</td><td>B</td><td>D</td><td>B</td><td>D</td><td>B</td><td>B</td><td>B</td><td>B</td></tr>
<tr><td>Measurement (B) [mm]</td><td colspan="2">300</td><td colspan="2">350</td><td colspan="3">400</td><td colspan="5">450</td><td colspan="6">500</td></tr>
</table>

Table 27: Measurement B = minimum water level over the bottom edge of the suction casing / Min. submergence.

2.4 Weights

The total unit weight consists of the following components:

1. Pump body
2. Rising main
3. Shaft enclosing Tube
4. Discharge head
5. Motor stool
6. Bearing Assembly
7. Motor (See Motor Catalogue)

2.4.1 Component Weight

2.4.1.1 Pump Bowl Assembly

The weights are approximate and can be taken for all material variants; however, for price calculations these have limited application.

No. of Stages \ Pump size	6	7	8	10	12	14	16	18	20	22	24
1	22	32	44	72	112	160	220	295	385	530	640
2	28	41	56	96	154	222	305	407	545	785	940
3	34	50	68	120	196	284	390	519	705	1040	1240
4	40	59	80	144	238	346	475	631	865	1295	1540
5	46	68	92	168	280	408	560	743	1025	1550	1840
6	52	77	104	192	322	470	645	855	1185		
7	58	86	116	216	364	532	730	967			
8	64	95	128	240	406	594	815				
9	70	104	140	264	448	686					
10	76	113	152	288	490	718					
11	82	122	164	312	532						
12	88	131	176	336	574						
13	94	140	188	360							
14	100	149	200	384							
15	106	158	212	408							
16	112	167	224								
17	118	176	236								
18	124	185	248								
19	130	194									
20	136	203									
21	142	212									
22	148										
23	154										
24	160										
25	166										

Table 28: Weight of the pump bowl assemblies in kg.

2.4.1.2 Rising main

2.4.1.2.1 Flanged execution

A standard column pipe set includes:

1 column pipe with 2 Flanges
1 Bearing spider with bearing bush / rubber bearing
1 Intermediate shaft with Shaft Protecting Sleeve
1 Shaft coupling
1 set of fasteners + Gaskets/O-Rings

A standard upper column pipe set (top set) consists of:

1 column pipe with 2 Flanges
1 Shaft coupling
1 set of fasteners + Gaskets/O-Rings

2.4.1.2.2 Threaded Execution

A standard column pipe set includes:

1 column pipe with bearing socket
1 Intermediate shaft with Shaft Protecting Sleeve
1 Shaft coupling

A standard upper column pipe set consists of:

1 column pipe line (top set) with 1 Flange + 1 side threaded – maximum length of top set is 1220 mm.
1 Shaft coupling
1 Set of fasteners + Gaskets/O-Rings

Following weights are of flanged column pipes without shaft enclosing tube. For threaded execution the weights can be reduced by 10%.

WEIGHT OF RISING MAIN SET										
SHAFT Ø (mm)	Rising Main Sets	Rising Main Nominal Diameters (NW)								
		80	100	125	150	200	250	300	350	400
20	1525	21.7	26.7	31.8						
	2000	35.5	33.0	39.3						
	2700	43.0	42.2	50.4						
	3050	46.8	46.8	55.9						
25	1525		26.7	34.7	58.6	80.1				
	2000		33.0	42.9	72.5	97.7				
	2700		42.2	54.9	92.9	123.7				
	3050		46.8	61.0	103.1	136.6				
30	1525			37.1	61.5	83.4	117.6			
	2000			46.1	76.2	101.9	142.4			
	2700			59.4	97.9	129.1	178.9			
	3050			66.1	108.7	142.7	197.1			
35	1525				64.1	88.3	115.8	148.6		
	2000				79.7	107.6	141.4	181.4		
	2700				102.6	136.1	179.1	229.7		
	3050				114.0	150.3	197.9	253.9		
45	1525					96.9	127.1	157.1		
	2000					118.6	155.1	192.4		
	2700					150.7	196.4	244.3		
	3050					166.70	217.05	270.29		
60	1525							174.4	231.21	303.3
	1800							191.4	251.78	328.9
	2700							246.9	319.10	412.75

	3050		268.47	345.28	445.33
70	1525		183.5	240.31	312.46
	2000		212.8	275.84	356.68
	2700		256.0	328.20	421.85
	3050		277.58	354.38	454.44

Table 29: Weights of the column sets in kg. VN. model / design / type.

2.4.1.3 Shaft Enclosing Tube

Consult Design Office

2.4.1.4 Discharge Head (type VN) without Motor stool.

Discharge Head Type	VN 1342A	VN 1342	VN 1830	VN 2030	VN 2541A	VN 2541	VN 3051
Weight	88	84	80	88	165	165	170

Table 30: Weight of the Discharge Head (VN type) in kg

2.4.1.5 Thrust Bearing Assembly

Consult Design Office

2.4.1.6 Motor Stool

Consult Design Office

2.4.1.7 Bearings

Consult Design Office

2.4.2 Weight of complete Bowl assembly

Following weights are required for the calculation of axial thrust or for the installation.

2.4.2.1 Weight of pump Rotor Assembly

The complete weight of bowl assembly of 1st stage pump consists of unit weight of pump shaft, impellers, clamping sleeve and sand guard. Weight of the intermediate / column shaft is not included (see Figure 5)

Pump Size	6	7	8	10	12	14	16	18	20	22	24
1st Stage	2.4	3.8	5.8	10.3	17.2	29.1	38.5	54	67	80	94
Each Additional Stage	1.2	1.8	2.8	4.9	8.4	15.1	21.7	30.5	41	52	63

Table 31: Weight of Pump Rotor in kg

2.4.2.2 Weight of the Intermediate Shaft

The weight of the intermediate shaft is required only for the thrust bearing load. For the calculation of the total pump weight it is already included in the rising main. For pump rotor weight, see Table 31, in which the weight of the drive shaft is included.

Refer to Figure 5 which gives weights of the shaft in kg (depending on the length L_e)

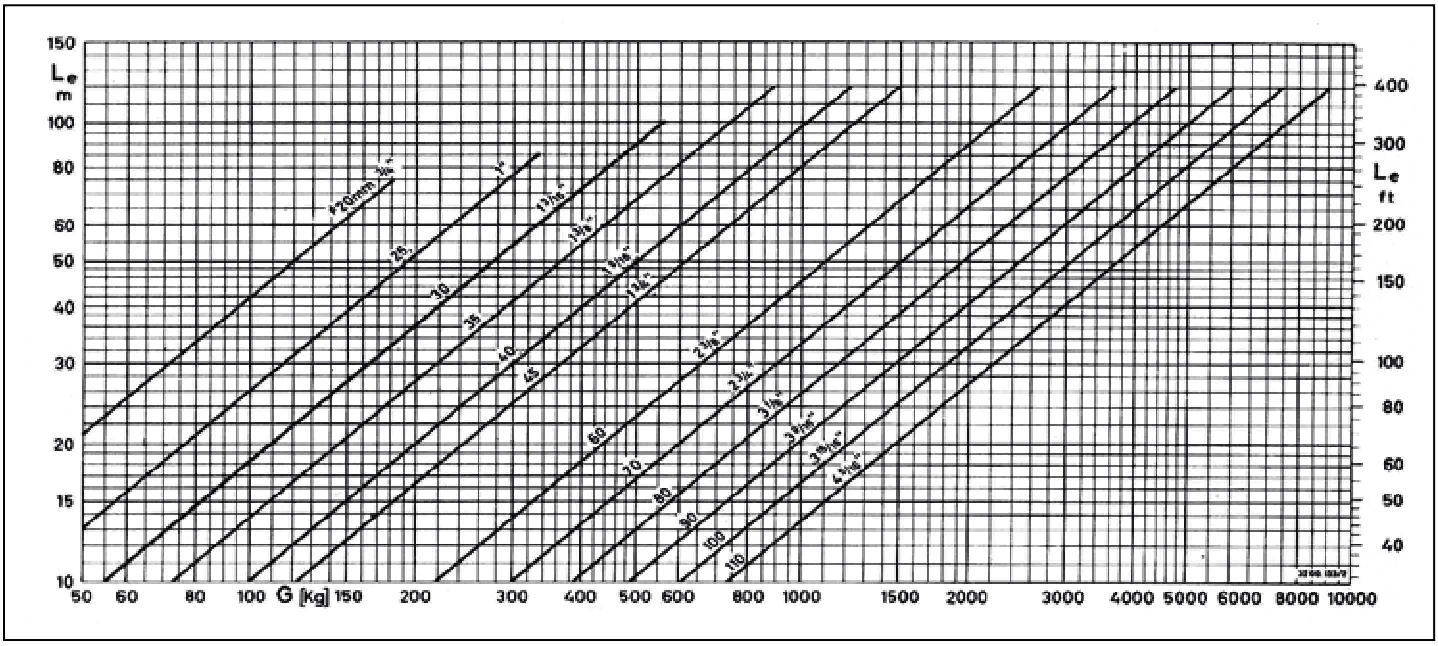


Figure 5: Weight of Column Shaft in kg, according to Column length L_e

2.4.2.3 Weight of the Pump Side (Flexible Coupling)

Size	**S0**	**S1**	**S1A**	**2BN**	**3BN**	**4BN**	**5BN**
Weight (kg)	2	3	6	9.5	15	30	58

Table 32: Weight of the pump side of the coupling half, according to HS 173

2.4.3 Weight of the Pumped Medium Filling

For static calculation of the base plate, the total aggregate weight of the pump with the filling medium is required.

For simplification, to measure the maximum possible weights from the drop down level to the suction strainer, generally the total volume of the medium filling the pumping unit is taken as a base. The submerged weight and the water thrust on the shafts are not considered.

The weight of the medium GF_g is calculated as follows:

I (dm^3) content of the complete pump aggregate (2.5.1)

γ (kg/dm^3) density of the pumping medium

2.5 Pump Filling Volume

2.5.1 Volume of the completely filled pump

The volume of the complete pumping unit consists of the total installation depth (including suction strainer) and the Nominal Diameter (NW) of the rising main. Pump assembly and the Discharge Head (VN) should be considered in addition to the Rising Main length. For the Discharge Head, 1 m column pipe length can be assumed. In Table 33 the content per running meter of the column line is given depending on NW.

NW	**80**	**100**	**125**	**150**	**175**	**200**
I (dm^3/m)	5.2	7.8	12.2	17.6	25.4	32.5
NW	**250**	**300**	**350**	**400**	**500**	
I (dm^3/m)	50.9	72.2	97.1	126	195	

Table 33: Content of the complete pumping unit in (dm^3/m), depending on the column line –NW

Example:

1. Bowl assembly

Pump without Suction Strainer

Discharge head Type VN

Rising Main NW 200

Installation depth = 10m (bottom of the suction casing)

I = (10+1) m x 32.5 dm^3/m = ~ 360dm^3

3 Construction (Design) Description

3.1 General

3.1.1 Type and Design

Complete pumping unit consists of pump, rising main, discharge head, suction pipe and/or suction strainer, foot valve. The axial thrust on Rotor and Intermediate shaft is taken care by provision of angular contact ball bearings (Thrust Bearings) provided in Discharge Head Assembly for V1 design while in ET (VHS) Design, the thrust bearings are provided in the VHS Motor. Each rising main set consists of Column Pipe, Bearing Spider with Rubber or Metal Bearing, Coupling (Threaded or Cone type) and intermediate shaft with shaft protecting sleeve.

3.1.1.1 Rotational Direction

Looking from the drive-end towards the pump, the rotational direction is counter-clock wise.

3.1.2 Arrangement and Installation

Installation is exclusively vertical. The pumping unit has been designed to suit outdoor Installation. The thrust bearings are sealed against the penetration of dust, sand, spray water etc through radial seal ring (bottom end and bearing cover at the top end) in thrust Bearing Assembly.

Discharge nozzle orientation is parallel to the axis of the shaft and is of:

VN Design: Discharge nozzle above ground on discharge head.

VU Design: Discharge nozzle below ground on the rising main (discharge tee pipe)

Irrespective of the discharge nozzle orientation (mentioned above) installation can be of following two types

Wet Installation

The pump stands completely or partially installed in the pumping medium up to the level of 1st stage impeller. The minimum submergence of the impeller of 1st stage should correspond to the measurement “B” (minimum submergence). In case there is a Suction Pipe attached with Suction Strainer then the water level can fall below the level of 1st Stage impeller. In this case care should be taken that the cavitation does not take place. For this the minimum medium level should be 1.0 x $NW_{suction\ casing}$ over the upper edge of the suction strainer.

Dry Installation

Dry pit installation is also possible for DWT under special condition. The supply line is connected with the suction casing through special foot elbow .A typical unit in dry installation is also called dry pit pump. For the minimum submergence, the same applies as in case of wet installation. Complete details can be provided on a case to case basis by the design department.

3.2 Pump Casing

Casing parts (suction casing, discharge casing and intermediate bowls) are vertically split with respect to the shaft. The individual casing parts are tightened together through Stud/Nut arrangement.

3.2.1 Suction Casing

The suction casing has a threaded connection for suction Pipe or suction strainer up to the sizes B16D. Flanged connections can also be provided on request.

From sizes B18 and above, the suction casing is available with flanged connection only. In suction casing bearings are also provided.

3.2.2 Intermediate Bowls

The number of Intermediate bowls is equal to the number of stages of the pump. The Intermediate bowls have hydraulic shrouds, to guide the flow from impeller to the outlet.

Each Intermediate bowl has a Rubber Bearing and a bowl sleeve.

3.2.3 Discharge Casing

Discharge casing has threaded as well as flanged connections depending upon the column set assembly. The internal hub takes up the pump bearing from the discharge side as well as the lowest shaft enclosing tube in certain cases.

3.3 Impeller

3.3.1 Impeller Type

Impellers are single suction, mixed flow (radial & axial). Up to size 16, impellers are fixed by providing a clamping sleeve and from size 18 and above impellers are fixed by providing a key, stage sleeve and nut on the pump shaft.

3.3.2 Casing Wear ring

Suction Piece and intermediate bowls are fitted with interchangeable casing wearing rings.

The material of the wearing ring has a difference of approx. 50 HBN less than the rotating part and therefore it tends to erode (for example stainless steel), hence it is required to increase the play of casing wear ring see 2.1.8.3.

3.3.2.1 Impeller – Entry Cross Sections

Pump Size	6	7	8		10			12			14		16		18	20	22	24
Impeller Type	B	B	B	D	B	D	F	B	D	F	B	D	B	D	B	B	B	B
Impeller cross section	26	38	50	76	83	115	148	118	176	210	160	263	210	327	286	429	527	536

Table 34: Impeller entry cross section in cm^2.

3.4 Shafts

Pump Shaft is always subjected to pump medium.

Intermediate Shaft: In standard design, Shaft Protecting Sleeve protects the shaft in the bearing area. In oil lubricated design, it is protected by shaft enclosing tube in which case oil acts as a lubricant.

There is no protection in the stuffing box region.

As special design the drive shaft is protected through a warm drawn up shaft-protecting sleeve in area of stuffing box packing.

3.4.1 Pump Shaft and Column Shaft Connection

Pump Size		6	7	8	10	12 , 14 & 16	18, 20. 22 24
Coupling	Threaded	20	20, 25	25, 30	25, 30, 35	25, 30, 35, 45	35, 45
	Cone			30	30, 35	30, 35, 45	45, 60, 70

Table 35: Possible column shaft connection on pump shaft in mm.

If the required diameter in design calculations for intermediate shaft is greater than the one given in Table 35, then there are two possibilities as far as the pump shaft is concerned.

Select complete shaft (including Top shaft) in better material. The smallest diameter to be fixed according to Table 13 and Table 14 (page 2-3)

Special design. Fix intermediate shaft diameter according to Table 13, Table 46 and Table 47 (page 3-13); and use reduced lower intermediate shaft diameter according to Table 35 in a better material (Examine according to Table 14)

3.4.2 Drive/Top shaft

In V1 design the top shaft passes through thrust bearing arrangement above the discharge head for taking up necessary axial thrust and in ET design (VHS drive) it passes through the motor's hollow-shaft and is coupled with the motor coupling.

BUA Bearing	**7309**	**7311**	**7312**	**7313**	**7314**	**7315**	**7316**
Shaft – Ø	25	33	33	33	38	43	38
Key [1)] b*h (mm)	8x 7	10 x 8	10 x 8	10 x 8	10 x 8	12 x 8	10 x 8
BUA Bearing	**7317**	**7318**	**7319**	**7320**	**7322**	**7324**	**7326**
Shaft – Ø	53	38	48	48	63	53	63
Key [1)] b*h (mm)	16 x 10	10 x 8	14 x 9	14 x 9	18 x 11	16 x 10	18 x 11

Table 36: Drive shaft and key on coupling seat in mm on the pump side.

1) Measurement according to DIN 6885

b = width of fitting key, h = height of fitting key

3.4.3 Shaft Protection

The intermediate and drive shafts are not protected against the medium. By the use of shaft enclosing tube only those shafts can be protected which lie above the maximum medium level. An adequate corrosion protection is possible only through selection of shaft material, which is resistant to medium.

3.5 Thrust Balancing

The impeller does not take up any hydraulic axial thrust. The hydraulic axial thrust and the complete rotor and intermediate shaft weight is taken up through a thrust bearing. The hydraulic axial thrust is internal thrust of the pump and does not limit the installation work.

3.6 Bearings and Lubrication

3.6.1 Bearing

There are 3 types of bearings which can be offered with B-Pump:

- Grease lubricated anti-friction bearing
- Medium lubricated guide bearings in pump and in the rising main.
- External water / oil lubricated plain bearing in the rising main.

3.6.1.1 Thrust Bearing Arrangement

The thrust bearing takes up the axial thrust directed towards suction side as well as the radial thrust. The thrust bearing with Angular Contact Bearings can also take up the additional axial force directed towards discharge side.

3.6.1.1.1 Axial Bearing Load

Thrust bearing shall be loaded through following components.

$P_{ax}\downarrow$ directed towards suction side

Weight of the intermediate / column shaft. Figure 5

Weight of the pump rotor. Table 31

Weight of the drive shaft.

Weight of the pump-side coupling half.Table 32

Hydraulic axial thrust of the pump (Figure 6 & Figure 7)

$P_{ax}\uparrow$ directed towards delivery side

$P_{ax}\uparrow = P_z \times F_{ws}$ (max intake pressure x shaft cross section)

$F_{ws} = d_{ws}^2 \times \pi/4$ (cm^2)

$P_{ax} = P_{ax} - P_{ax}$ (kg)

P_z (kg/cm^2) intake pressure

d_{ws} (cm) effective diameter in the shaft sealing

Hydraulic axial thrust can be seen by looking the pump head from operating point in meters against pump size.

As a rule the hydraulic axial thrust is directed towards the suction side of the pump. If the pump stands under intake pressure, which is higher than the atmospheric pressure the axial thrust directed toward suction side shall be relieved.

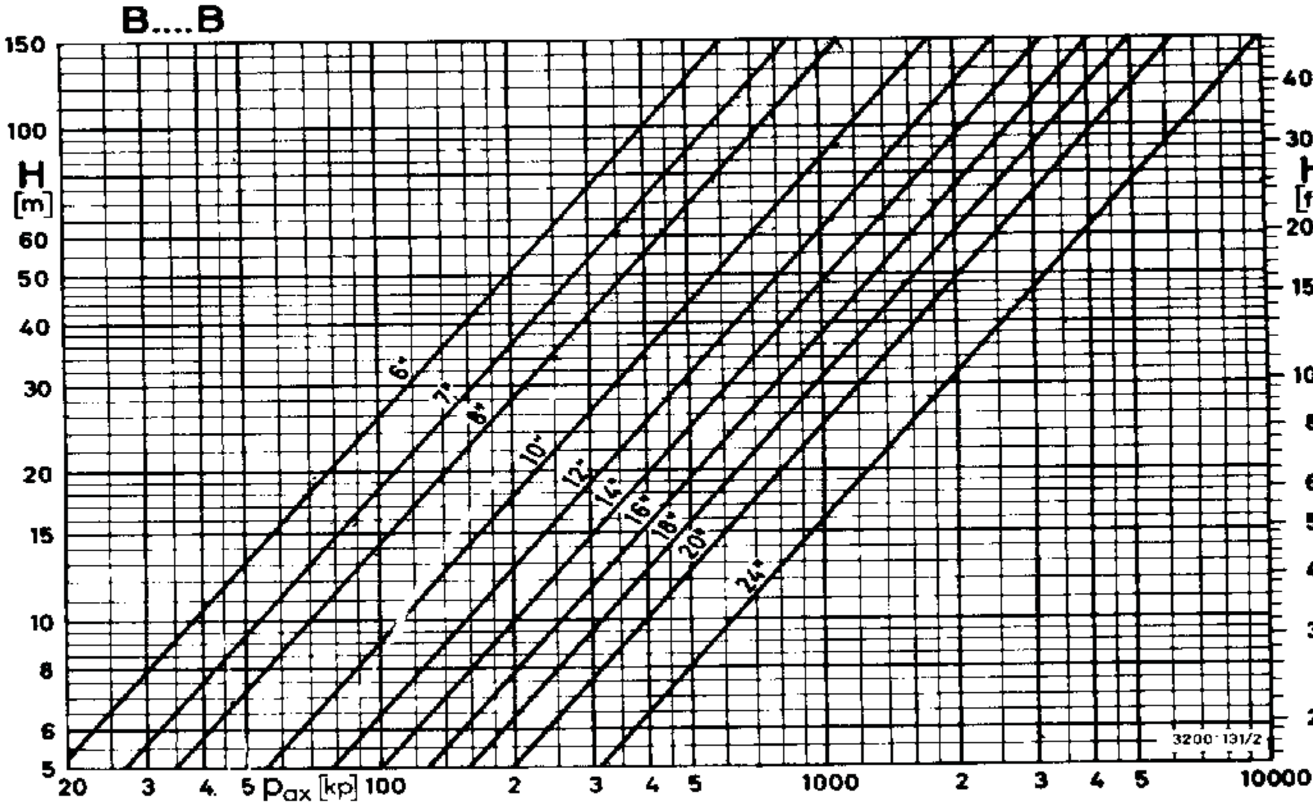


Figure 6: Hydraulic axial thrust P_{ax} in kg dependent on the total head at operating point for Impeller type B.

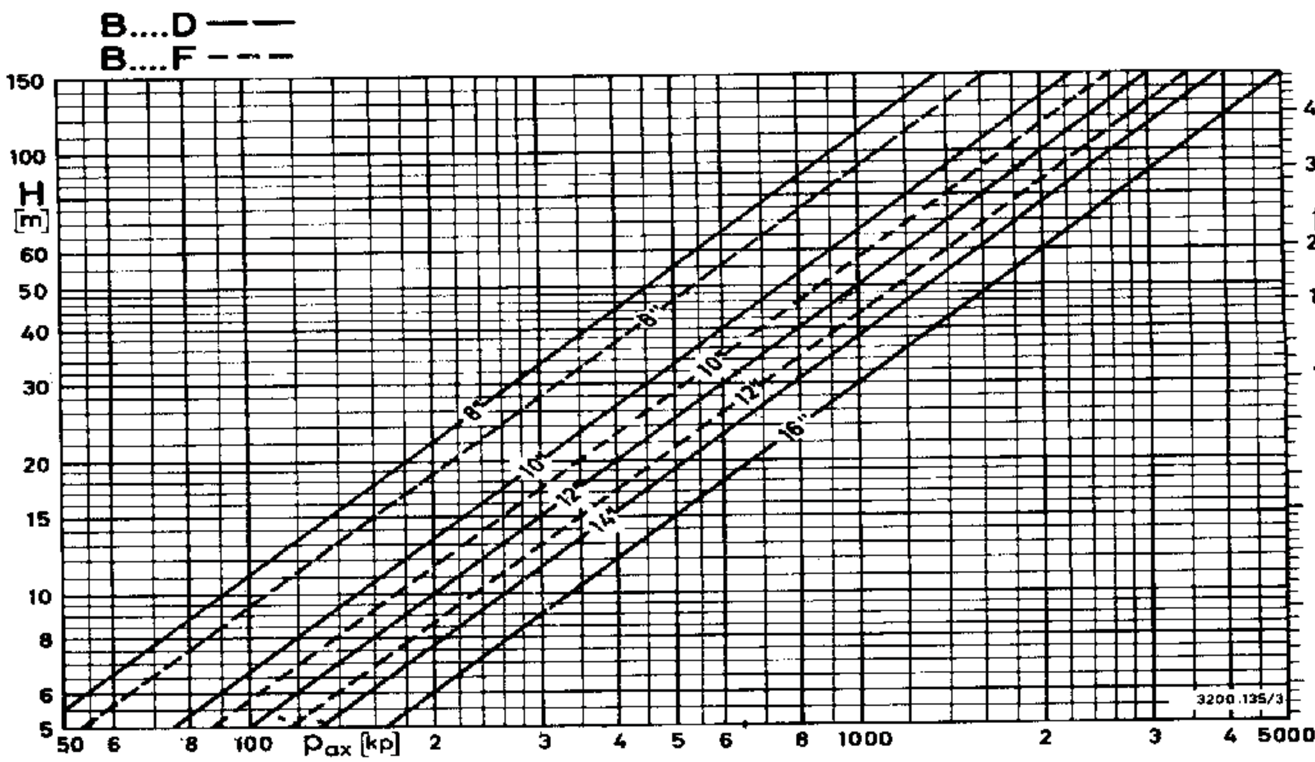


Figure 7: Hydraulic axial thrust P_{ax} in kg dependent on the head at operating point for Impeller type D and F

The diagrams are independent from the speed and size of impeller.

3.6.1.1.2 Selection of Bearing Stool

Consider speed limitations according to Table 9 & Table 10 Page 2-2.

a. Bearing according Table 11 for P/N limitation.

b. Check the admissible axial thrust of the bearing in O arrangement as well in tandem arrangement according to Table 37.

Discharge head size 8 (Exception: size 8 with 45 and 60 BUA) and larger (from 75 BUA)

a. Bearing according to Table 11

b. Checking of admissible axial thrust of bearing in O-arrangement as well in Tandem arrangement according to illustration 52.

		Bearing Type (BUA) Single Arrangement													
	RPM	**7309**	**7311**	**7312**	**7313**	**7314**	**7315**	**7316**	**7317**	**7318**	**7319**	**7320**	**7322**	**7324**	**7326**
P_{ax} Permissible	**1450**	7.686	10.833	12.149	13.736	15.124	16.909	18.182	19.454	20.992	22.645	25.802	28.612	30.264	31.917
	1740	7.240	10.205	11.445	12.939	14.247	15.928	17.128	18.327	19.775	21.332	24.306	26.953	28.51	30.067
	2900	6.244	8.802	9.870	11.16	12.288	13.738	14.773	15.807	17.056	18.399	20.964	23.247	24.59	25.933
		Bearing Type (BUA) Double (O & X) Arrangement													
	RPM	**7309**	**7311**	**7312**	**7313**	**7314**	**7315**	**7316**	**7317**	**7318**	**7319**	**7320**	**7322**	**7324**	**7326**
P_{ax} Permissible	**1450**	12.397	17.546	19.835	22.123	24.793	26.954	29.116	32.913	34.329	36.363	41.322	46.280	49.587	51.239
	1740	11.678	16.528	18.685	20.841	23.356	25.392	27.428	30.063	32.339	34.256	38.926	43.598	46.712	48.269
	2900	10.072	14.256	16.116	17.975	20.144	21.900	23.657	25.230	27.892	29.545	33.574	37.603	40.289	41.632

Table 37: BUA – Bearing permissible axial thrust kN for single and double bearing installations.

3.6.1.1.3 Area of Usage

Bearing Type	Pump Size
7309	6, 7, 8, 10, 12
7311	6, 7, 8, 10, 12
7312	6, 7, 8, 10, 12
7313	6, 7, 8, 10, 12, 14
7314	6, 7, 8, 10, 12, 14
7315	6, 7, 8, 10, 12, 14,16
7316	6, 7, 8, 10, 12,14, 16, 18
7317	6, 7, 8, 10, 12,14, 16, 18
7318	6, 7, 8, 10, 12,14, 16, 18
7319	6, 7, 8, 10, 12,14, 16, 18
7320	14, 16,18,20,22,24
7322	14, 16, 18,20,22,24
7324	14,16, 18, 20,22,24
7326	16, 18,20, 22,24

Table 38: Possible bearings for different pump size

3.6.1.1.4 Bearings Temperature

The permissible bearing temperatures amount to the following by a temperature of the liquid t ≤ 105°C and a surrounding temperature of 20°C:

Bearing:

7309-7315 60°C[1)] 7316-7326 70°C[1)]

1) Measured at the outer wall of the bearing cover

In case the operating conditions demand higher temperatures then the bearing temperatures can be increased by 10°C Maximum.

3.6.1.2 Pump Bearing

Bearings provided in the pump are guide bearings (plain bearings). They can not take up the axial forces. Bearing of the suction side is provided in suction casing and is medium lubricated.

The bearing of the delivery side is fitted in the discharge piece, with the exception of B20, B22 with intermediate shaft > 60 and B24 with intermediate shaft > 80. In those case, a bearing spider is fitted in the discharge piece.

3.6.1.3 Bearing Clearance

The bearing clearances given in the following section refer to the diameters of the bearings and shafts and are for new components.

3.6.1.3.1 Pumps

Pump size				**6 – 8**	**10 – 12**	**14 – 16**	**18**	**20**	**22 – 24**
Suction casing	M	Clearance	Min.	0.065	0.080	0.105	0.130	0.130	0.130
			Max.	0.228	0.279	0.290	0.350	0.350	0.280
Pump bowl	G		Min.	0.200	0.200	0.340	0.350	0.370	0.336
			Max	0.383	0.389	0.730	0.740	0.790	0.571
Delivery casing	M		Min.	0.065	0.080	0.130	0.130	0.130[1)]	0.130[2)]
			Max.	0.228	0.279	0.234	0.234	0.234	0.280

Table 39: Clearance of pump bearing in mm

M = metal, G = rubber

1) for intermediate shaft > 60 Ø Bearing

2) for intermediate shaft > 80 Ø

Bearing play according to intermediate shaft

3.6.1.3.2 Rising Main

a. Standard design (medium lubricated) - without shaft enclosing tube

Intermediate shaft – Ø			**20**	**25**	**30**	**35**	**45**	**60**	**70**
Rubber bearing	Clearance	Min.	0.31	0.32		0.33	0.34	0.35	
		Max	0.59	0.63		0.64	0.73	0.74	
Metal bearing		Min.	0.080	0.100			0.120		
		Max	0.146	0.178			0.212		

Table 40: Clearance of the intermediate shaft bearing in mm (Rising main without shaft enclosing tube)

b. Special Design (External Lubrication) – with Shaft enclosing tube

Intermediate shaft – Ø			**20**	**25**	**30**	**35**	**45**	**60**	**70**
Metal bearing [1)]	Clearance	Min.	0.065			0.080		0.100	
Oil lubrication		Max	0.150			0.181		0.220	
Rubber bearing [2)]		Min	0.31	0.32		0.33	0.34	0.35	
External water lubrication		Max	0.59	0.63		0.64	0.73	0.74	

Table 41: Clearance of the intermediate shaft bearing in mm (rising main with shaft enclosing tube)

1) Shaft without shaft protecting sleeve
2) Shaft with shaft protecting sleeve

3.6.1.3.3 Bearing

Angular Contact Bearing

Bearing with the suffix “UA” is for coupled arrangement through Tandem arrangement and the load distribution is even. In O-arrangement a bearing is coupled without clearance.

3.6.1.4 Friction Losses

Friction losses in thrust bearings and radial bearings in the pump can be ignored. For losses in column pipe, refer to 3.8.5.4.6

3.6.2 Thrust Bearing Arrangement

3.6.2.1 Lubrication

Selection of suitable lubricant depends on the operating conditions i.e.; speed, ambient temperature and operating temperature.

For the selection, the bearing manufacturer’s manual shall be consulted. For special cases, the information can also be taken from lubricant manufacturers.

3.6.2.1.1 BUA- Bearing Arrangement

For lubrication of the bearing, grease that has metal soaps as thickener and mineral oils as base are used.

Lithium soap greases are suitable which are remarkable for resistance to temperature and are slightly water sensitive. For higher temperatures and water entry these greases are preferred.

They should have the following characteristics.

Drop point not under 160°C

Worked penetration by 25°C 265 to 295mm/10mm

3.6.2.1.2 Re lubricating and Lubricating Time

BUA- Bearing Bracket

Re-greasing depends on the bearing size and lubricating time

a. 1st Lubrication after 24 operating hours with three-fold grease quantity from the Table 42.

b. 2nd Re-lubrication after further 24 operating hours with three-fold grease quantity from the Table 42

c. Regular re-lubrication after 800 operating hours with the normal grease quantity.

Bearing Arrangement		**7309**	**7311**	**7312**	**7313**	**7314**	**7315**	**7316**	**7317**	**7318**	**7319**	**7320**	**7322**	**7324**	**7326**	**7330**
Initial Fill (grams)	O	260	260	390	390	390	900	900	900	900	900	900	900	900	900	900
	T	300	300	450	450	450	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Re-Lubrication (grams)	O	35	35	50	50	50	80	80	80	80	80	80	80	80	80	80
	T	50	50	70	70	70	100	100	100	100	100	100	100	100	100	100

Table 42: Required Grease Quantity in grams

O = O arrangement, T = Tandem arrangement

3.7 Shaft Sealing

3.7.1 Stuffing Box Packing

Stuffing box packing is fitted in the discharge head.

Stuffing box pressure reduces with increase in installation depth, height of the rising main and the head loss because of the frictional losses in the rising main.

VSM-Stuffing box

Application of lantern ring is recommended only when it is required to prevent air from entering in the stuffing box zone during stand still of the pump.

Sealing water quantity can be adjusted according to packing condition and lie between 30 and 200 dm^3/h with a water pressure of 1-3 kg/cm^2. In the sealing water pipeline non-return valve should be installed so that during operation of the pump stuffing box pressure variant/ change does not let the packing ring run dry.

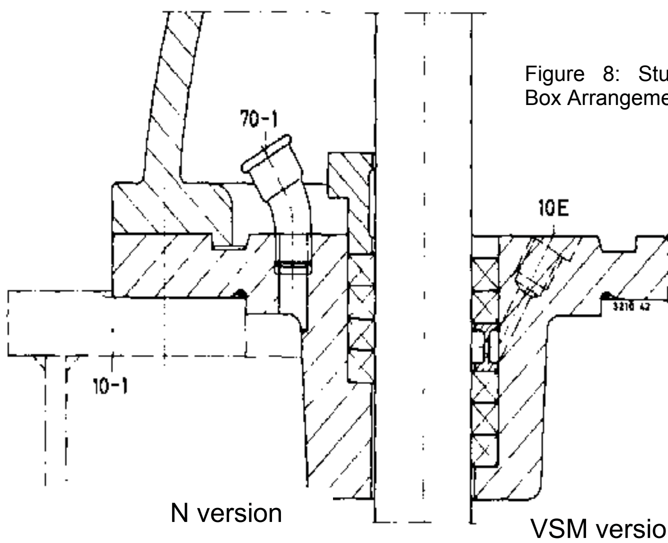


Figure 8: Stuffing Box Arrangement

3.7.1.1 3.7.1.2 Packing Material

Material of the packing ring must be selected according to the pump media and its temperature. Use only specified gland-packing material/make. In the following table few packing types are mentioned.

Designation	Manufacturer	Operating Temp.
Buraflon/5846	Burgmann	Water t ≤ 105°C
Araflon/6426	Burgmann	
Isaraflon/3435	Burgmann	
Thermoflon/6230	Burgmann	

Table 43: Packing materials

3.7.1.2 Friction Losses

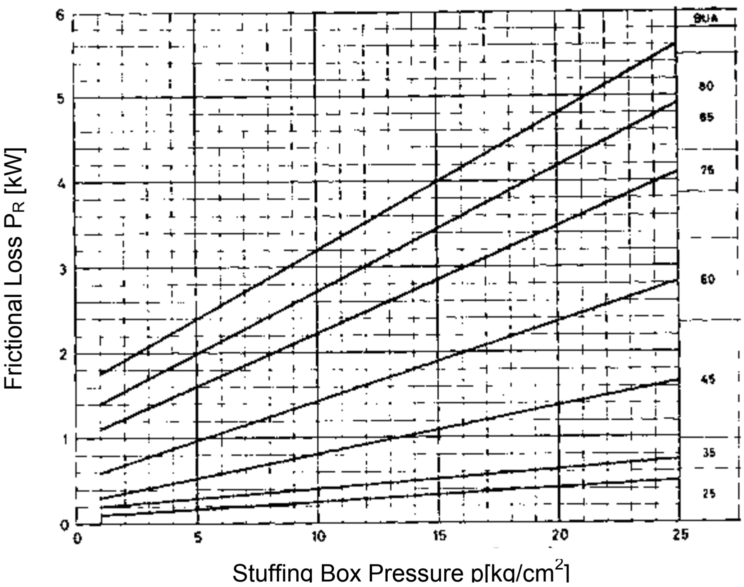


Figure 9: Friction performance depending on the stuffing box pressure at 1450 rpm.

The frictional losses in Stuffing Box Zone can be calculated according to figure 7. Friction Performance P_R given corresponds to 1450 RPM. For other speeds, it must be converted accordingly.

Example:

n = 2900 rpm; 45 BUA, Stuffing Box pressure 10 kg/cm2

P_R = 2900/1450*0.8 = 1.6 kW

3.7.1.3 Leakage Water

There is a leakage of medium in the Stuffing Box Zone. Its quantity depends on the stuffing box pressure, type of packing, packing material, pump speed, situation of the packing (wear) as well as the pump medium. Specification of a leakage quantity is therefore not possible. Leakage should however be at least 6 dm^3/h.

3.8 Drive

3.8.1 Types of drive

1. V1 Electric motor, V1
2. Hollow shaft motor, ET
3. Hollow shaft bevel gear drive, KT
4. Hollow shaft motor with hollow shaft bevel drive, EK (combination drives)
5. Diesel Engine via flat belt – Belt Head Drive (RT)

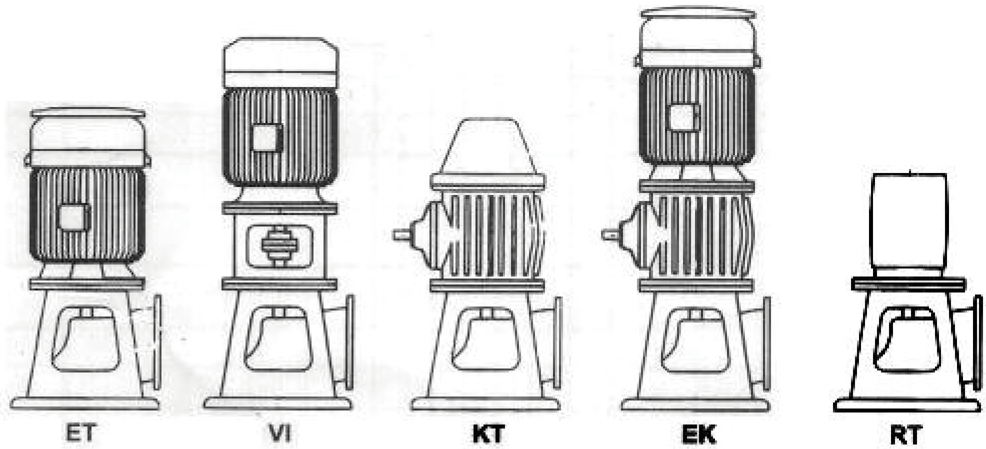


Figure 10: Type of Drives

In hollow shaft drive the axial thrust of the pump (see 2.4.2) is taken up by the motor bearing. Gear drive arrangement can be adopted for driving the vertical turbine pumps through electric motors and diesel engines or as combination drives.

For diesel engine installations it is to be ensured that pump and the engine should be installed on separate foundations. The minimum distance of both the shaft extensions should not be less than 1 meter. Universal joint Cardon Shafts can be used for coupling.

3.8.1.1 Driver Power Requirement / Reserve

Power requirement shall be determined from the operating point of the pump, friction losses through shaft sealing (illustration 66) are still to be added. The minimum power rating of the drive shall conform to the following limitations of performance.

For smooth performance requirement

Up to 25 kW min. 20%

From 25-75 kW min. 15%

Over 75 kW min 10%

3.8.2 Couplings

3.8.2.1 Fixed Coupling – Intermediate Shaft

Shaft Diameter	**20**	**25**	**30**	**35**	**45**	**60**	**70**
Cone Coupling							
Threaded Coupling							

Table 44: Coupling Types for various Intermediate shaft diameters

3.8.2.1.1 Switching Frequency

Maximum Power transfer of the cone coupling (see 2.1.6.2) is measured for constant operation of the pump. The transferable efficiency diminishes to:

- 0.8 times from the given values by 2-10 switching /day
- 0.5 times from the given values by 10-50 switching /day

Higher switching number should be avoided.

No restriction exists for threaded couplings.

3.8.2.1.2 Reverse Safety

For Threaded coupling designs, a Non Reverse arrangement (Back Stop Unit) is provided so that the threaded couplings do not loosen by reverse rotation. Hollow shaft motor and hollow shaft bevel drive have built-in non-reverse ratchets, V1 Design Motors do not have this arrangement. Before coupling the motor the direction of rotation shall be observed.

3.8.2.2 Flexible Coupling

Coupling types according to HS 173 for Elastic Couplings shall be used. The pump side shaft diameter for the coupling to be considered according to illustration: 49. Other coupling types are also possible.

Switching frequency according to manufacturer's specification.

3.8.3 Motor Stool and Discharge Head

3.8.3.1 Motor Stool for V1 motors

Motor Stools can be categorized according to the following:

VN = Discharge nozzle above ground

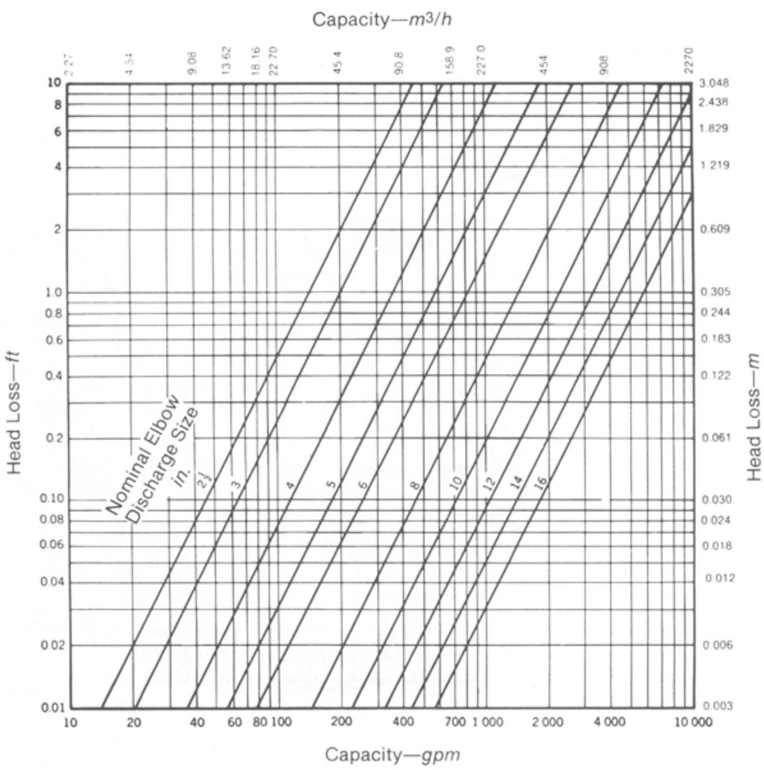
VU = Discharge nozzle below ground

Motor Stool for V1 motor are steel fabricated with bearing casing including thrust bearing to take up the axial thrust and weight of the rotating parts.

Motor Stool sizes are classified according to IEC-Frame reference of motors (DIN 42 676/77). For motors other than IEC-Frames, special design motor stool are fabricated. Shaft seal is provided in discharge head.

The base plate is quadratic for VN type discharge head and motor stool. Discharge Head and Motor Stool are separate basically and are fastened together through stud/nut arrangement. For standard type the design pressure of discharge head is 24.5 bar. The discharge flange is generally according to BS 10 Table 'D'. Discharge Flange can also be provided as per following standards:

- ANSI B 16.5
- DIN 2533 ND 16



3.8.3.2 Discharge Head for Hollow shaft motors and gear units

Discharge head for hollow shaft motor is made of grey cast iron GG-25. In VN type, the motor is directly mounted on the Discharge head. The discharge pressure is 16 kg/cm^2. The discharge flange is according to BS 10 Table 'D'. Discharge Flange can also be provided as per following standards:

- ANSI B 16.5
- DIN 2533 ND 16

Discharge head selection and measurements according to 4.1.3.6.1, Table 56, Figure 36, Figure 37, Figure 35, Figure 38

3.8.3.3 Discharge Head Losses

The losses in the discharge head can be calculated from following figure:

Figure 11: Discharge Head Losses

3.8.4 Safety against Reverse Rotation.

Hollow shaft motors and drives are always provided with non-reverse ratchet. It protects the pump from reverse rotation (Turbine operation) as a result of the back flow of the water filling present in the rising main.

3.8.5 Rising Main

The price of rising main is a major part of the total price of the pumping unit of DWT. Therefore the selection of the rising main must be done very carefully. Following points have to be considered while selecting the rising main.

- Discharge Flow of the pump
- NW (nominal diameter) of the discharge casing (compare Table 47)
- Intermediate shaft diameter (compare Table 13, Table 42 and Table 50)

3.8.5.1 Design Types of Rising Main

There are following design types

FG MG

FGS MGS

FMS MMS

It means

1. F = Flange
2. M = Socket
3. G = Rubber bearing
4. M = Metal bearing
5. S = Shaft protecting sleeve

FG and MG are standard types, all the other are special types.

3.8.5.2 Bearing Spider- Bearing in Rising Main

Numbers of bearing spiders in all sizes are equal to the number of intermediate column pipes.

Exceptions:

In B20 and higher, where shaft diameter is greater than 60mm the number of bearing spider is equal to the number of intermediate columns pipes plus one. The top column pipe is not counted in the total number of columns.

3.8.5.2.1 Bearing Types / Lubrication / Shaft Protection

Bearing	**Lubrication**	**Shaft Protection**
Rubber	With pumped media (Standard)	Shaft protecting sleeve in 1.4301
Metal	Oil: with shaft enclosing tube	Shaft protecting sleeve in 1.4301
	Water: with shaft enclosing tube	Shaft protecting sleeve in 1.4301

Table 45: Bearing type, lubrication and shaft protection.

Rubber bearing containing the support shell, the shaft-protecting sleeve shall is shrink-fitted by heating, on the shaft.

3.8.5.2.2 Bearing Lubrication

1. Pumped fluid

Rubber bearings are lubricated by the pumping medium. Rubber bearings have no dry running protection. It is therefore necessary to lubricate the rubber bearings before starting of the pump through pre-lubrication arrangement provided in the pump. After a long non-operational time, pre-lubrication of the bearing is necessary. For that a container measuring 50 dm^3 is provided at the height of motor stool.

2. Outside / External Lubrication.

Rubber bearings in shaft enclosing tube are lubricated through outside water. If outside water is not available, a filtered pumping medium can be used instead for lubrication of the bearing.

3. Oil

The metal bearing in the shaft enclosing tube are lubricated by oil from the oil tank with a solenoid valve to control the flow of the oil.

3.8.5.2.3 Friction Losses

According to Figure 12, Friction Performance PR_{St} in kW/100 meters shaft length. Values given are for 3050 mm shaft length. For others, multiply the values in relation to the selected set length (see example)

Example:

Shaft 30 φ mm, setting length 1600 mm, speed 1500 RPM

PR_{St} = 1.55 x 3050 / 1600 = 2.95 (kW/100m)

Double the value in types with shaft enclosing tube.

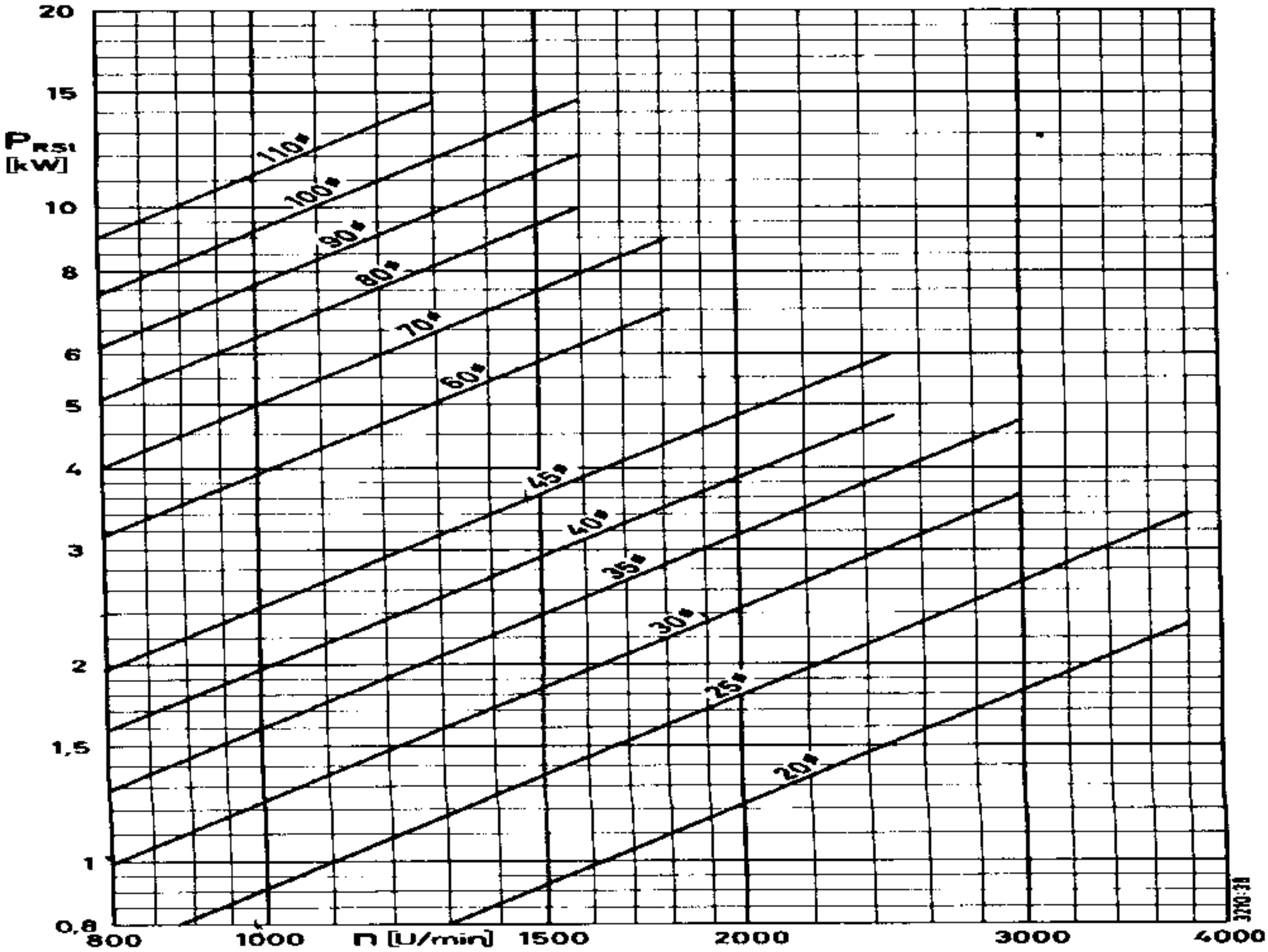


Figure 12: Friction losses in kW/100 m shaft length.

3.8.5.3 Intermediate Shaft

3.8.5.3.1 Determination of Diameter

For intermediate shaft diameter carried out according to Table 13. The motor rated output is taken 1.3 times that of pump output.

Through material selection the performance can be influenced very strongly (see Table 14). For selection of cone coupling consider the admissible switch frequency (3.8.2.1.1)

3.8.5.3.2 Possibilities of Installation

Column pipe		Column pipe						
mm	inch	20	25	30	35	45	60	70
80	3	○ ●	○ ●	○	○			
100	4	○ ●	○ ●	○ ●	○			
125	5	○ ●	○ ●	○ ●	○ ●	○		
150	6	○ ●	○ ●	○ ●	○ ●	○ ●		
175	7		●	○ ●	○ ●	○ ●	○	
200	8		●	○	○ ●	○ ●	○ ●	
250	10			○	○ ●	○ ●	○ ●	○ ●
300	12				○ ●	○ ●	○ ●	○ ●
400	16						○ ●	○ ●
500	20						○	

Table 46: Connection between column pipe diameter and possible shaft diameter of the intermediate shaft.

o- open shaft ●- shaft inclosing tube

3.8.5.4 Installation depth

3.8.5.4.1 Possible Column Pipe Connection

Type Size	Thread Execution (in inches)									Flanged Execution (in mm)										
	3	4	5	6	7	8	10	12	14	80	100	125	150	175	200	250	300	350	400	500
B6B																				
B7B																				
B8B																				
B8D																				
B10B																				
B10D																				
B10F																				
B12B																				
B12D																				
B12F																				
B14B																				
B14D																				
B16D																				
B18B																				
B20B																				
B22B																				
B24B																				

Table 47: Possible Column Pipe connection with Pump Bowl Assembly

3.8.5.4.2 Maximum Installation Depth

Diameter of shaft (mm)	**20**	**25**	**30**	**35**	**45**	**60**	**70**
Max. installation depth (m)	75	85	100	120	120	120	120
Max. Installation depth (ft)	250	275	325	395	395	395	395

Table 48: VN type maximum installation depth in m depending on the diameter of the intermediate shaft in mm.

With rotations of 2 pole electric motors the maximum installation depth is 50 m.

Column pipe Dia (mm)	**Up to 100**	**125-200**	**> 200**
Max. installation depth (m)	35	30	25

Table 49: VU- type maximum Installation depth in m depending on the diameter of the intermediate shaft in mm.

3.8.5.4.3 Set Length of the Normal – Rising Pipe

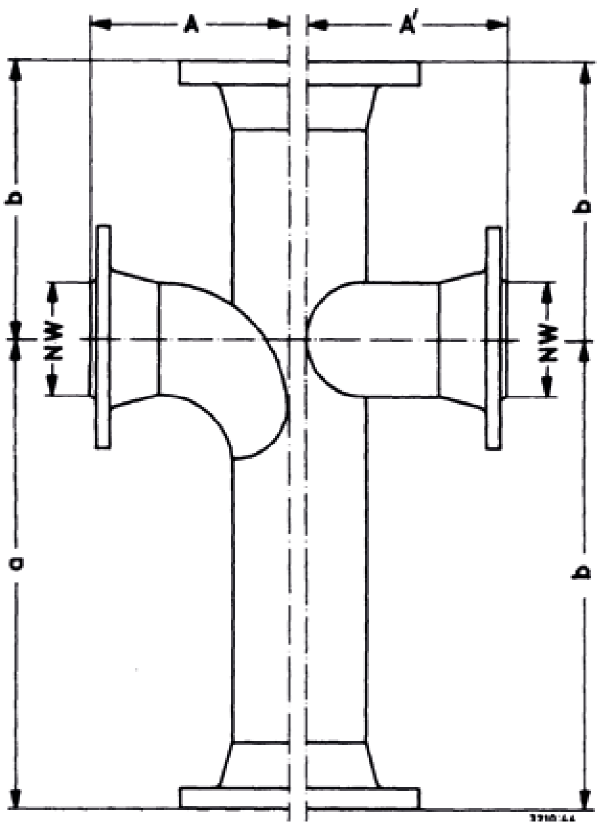
<table>
<tr><td colspan="2" rowspan="2">Length of the set</td><td colspan="7">Diameter of Intermediate Shaft in mm</td></tr>
<tr><td>20</td><td>25</td><td>30</td><td>35</td><td>45</td><td>60</td><td>70</td></tr>
<tr><td rowspan="3">1525</td><td>Coupling</td><td colspan="2">G</td><td colspan="2">K, G</td><td>K, G</td><td colspan="2"></td></tr>
<tr><td>Lubrication</td><td colspan="5">E</td><td colspan="2"></td></tr>
<tr><td>Max. rotation RPM</td><td colspan="5">1800</td><td colspan="2"></td></tr>
<tr><td rowspan="3">2000</td><td>Coupling</td><td colspan="2">G</td><td colspan="2">K, G</td><td colspan="3"></td></tr>
<tr><td>Lubrication</td><td colspan="4">E, F</td><td colspan="3"></td></tr>
<tr><td>Max. rotation RPM</td><td colspan="3">3600 1)</td><td>3000 1)</td><td colspan="3"></td></tr>
<tr><td rowspan="3">3050</td><td>Coupling</td><td colspan="2">G</td><td colspan="2">K, G</td><td colspan="2">K, G</td><td>K</td></tr>
<tr><td>Lubrication</td><td colspan="6">E, F</td><td>E</td></tr>
<tr><td>Max. rotation RPM</td><td colspan="4">2200</td><td colspan="3">1800</td></tr>
</table>

Table 50: set length of normal rising pipe, dependent from intermediate shaft diameter, coupling & lubrication type and max admissible speed

K = Cone Coupling E = Own Lubrication = without Shaft enclosing tube = 1 Bearing / Column Pipe Set

G = Thread coupling F = Outer Lubrication = with Shaft enclosing tube = 2 Bearing / Column Pipe Set

1) from 2200 rpm



3.8.5.4.4 Set length of Upper Rising Pipe

For different installation depths following lengths for top column pipe sets are available.

Length	**300**	**600**	**900**	**1200**

Table 51: Top Pipes (Measurements in mm)

Speed limitation can be seen from the Table 10. For the coupling selection refer to 2.1.6.3. Lengths smaller than 300 mm as well as larger than 1200 mm are not possible. Lengths other than standard sizes come under special design production program and must therefore be avoided. If there is a requirement of exact setting depth then the addition of suction pipe is recommended for obtaining exact setting depth.

3.8.5.4.5 Discharge Tee Pipe (VU-type)

Discharge tee pipes are used in between the setting of normal and upper rising pipe set lengths. Because of the welded sockets, certain minimum dimensions are to be observed.

Figure 13 specifies minimum dimensions for the distance between center line (vertical) of the pump and the discharge tee pipe flange as well as overhang of the discharge support. Table 52 gives the dimensions of the discharge tee pipe for B-Pump.

If customer's requirements are not available, then for standard discharge pipe of 1200mm length, the standard value for dimension 'b' is 500mm.

Figure 13: Discharge tee pipe

The discharge tee pipe is always positioned as the last/upper-most column pipe (below top pipe) in the rising main. If the discharge position requirement is deeper, then column can be added in between the top pipe and the discharge pipe. In this case it must be noted that pump assembly is not pushed out of the position due to discharge piping force and heat expansion otherwise it can even lead to break down of the pump. In addition to this, for deeper discharge setting, it should be made sure that the bearings above the discharge pipe are properly lubricated and protected against dry running, especially in free-delivery systems.

Nominal Diameter (mm)											
80	**100**	**125**	**150**	**175**	**200**	**250**	**300**	**350**	**400**	**500**	
270	300	370	410	470	530	550	630	630	Contact Design Dept.	Contact Design Dept.	**a**
170	190	210	220	250	260	290	290	310			**b**
210	250	280	320	370	440	510	590	460			**A**
220	240	250	290	310	370	410	440	410			**A'**

Table 52: Discharge Tee Pipe Dimensions

3.8.5.4.6 Column Pipe Friction Losses

For shafts without shaft enclosing tube, and length of rising pipe 1200, 1600 and 2100 mm see Figure 14. For shaft without shaft enclosing tube and rising pipe length of 3050 and 2000 mm Figure 15. For shaft with shaft enclosing tube and length rising pipe 3050, 2100, and 2000 mm see Figure 18.

The column pipe line losses should be maintained between 1 and 10 meter per 100 meters column pipe length. The upper limits are only allowable when setting depths are 10 meters or more.

The column pipe connection combinations can be seen from the dimension tables.

3.8.5.4.7 5 ft long column friction losses (Open Line Shaft Design)

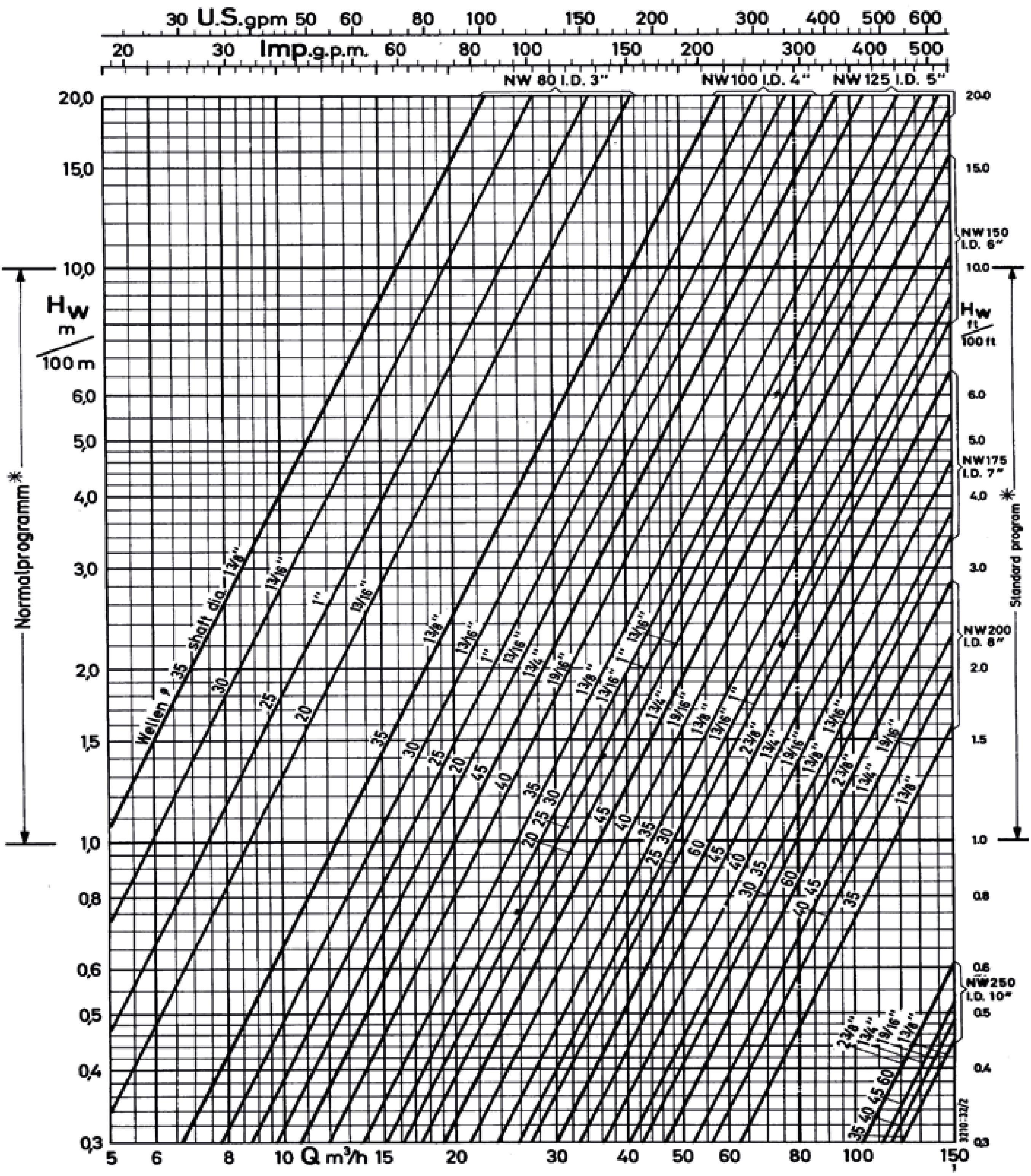


Figure 14: Column Pipe Friction Losses without Shaft Enclosing Tube (1200, 1600, 2100)

The values are applicable for set lengths of 1200 mm (shafts ø 30 to 110 mm). Table values are to be multiplied by 1.2, for set lengths of 1600 mm with shafts of ø 20, 25, 30, 35, and 45 mm and for set lengths of 2100 mm with shafts ø 60, 70mm.

3.8.5.4.8 5 ft long column friction losses (Open Line Shaft Design)

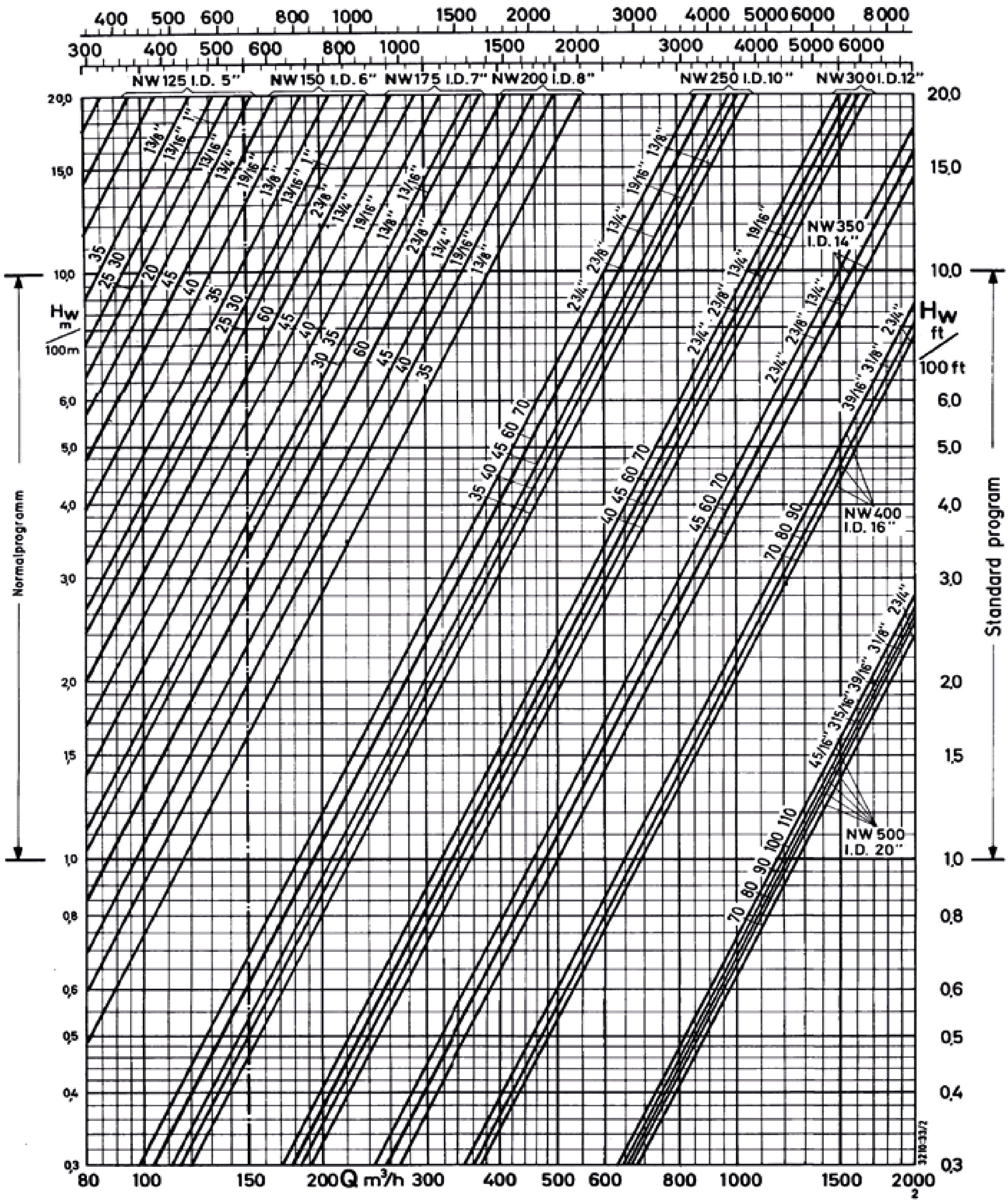


Figure 15: Column Pipe Friction Losses without Shaft Enclosing Tube (1200, 1600, 2100) Higher Q.

3.8.5.4.9 10 ft long column friction losses (Open line shaft version)

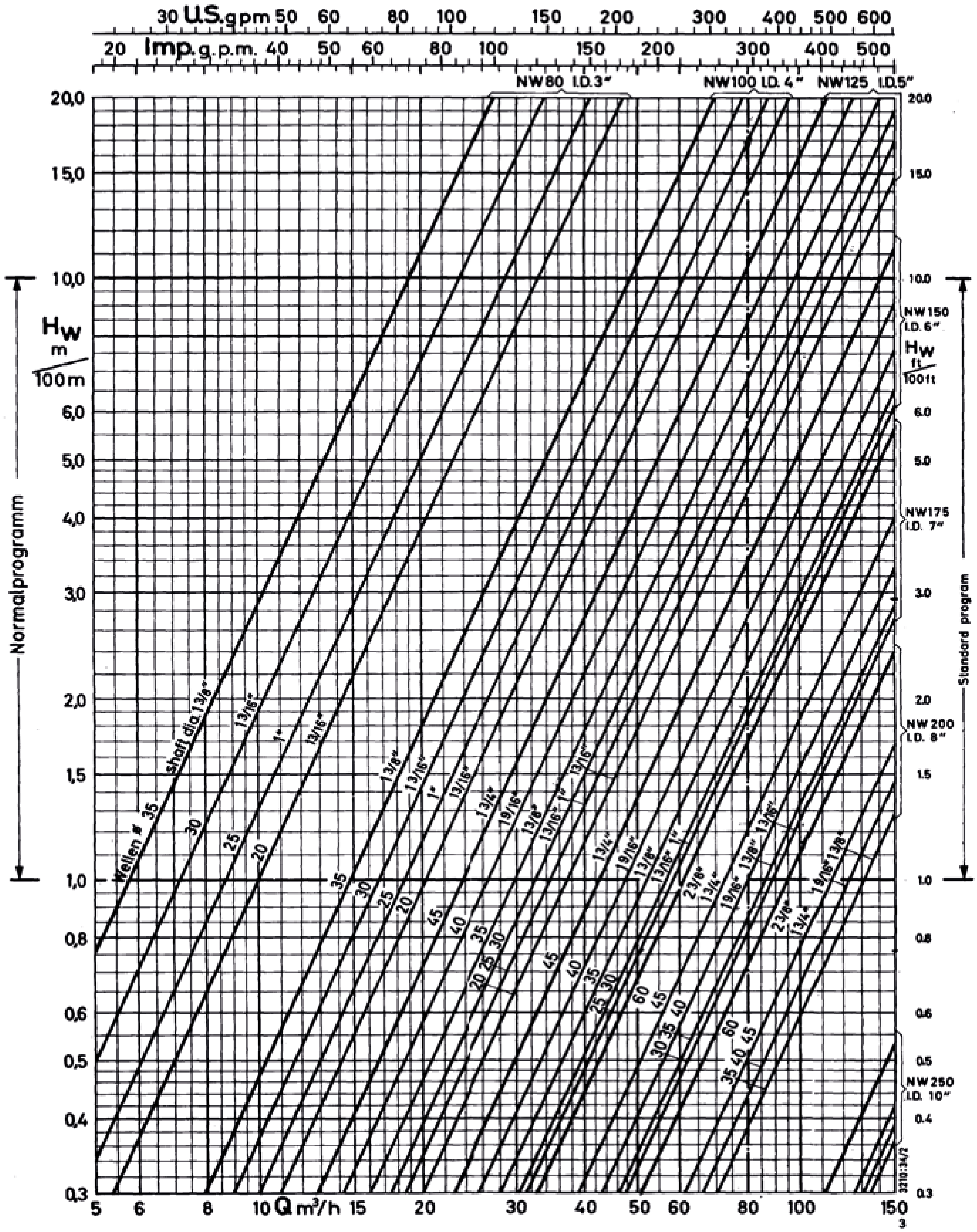


Figure 16: Column Pipe Friction Losses without Shaft Enclosing Tube (3050 mm)

3.8.5.4.10 10 ft long column friction losses (Open line shaft version)

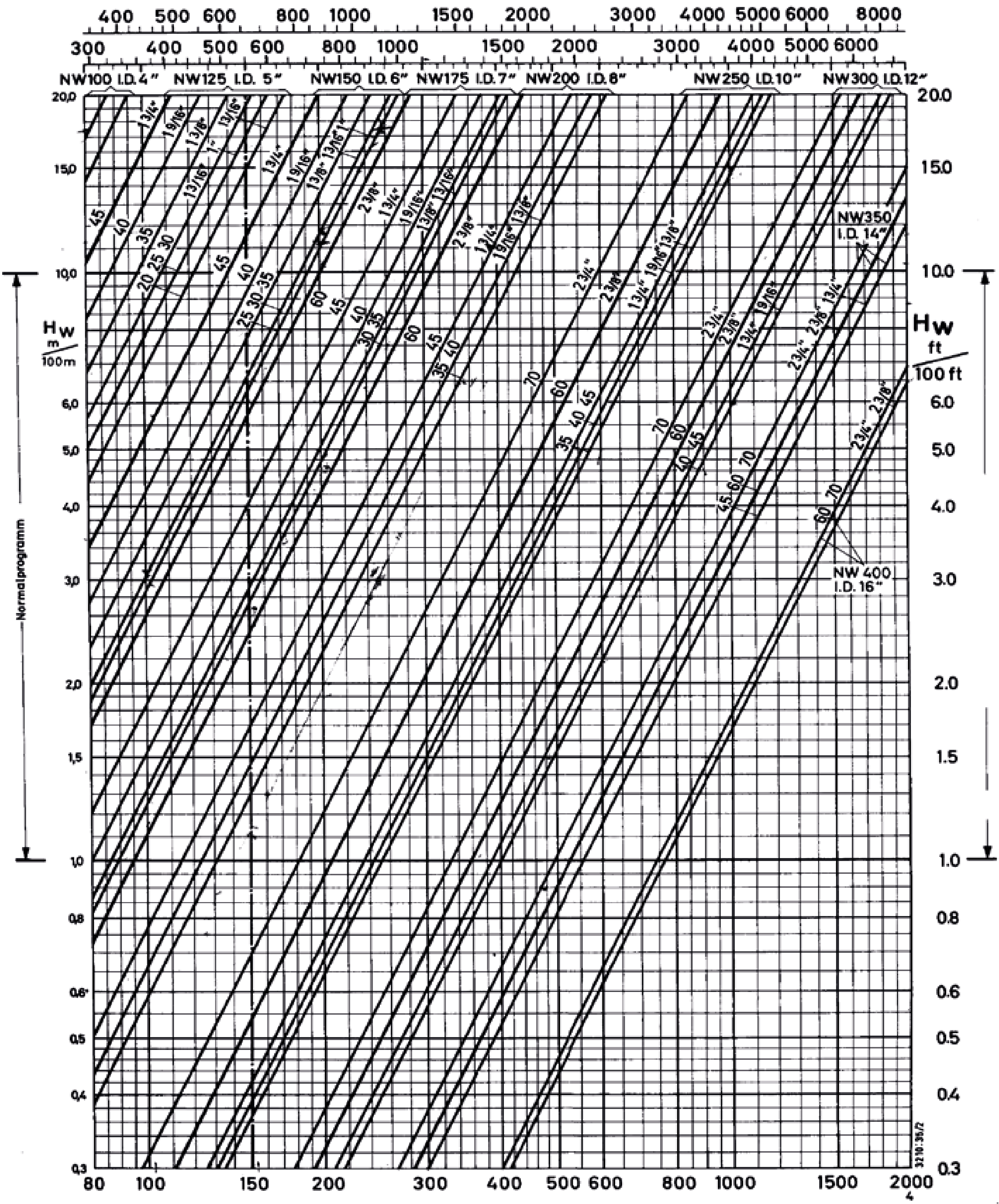


Figure 17: Column Pipe Friction Losses without Shaft Enclosing Tube (3050 mm) Higher Q

3.8.5.4.11 10 ft long column friction losses (With Shaft enclosing tube)

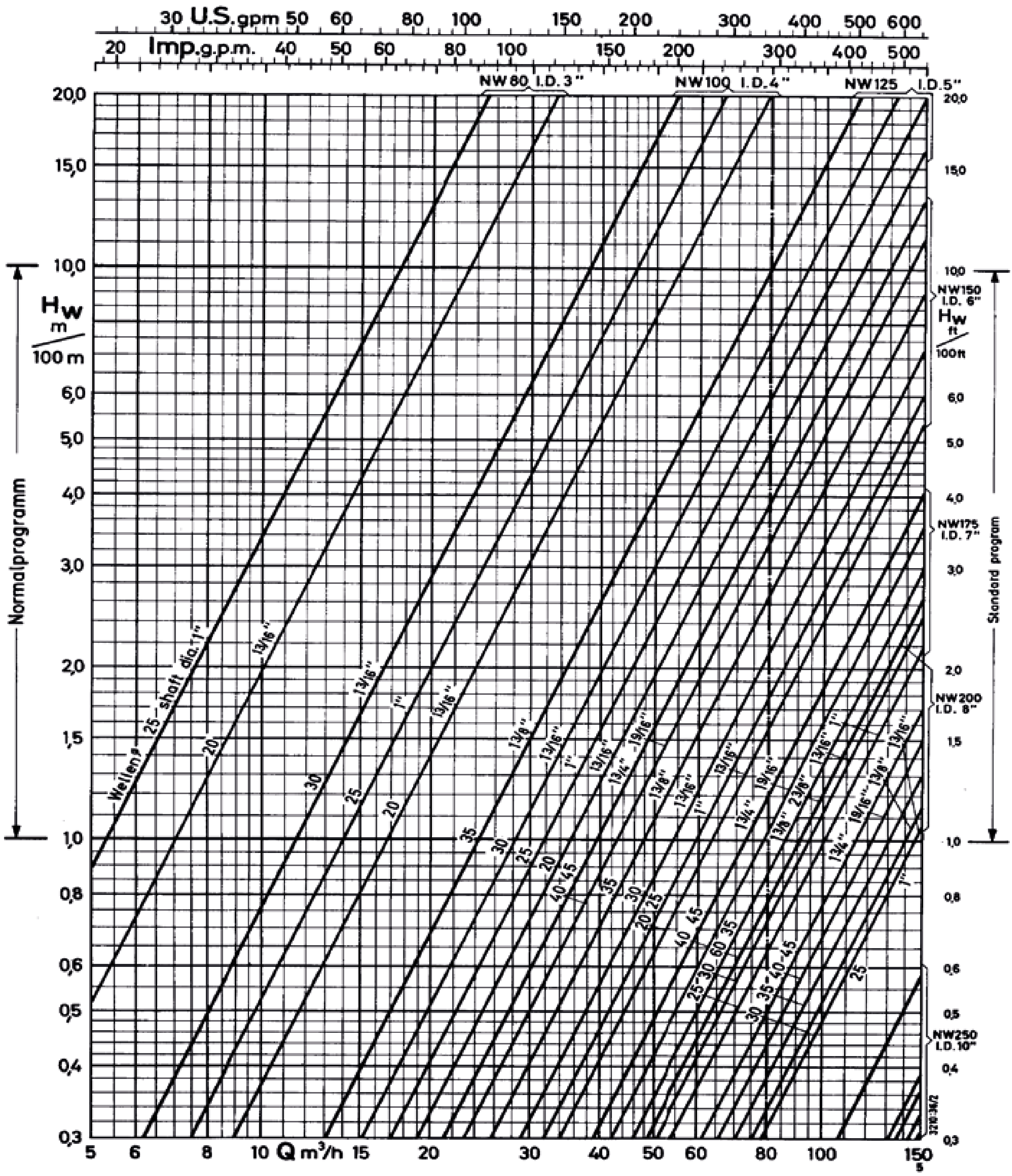


Figure 18: Column Pipe Friction Losses with Shaft Enclosing Tube (2100, 3050)

The values are valid for set lengths of 3050 mm, 2100 mm with screwed coupling; in case of cone coupling the values in the table are to be multiplied with 1.2.

3.8.5.4.12 10 ft long column friction losses (Shaft enclosing tube)

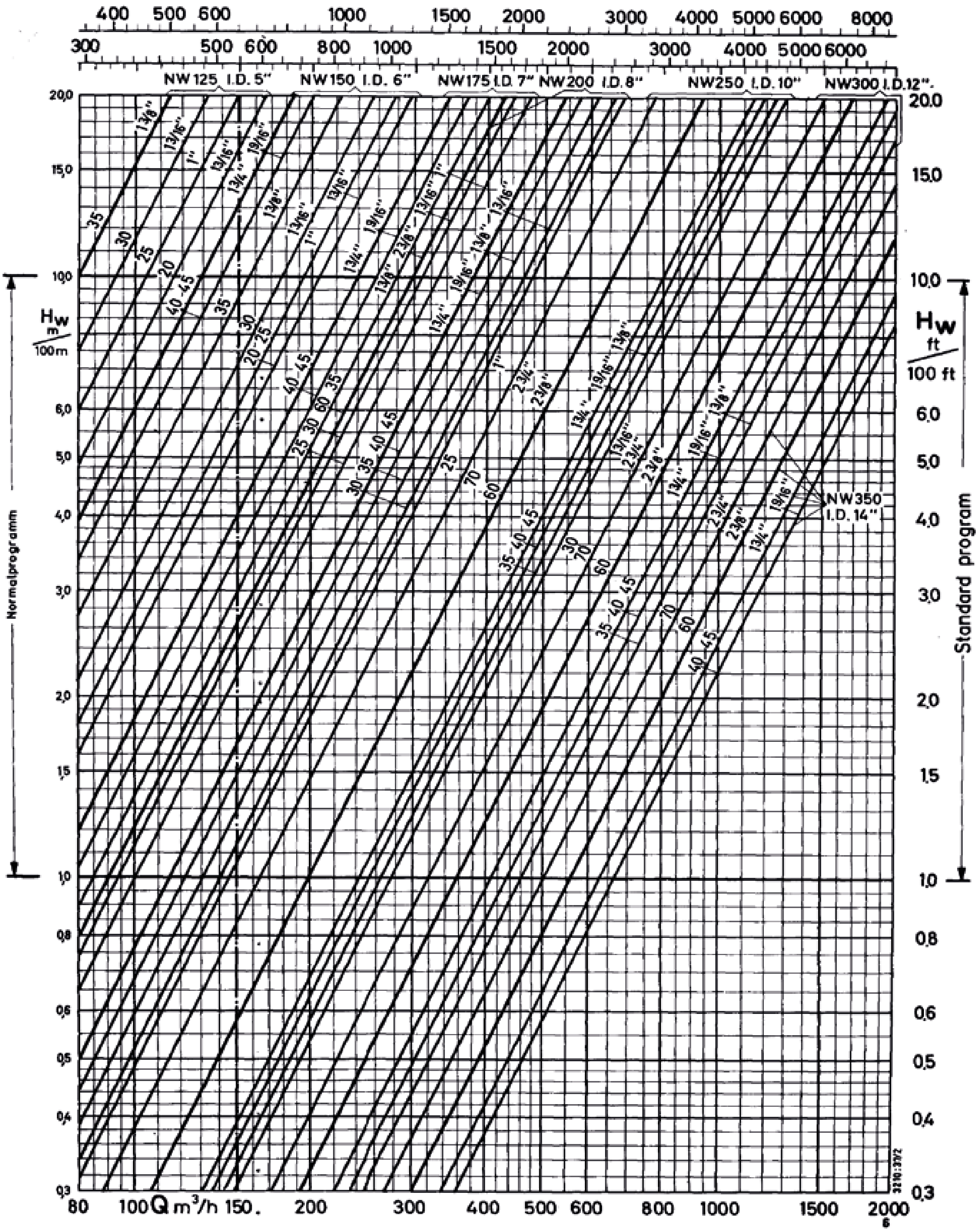


Figure 19: Column Pipe Friction Losses with Shaft Enclosing Tube (2100, 3050) Higher Q

3.9 Scope of Supply

3.9.1 Standard equipment

Scope of supply of DWT unit consists of the following items:

Type I:

1. Complete bowl assembly
2. Rising main with rubber bearing for lubrication through pumping media
3. Discharge head assembly
4. Flexible coupling (for V1 design)
5. Priming Funnel or Tank
6. Erection & Mounting Clamps for rising main
6. Motor (if ordered)

Type II

Scope of supply according to I, with addition of Shaft Enclosing tube and oil lubrication arrangement for line shaft rubber bearings.

Type III

Scope of supply according to I, with addition of Shaft Enclosing tube and oil lubrication arrangement (oil tank) and solenoid valve, if ordered, for line shaft bronze bearings.

3.9.2 Normal Accessories

The following items are not included in the standard scope of supply but they should be recommended to the customer.

Drawing tool for cone coupling, impeller pulling and opening device: for tightening of clamping sleeve of impeller (up to B 16), suction strainer with foot valve (for medium lubricated design) as well as inlet strainer (for rising main with shaft enclosing tube)

3.9.3 Special Accessories

- Oil level indicator,
- Flow meter,
- Thermometer (PT100 for thrust bearing),
- Pressure controller,
- Pressure/ vacuum gauge,
- Foundation base frame,
- Foot elbow,
- Non-return valve,
- Switch and control equipment.

3.10 Inlet

3.10.1 Inlet Strainer

Coarse contamination is kept out of the pump through inlet strainer. If the strainer gets clogged or blocked, possibility exists that the pump runs dry and mechanical failure may occur. First indication of clogging is the reduction in capacity and head.

Resistance of inlet strainer is approx. 1/3 of the suction strainer with foot valve (see Figure 20)

(3.2.1 to be consulted, socket connection is possible only up to pump size B16D)

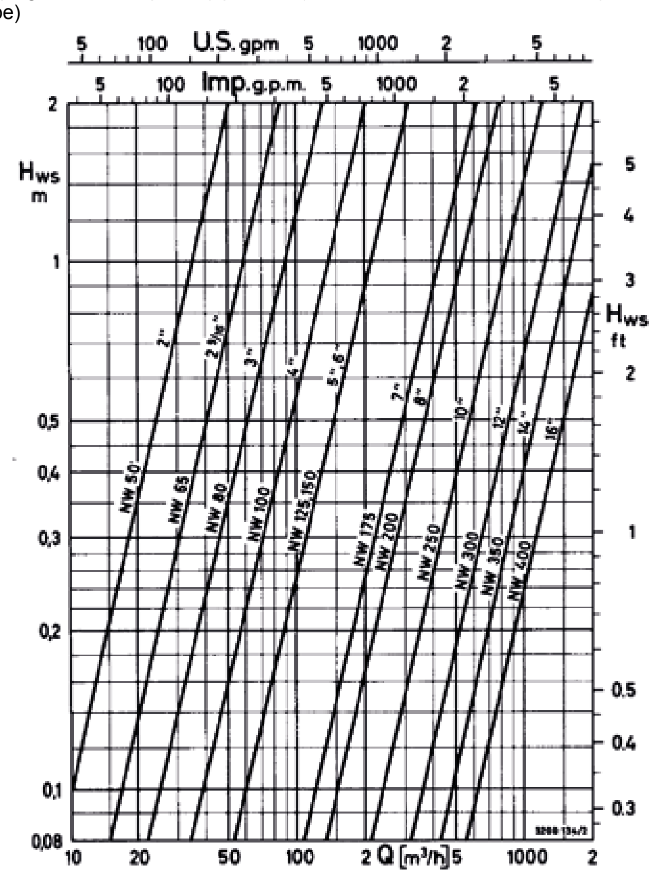


Figure 20: Flow Resistance in suction strainer with foot valve

3.10.2 Suction Strainer with Foot Valve

Regarding contamination the same applies as for inlet strainer. In foot valves danger exists that cone of the valve is not properly closed due to fine deposits.

For long pressure lines it is recommended to install non-return valve in addition to foot valve. Through the provision of N.R.V, pressure on the pump is avoided. It should be ensured that the non-return valve reacts quickly and gets closed before the foot valve.

If it is not certain, it is better to dispense with the foot valve and a pre-lubrication of the rising main. In this situation the first impeller should stand under water during the operation. If the application of foot valve due to water level cannot be avoided, then pressure impact safety must be installed with the non-return valve.

Refer to (3.2.1, socket-connection is possible only to the pump size 16D)

3.10.2.1 Flow Resistance in Suction Strainer with Foot Valve

If the difference between NPSH required and NPSH available is less, resistance in the suction line is to be considered while frictional losses in suction pipe can be neglected. If NPSH available is less than NPSH required, cavitation occurs in the pump.

See Figure 20

3.10.3 3.12.3 Suction Pipes

Standard pipes lengths are of 1500 and 3000 mm. However, for adjustment in the exact installation depths, shorter lengths can also be supplied. The diameter of the suction pipes is designed according to the connection diameter of the pump suction.

The lower end of the suction pipe must be at least 1.0 NW of suction pipe under the lowest water level Ht.

3.10.4 3.12.4 Suction Elbow

For dry installation pumps, special suction elbows according to Figure 21 are available. These shall be mounted axially in the ground plate of the foundation, which prevents radial shifting of the pump.

To use the suction elbow a pipe length of a least 20D must be provided before the suction elbow, a straight pipe length be tried between the suction elbow and pump suction. The NPSH available values can be reduced up to 0.5 to 1.0 meters according to design of the intake.

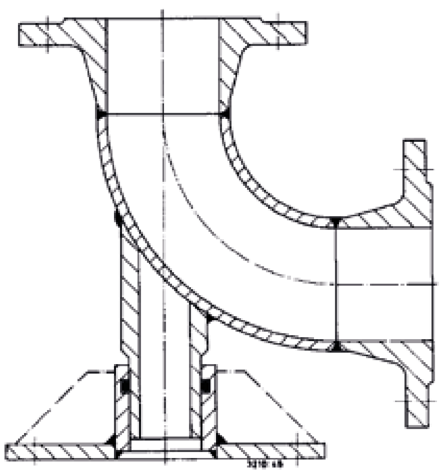
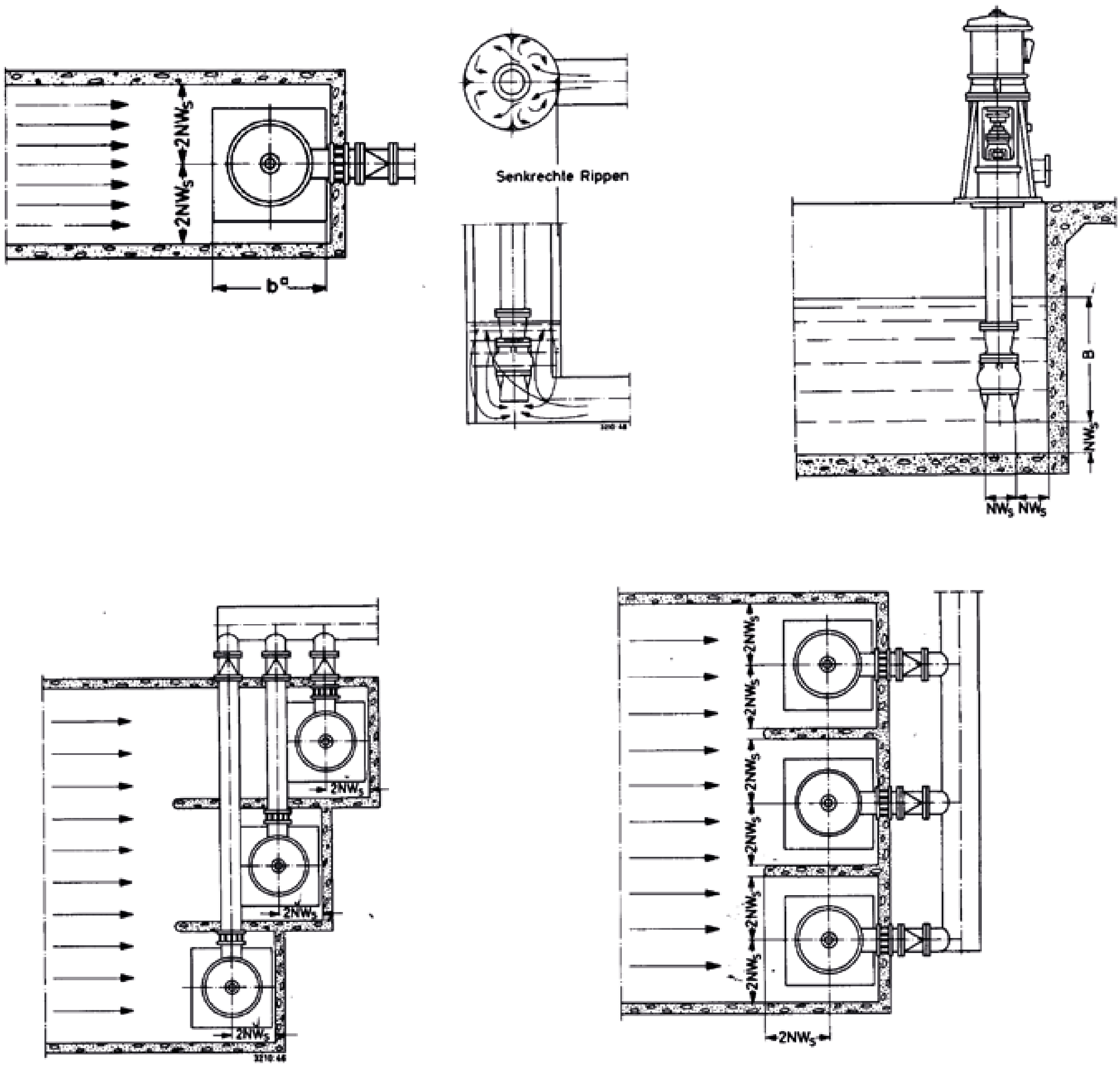


Figure 21: Suction Elbow

3.10.5 Inlet Design of Pump Chamber

The correct design of inlet chamber can improve the performance of the pump considerably. In the Figure 22 few advantageous installation possibilities are presented. Dirt, sand, etc. must be separated / filtered out before intake of the pump.



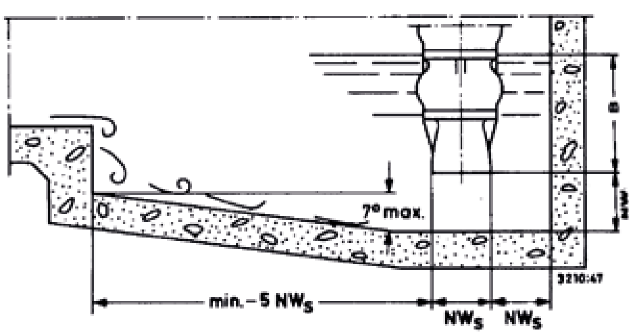


Figure 22: Inlet Designs of Pump Chamber

3.11 Protection of the Upper Surface

All steels and casting material, with the exception of non rusting materials, have, if not mentioned specifically, a color coating (paint) according to the material norms ZN 35.

For mediums which have significant corrosive properties for iron, it is not always possible to use special materials which are corrosion resistant to the pumped medium due to high costs of the material and manufacturing. The quality of the painting must be specified.

Table 53, Table 54 & Table 55 give general idea of the paints/coating materials.

Bowl Assembly (Standard)	**Inside**	**Outside**
Pre-Treatment	Shot Blasting, De Rusting St 2 DIN 12944	
Primer	1 Component Alkyd primer Red Oxide, 0.05mm	
Top Coat		Black Bitumen 0.08mm
Column Assembly (Standard)	Inside	Outside
Pre-Treatment	Rust Protected	
Primer		
Top Coat	Black Bitumen 0.08mm	
Discharge Head Assembly (Standard)	Inside	Outside
Pre-Treatment	Shot Blasting, De Rusting St 2 DIN 12944	
Primer	1 Component Alkyd primer Red Oxide, 0.05mm	
Top Coat		I component Alkyd based synthetic enamel, RAL 5002 (KSB Blue), 0.04mm

Table 53: Upper surface protection with the help of painting materials.

Bowl Assembly (Standard Epoxy)	**Inside**	**Outside**
Pre-Treatment	Shot Blasting SA 2-1/2, DIN 12944	
Primer	2 Component epoxy resin based zinc paint, red thickness 0.04mm	
Top Coat	2 component epoxy resin based coat, black C-200, Thickness 0.3mm	
Column Assembly (Standard Epoxy)	Inside	Outside
Pre-Treatment	Shot Blasting SA 2-1/2, DIN 12944	
Primer	2 Component epoxy resin based zinc paint, red thickness 0.04mm	
Top Coat	2 component epoxy resin based coat, black C-200, Thickness 0.3mm	
Discharge Head Assembly (Standard Epoxy)	Inside (In contact with medium)	Outside (Not in Contact with medium)
Pre-Treatment	Shot Blasting SA 2-1/2, DIN 12944	Shot Blasting, De Rusting St 2 DIN 12944
Primer	2 Component epoxy resin based zinc paint, red thickness 0.04mm	1 Component Alkyd primer Red Oxide, 0.05mm
Top Coat	2 component epoxy resin based coat, black C-200, Thickness 0.25mm	I component Alkyd based synthetic enamel, RAL 5002 (KSB Blue), 0.04mm

Table 54: Upper surface protection with the help of painting materials.

Bowl Assembly (Special Epoxy)	**Inside**	**Outside**
Pre-Treatment	Shot Blasting SA 2-1/2, DIN 12944	
Primer	2 Component epoxy resin based zinc paint, red thickness 0.04mm	
Top Coat	2 component epoxy resin based coat, black C-200, Thickness 0.45mm	
Column Assembly (Special Epoxy)	Inside	Outside
Pre-Treatment	Shot Blasting SA 2-1/2, DIN 12944	
Primer	2 Component epoxy resin based zinc paint, red thickness 0.04mm	
Top Coat	2 component epoxy resin based coat, black C-200, Thickness 0.45mm	
Discharge Head Assembly (Special Epoxy)	Inside (In contact with medium)	Outside (Not in Contact with medium)
Pre-Treatment	Shot Blasting SA 2-1/2, DIN 12944	Shot Blasting, De Rusting St 2 DIN 12944
Primer	2 Component epoxy resin based zinc paint, red thickness 0.04mm	1 Component Alkyd primer Red Oxide, 0.05mm
Top Coat	2 component epoxy resin based coat, black C-200, Thickness 0.45mm	I component Alkyd based synthetic enamel, RAL 5002 (KSB Blue), 0.04mm

Table 55: Upper surface protection with the help of painting materials.

4 Illustrations

4.1 Sectional Views and List of the Individual Parts

4.1.1 Pump Body

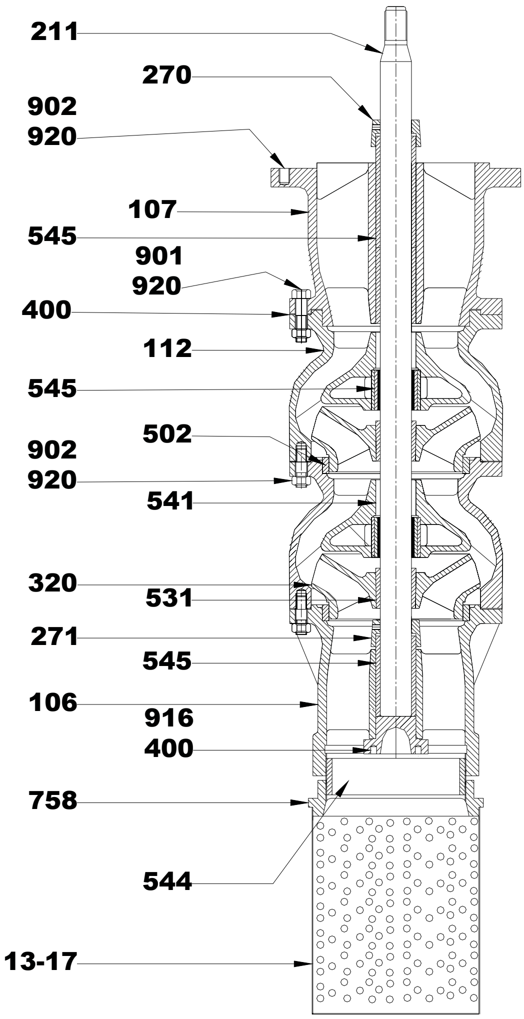


Figure 23: Bowl Assembly with Flanged Suction Strainer

In case of placing an order for spare parts the following must be given under all circumstances:

Pump type, order number (see the rating plate / instructions plate), the name of the part, parts number, number of pieces, number of the sectional view, instructions about delivery / dispatch.

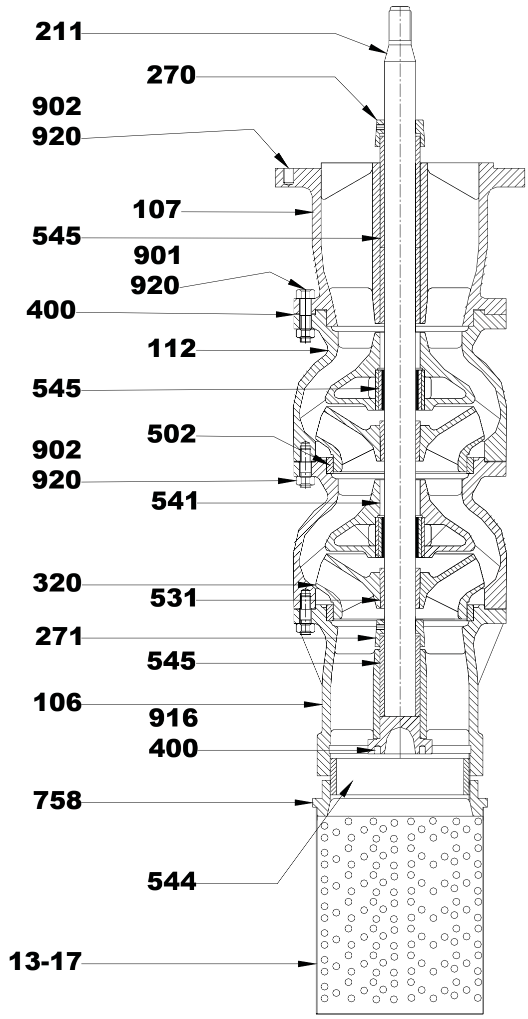


Figure 24: Bowl Assembly with Threaded Suction Strainer

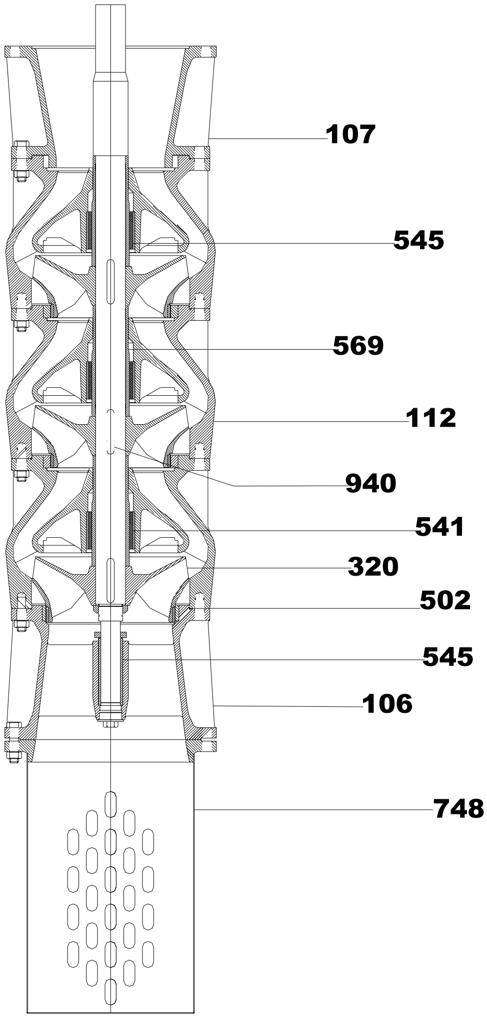


Figure 25: Bowl Assembly for B18-B24

4.1.2 Column Pipe

4.1.2.1 Column Pipe with Shaft Enclosing Tube

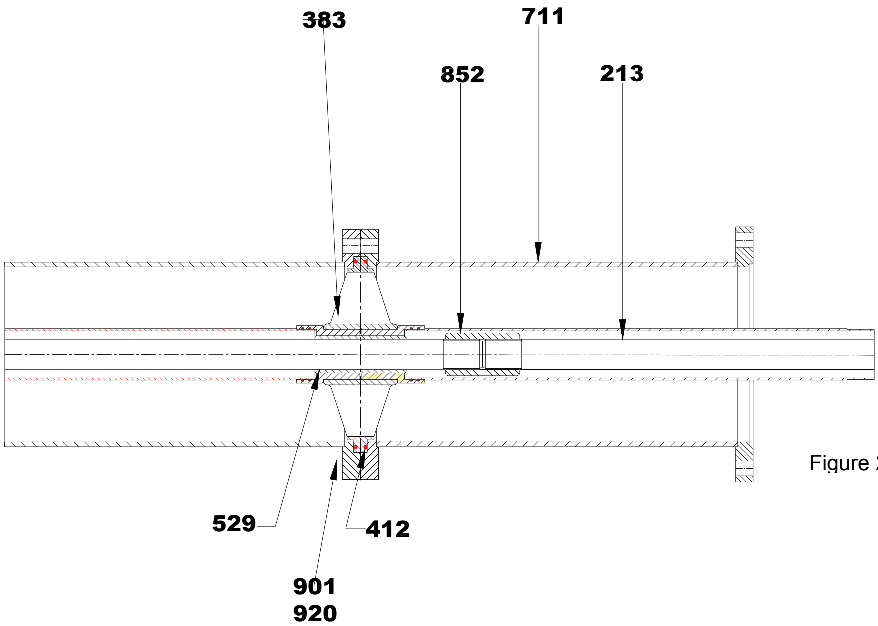


Figure 26: Shaft Enclosing Tube Design

4.1.2.2 Standard Column Pipe Design with Threaded Execution

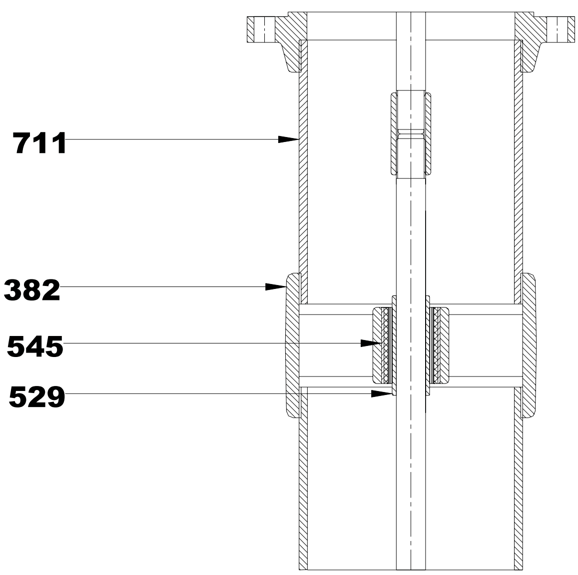


Figure 27: Threaded Column Pipe

4.1.2.3 Standard Column Pipe Design with Flanged Execution

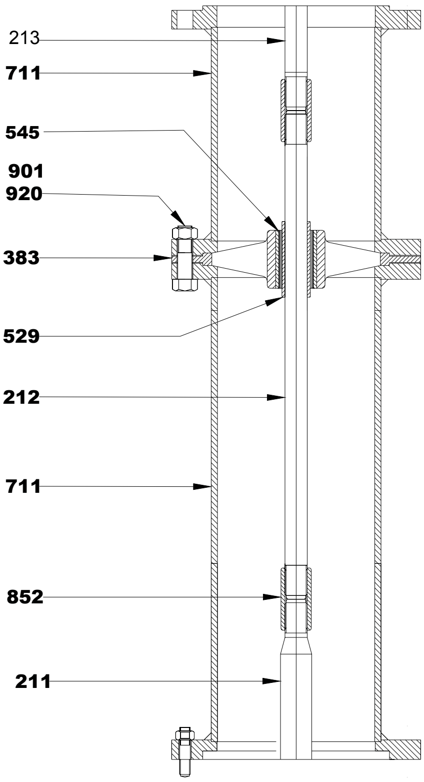


Figure 28: Flanged Column Pipe

In case of placing an order for spare parts, the following must be given under all circumstances:

Pump type, order number (see the rating plate / instructions plate on the discharge head), the name of the part, parts number, number of pieces, number of the sectional view, instructions about delivery / dispatch.

4.1.3 Discharge Head

4.1.3.1 Lubrication Arrangement for Shaft Enclosing Tube

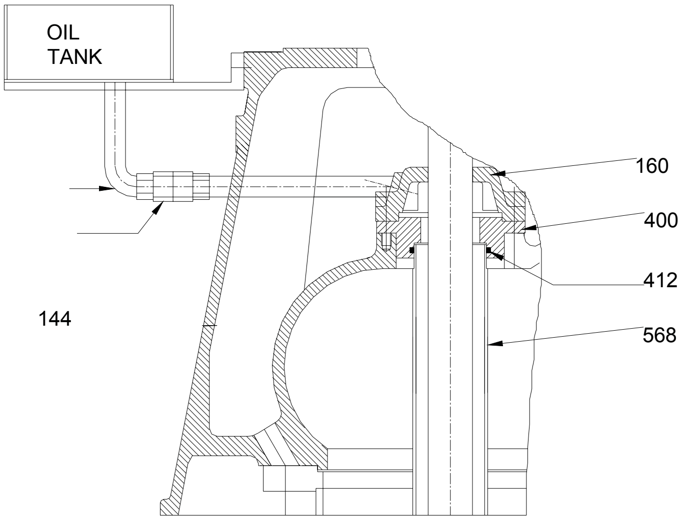


Figure 29: Lubrication Arrangement for Shaft Enclosing Tube

4.1.3.2 Motor Stool with Thrust Bearing Arrangement

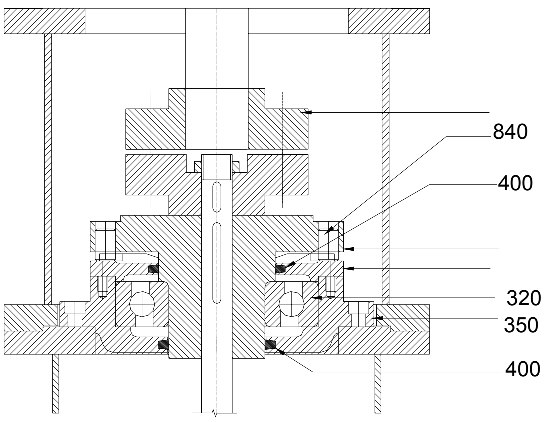


Figure 30: Motor Stool with Thrust Bearing Arrangement

4.1.3.3 Discharge Piece for Shaft Enclosing Tube Design

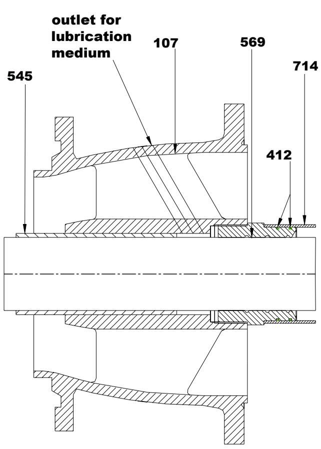


Figure 31; Discharge Piece for Shaft Enclosing Tube

4.1.3.4 Stuffing Box Housing

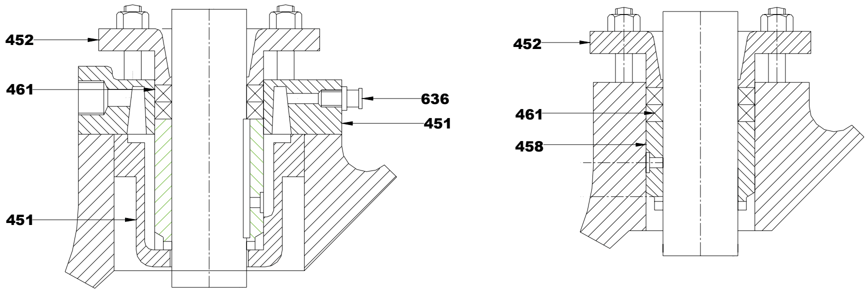


Figure 32: Stuffing Box Housing

4.1.3.5 Motor Stool with Double Bearing Arrangement

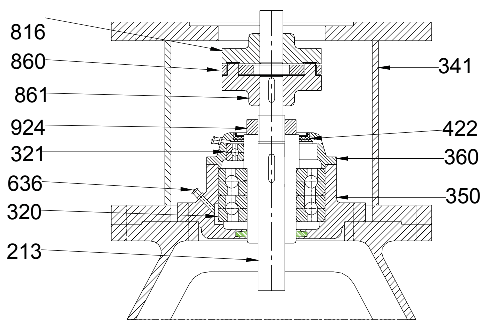


Figure 33: Motor Stool with Double Bearing Arrangement

4.1.3.6 Discharge Head with Solid Shaft and Stuffing Box Housing

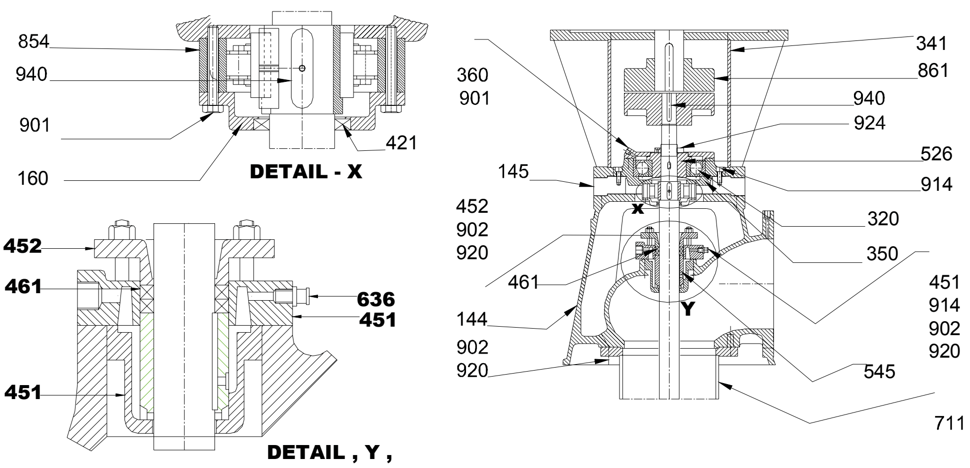


Figure 34: Motor Stool & Discharge Head

In case of placing an order for spare parts the following must be given under all circumstances:

Pump type, order number (see the rating plate / instructions plate on the Discharge head), the name of the part, parts number, number of pieces, number of the sectional view, instructions about delivery / dispatch.

4.1.3.6.1 Discharge Head Dimensions:

Type	a	b	e	f	h	g	NWst	ShaftØ	NWd	d	Foundation Bolt	Material
VN 1342 A		425	148	210	297	350	75, 100	25, 30, 35	100	As per Flange Standard	M 16 x 250mm	Cast Iron
VN 1342		425	148	210	297	350	100, 125	25, 30, 35	125		M 16 x 250mm	Cast Iron
VN 1830		425	148	210	297	350	150, 175	25, 30, 35	150		M 16 x 250mm	Cast Iron
VN 2030		440	171.5	200	400	370	175, 200	25, 30, 35	200		M 16 x 250mm	Cast Iron
VN 2541 A		600	225	290	470	430	200	25, 30, 35, 45	200		M 16 x 300mm	Cast Iron
VN 2541		600	225	290	470	430	250	30, 35, 45	250		M 16 x 300mm	Cast Iron
VN 3051		700	290	305	570	600	200, 250	30, 35, 45	300		M 20 x 250mm	Steel Fabricated

Table 56: Discharge Head Dimensions

Figure 36: VN 1830 & VN 2030

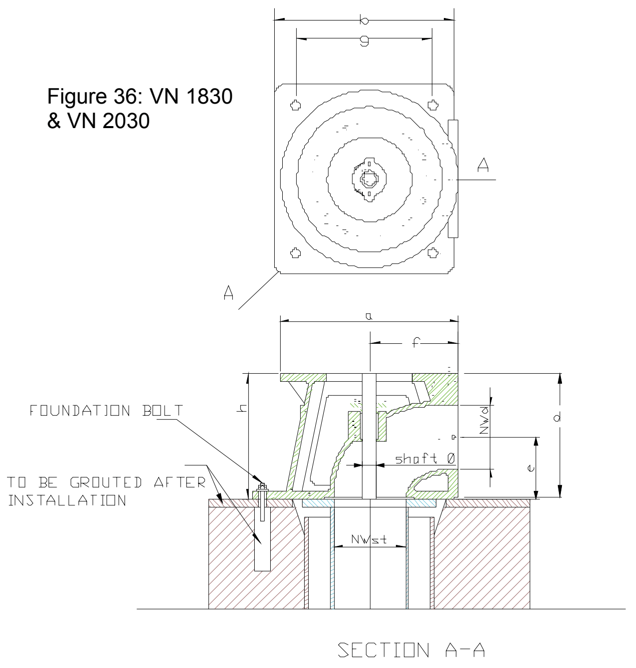
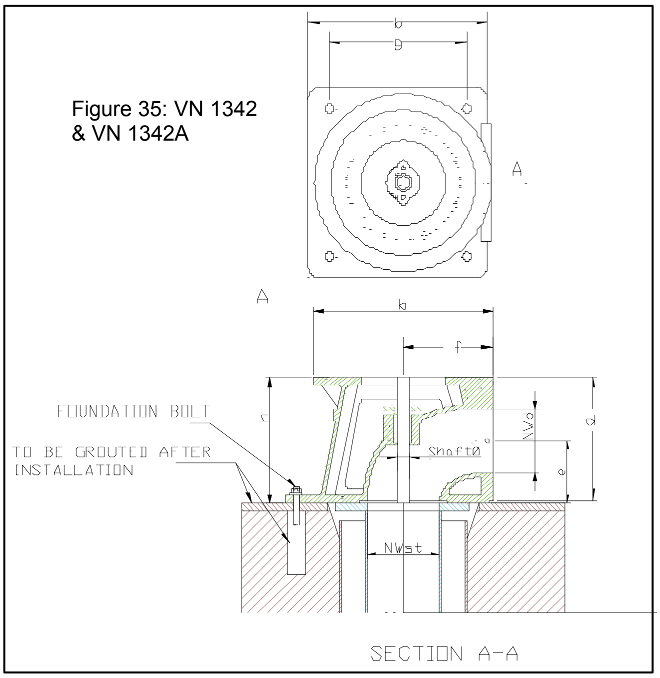


Figure 35: VN 1342 & VN 1342A



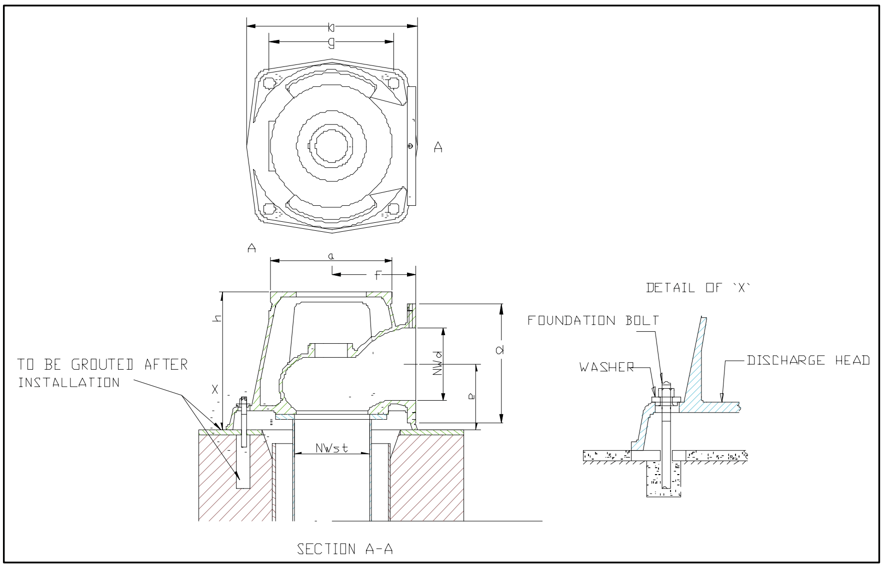
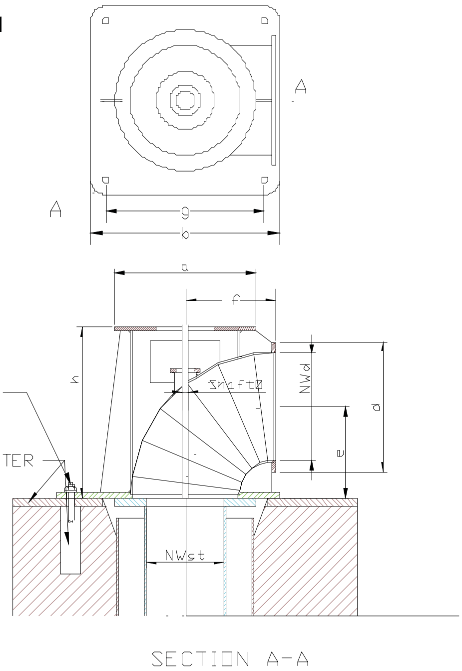


Figure 37: VN 2541 & VN 2541A

Figure 38: VN 3051



5 Spare Parts

When ordering spare parts, always please specify the item numbers, designations of the components concerned, and the works number / serial number of the pump. This will avoid any delays in delivery and possible queries. The works number of the pump is given on the title page of instruction manuals, and is also stamped on the pump rating plate.

Following is the recommended spare parts list in accordance with VDMA 24296 (recommended spares).

For a more specific spare parts list, please consult the O&M Manual supplied with each order.

Item No.	Designation	Qty.	Remarks
211	Pump Shaft	1	
212	Column Shaft	Z	
213	Top Shaft	1	
230	Impeller	1	
271.1	Sand guard	1	
271.2	Sand guard	-	
320	Angular contact ball bearing	-	
321	Deep groove ball bearing	-	
382.1	Bearing body	1	
384	Thrust bearing disc	1	
400.1	Flat gasket	1	
400.2	Flat gasket	S	
400.3	Flat gasket	1	
400.4	Flat gasket	2	
400.5	Flat gasket	1	
412.1	O-ring	1	
422.1	Felt ring	-	
422.2	Felt ring	-	
461	Stuffing box packing (in meters)	-	
502	Casing wear ring	S	
521	Stages sleeve	S-1	Only from size 14 upwards.
524	Shaft protecting sleeve	1	If fitted.
526	Centering sleeve	-	
529	Bearing sleeve	1	
540	Bush	1	
541	Stage bush	S-1	Not applicable to sizes 6-7-14 and above.
52-1	Clamping sleeve complete	S	Upto size 12 inclusive.
544	Threaded bush	1	
545.1	Bearing bush	1	
545.2	Bearing bush / rubber	S	
545.3	Bearing bush	1	
851	Cone coupling	-	
852	Screwed coupling	Z + 1	
920.1	Nut with 2 flats	-	Only from size 14 and upward.
931.1	Tab washer	-	Only from size 14 and upward.
931.2	Tab washer	-	

6 Sample Sectional Drawing with Parts List

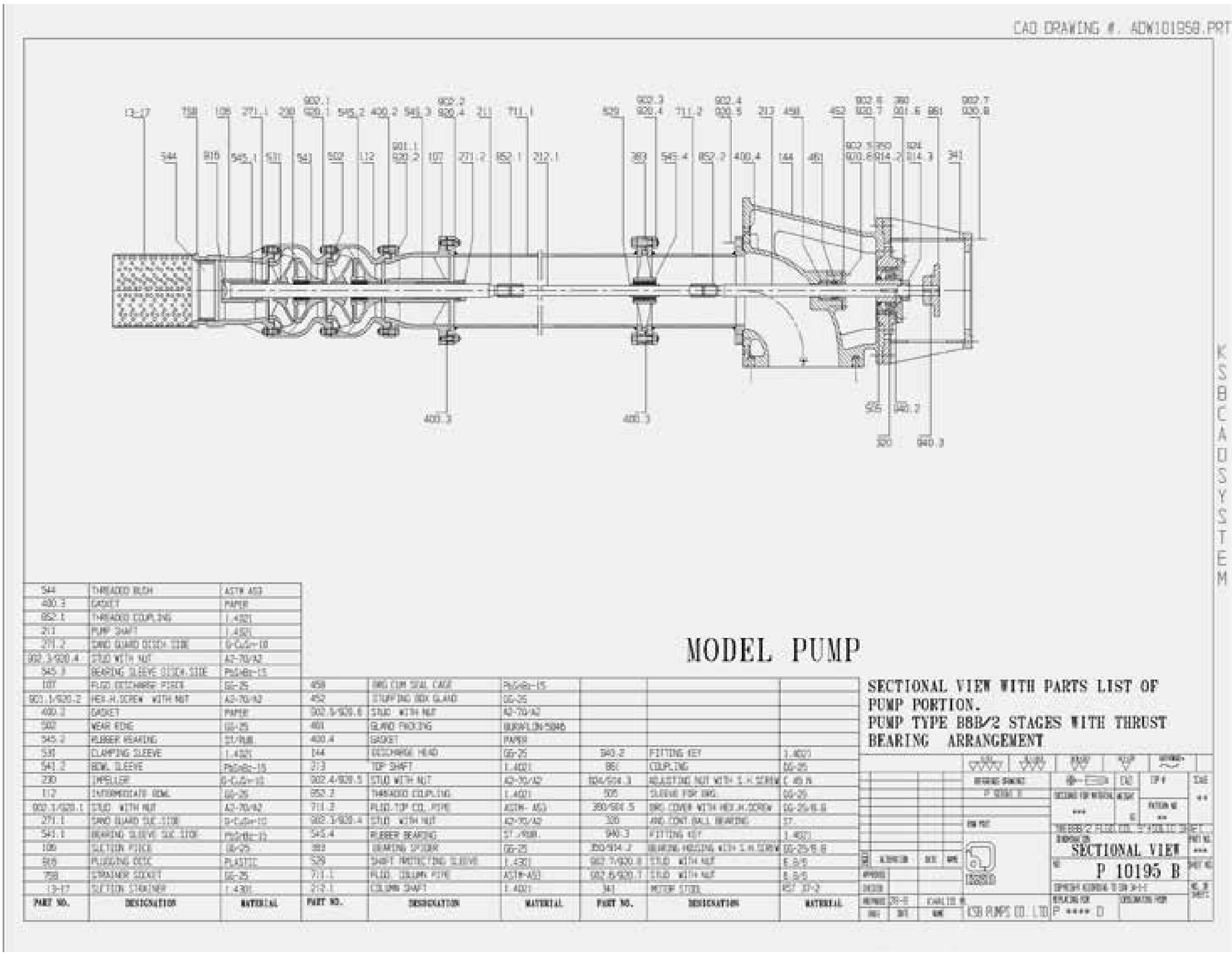


Figure 39: Sectional Drawing with Parts List