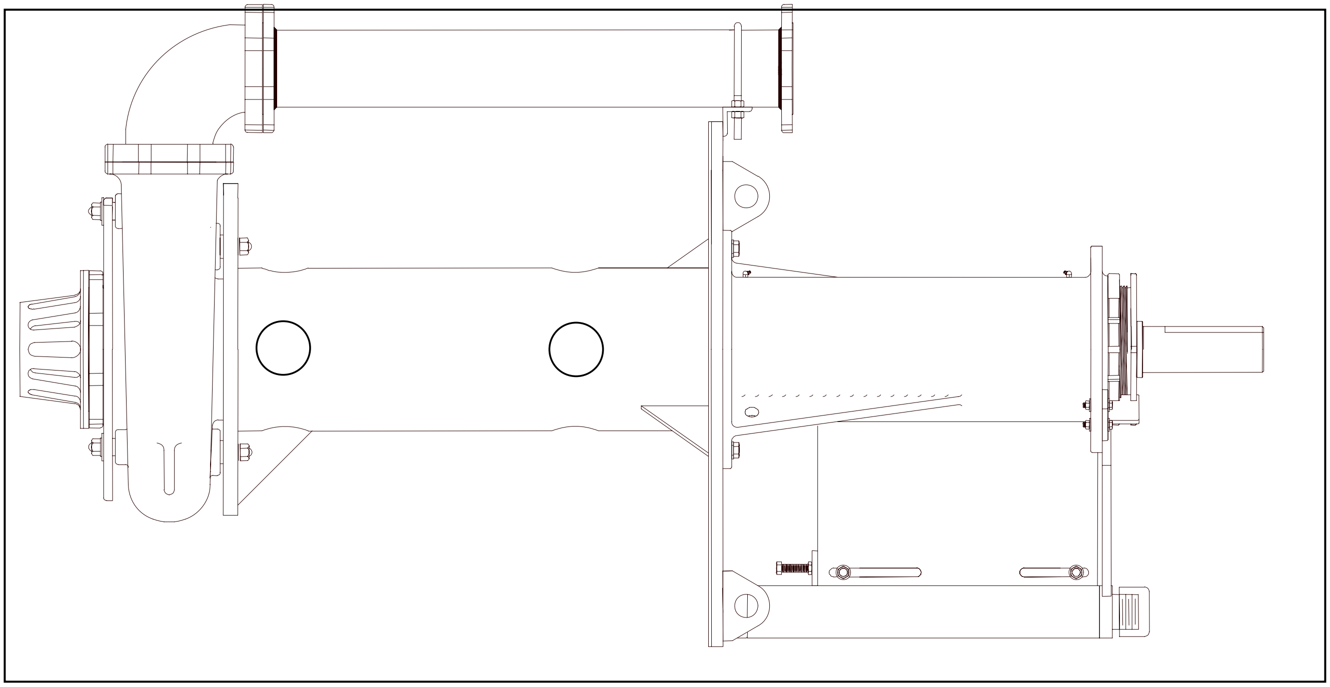
Technical Booklet **LCV**

05/06/05



Index

Figures

1 Field of Application

Heavy-Duty slurry pumps are recommended for coarse or fine particles from solids-laden waste water to aggressive slurries of an abrasive or corrosive nature.

2 Pump Type Description

Vertical, end suction, modified volute casing pump includes three-vane impeller for large solids passage with good suction performance, high efficiency and good wear characteristics over a broad operating range. Interchangeable elastomer and metal designs allow best material choice for application. The single-stage, compact, low weight arrangement allows easy maintenance of wet-end components once removed from sump.

3 Pump Designation Code

LCV-M80-300.3T-1OB M1

Pump Type----------------------|
Hydraulic Type-------------------|
Discharge Nozzle DN in mm-----|
Nominal Impeller Diameter in mm---|
Shaft Size--|
Seal Type--|
Cantilever Length--------------------------------|
Options--I
Motor Mount--I
Material Code --|

Hydraulic Type
M ....Metal

Mechanical (Shaft) Size (mm)

1	2	3	4	5	6
90	110	130	150	170	200

Seal Type
S ....…… Seal Plate
T ....……. Throttle Seal

Motor Mount
A ....…… Small
B ....……. Large

Options
O………………………………………Open Shroud
C………………………………………Closed Shroud

Nominal Cantilever Lengths

1	2	3	4	5
900	1200	1500	1800	2100

Nominal Flange and Impeller Diameters in mm (inches)

Designation	Discharge	Suction	Impeller
LCV 50 - 230	50 (2")	80 (3")	225 (8.86")
LCV 80 - 300	80 (3")	100 (4")	310 (12.22")
LCV 100 - 400	100 (4")	150 (6")	395 (15.55")
LCV 150 - 500	150 (6")	200 (8")	500 (19.69")
LCV 200 - 610	200 (8")	250 (10")	610 (24")
LCV 250 - 660	250 (10")	300 (12")	660 (26")
LCV 300 - 710	300 (12")	350 (14")	710 (27.95")

4 Technical Data

The selection and application of vertical cantiltever centrifugal slurry pumps is similar to that of other water pumps, but several additional considerations must be recognized. These considerations arise from the effects of the solid particles being conveyed. These solids have four primary effects:

1. Wear effects due to the action of the solids against the wetted surfaces of the pump.
2. Hydraulic loading effects due to the specific gravity of the slurry, which is often well above that of water and commonly varies with time in a typical slurry system.
3. Small to moderate reductions in generated head and operating efficiency caused by friction between the solids and the liquid.
4. Piping system considerations including friction losses and overall system stability.

Items 1, 2 and 3 directly affect the selection and performance of the pump and are covered in this document. Item 4 represents an area of study too broad to address here. For further information, refer to the book*, "Slurry Transport Using Centrifugal Pumps,"* by Wilson, Addie & Clift. Another useful reference which should be read is the *LCV Maintenance Manual*, especially sections on Operational Problems and Solutions, and Trouble Shooting.

Some of the practical considerations include hydraulic design, materials of construction, limitations on operating parameters to resist wear, and the construction and operation of the shaft seal and mechanical element.

4.1 Classification of Slurry Duties

In selecting a slurry pump, it is prudent to adjust the allowable operating range of the pump in accordance with the severity of the slurry duty. Figure 1 contains the current GIW method in which the severity of the slurry is rated (class 1 to 4) based on slurry specific gravity, average particle diameter and abrasivity. The resulting limits on impeller speed, casing velocities and range of flow rate are given for each class.

It must be stressed that this chart, like any selection chart, is for estimating purposes and will most often result in conservative selections. Rating of slurry class and application of limits is open to interpretation, and successful slurry operation outside of the given limits is common. The important feature of the chart is that it gives the novice a solid basis for selection and the expert a reference point from which to build and apply experience.

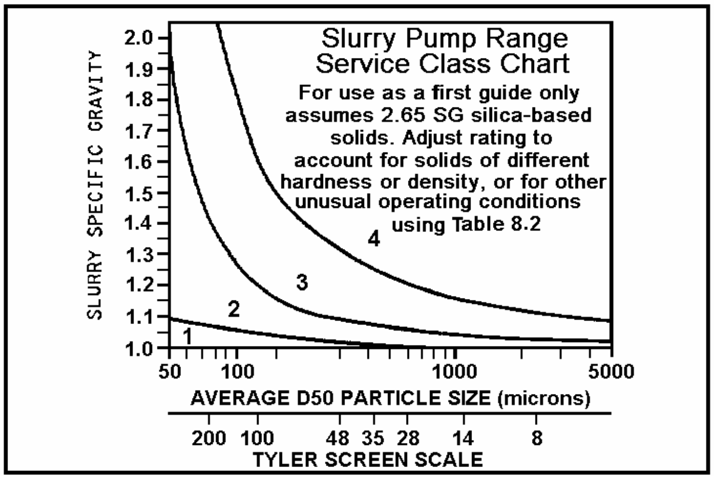
This method is automatically applied by the GIW pump and pipeline program, Slysel.

4.2 Head-Flow Selection Charts

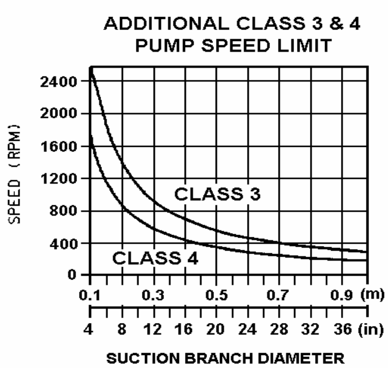
Figures 2 through 5 give head-flow based pump sizing charts for the LCV range. Each chart is based on one of the four slurry severity "classes" described in section 4.1.

In these charts the dividing line between pumps of different sizes is based on the point at which the larger pump becomes at least 2% more efficient than the smaller pump.

PUMP RANGE SERVICE CLASS CHART AND OPERATING LIMITS



OPERATING * LIMITS	SHELL TYPE	SERVICE CLASS 1	2	3	4
Maximum Discharge (R) Velocity		40. (ft/s) 12.2 (m/s)	32. (ft/s) 9.8 (m/s)	27. (ft/s) 8.2 (m/s)	20. (ft/s) 6.1 (m/s)
Maximum Throat (R) Velocity		50. (ft/s) 15.2 (m/s)	40. (ft/s) 12.2 (m/s)	30. (ft/s) 9.1 (m/s)	20. (ft/s) 6.1 (m/s)
Recommended Percent Range (w) Of BEP Flow Rate	AH	20 – 120%	30 – 110%	40 – 100%	50 – 90%
	CH	30 – 130%	40 – 120%	50 – 110%	60 – 100%
	TH	50 – 140%	60 – 130%	70 – 120%	80 – 110%
	OBH	10 – 110%	20 – 100%	30 – 90%	40 – 80%
All Metal Pump Maximum Impeller (R) Pheripheral Speed		8500 (sfpm) 43.2 (m/s)	7500 (sfpm) 38.1 (m/s)	6500 (sfpm) 33.0 (m/s)	5500 (sfpm) 27.9 (m/s)
Rubber Lined Pump Maximum Impeller (R) Pheripheral Speed		5500 (sfpm) 27.9 (m/s)	5000 (sfpm) 25.4 (m/s)	4500 (sfpm) 22.9 (m/s)	4000 (sfpm) 20.3 (m/s)



SLURRY ABRASIVITY ADJUSTMENT
(To apply multiply both slurry solids D50 size & specify gravity of slurry by correction factor)

SERVICE TYPE	CORRECTION FACTOR
Normal Silica Slurries Such As Dredged River Material, Taconite, Tailings, ect.	1.0
Dredged Coral, Bottom Ash, Copper Mill Circuit Slurries & Slurries Known to be Abrasive	1.2
Coal Slurries, Slurries that are Friable & Breack up & Slurries With Slimes Content	0.8

	REJECTION (R)	WARNING (W)
FLOW	< 10% BEPQ > 150% BEPQ	SEE ABOVE
TURNDOWN	> 1.02 < 0.7	> 1.004 < 0.8
IF RUN SYSTEM	N/A	NPSHA < NPSHR
SUCTION VELOCITY	N/A	< 3.0 FT / SEC (1 M/SEC)

* Selection Rejection (R) or Warning (W) applies as noted in GIW Selection program.

Figure 1. Slurry Service Class Chart

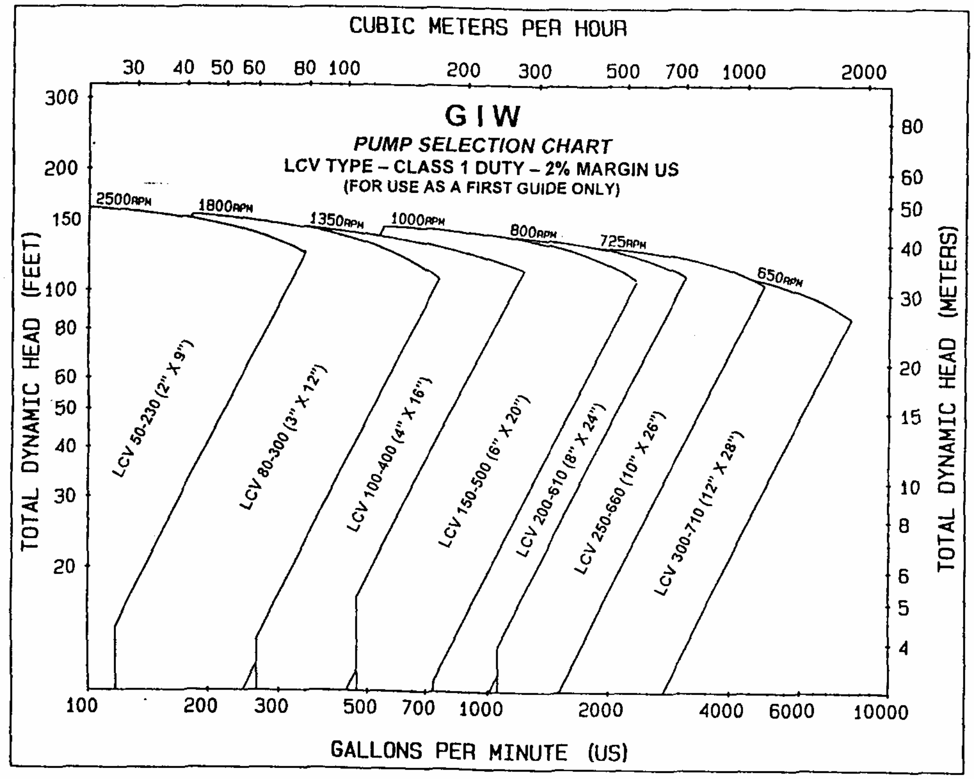


Figure 2. LCV Head-Flow Selection Chart for Class 1 Duty

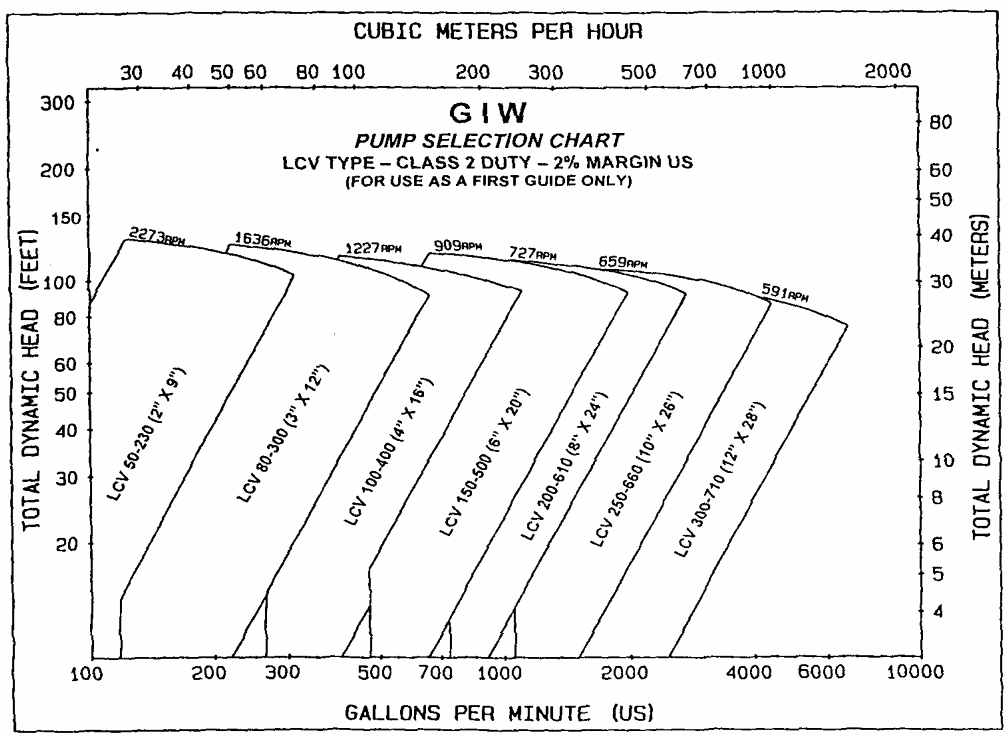


Figure 3. LCV Head-Flow Selection Chart for Class 2 Duty

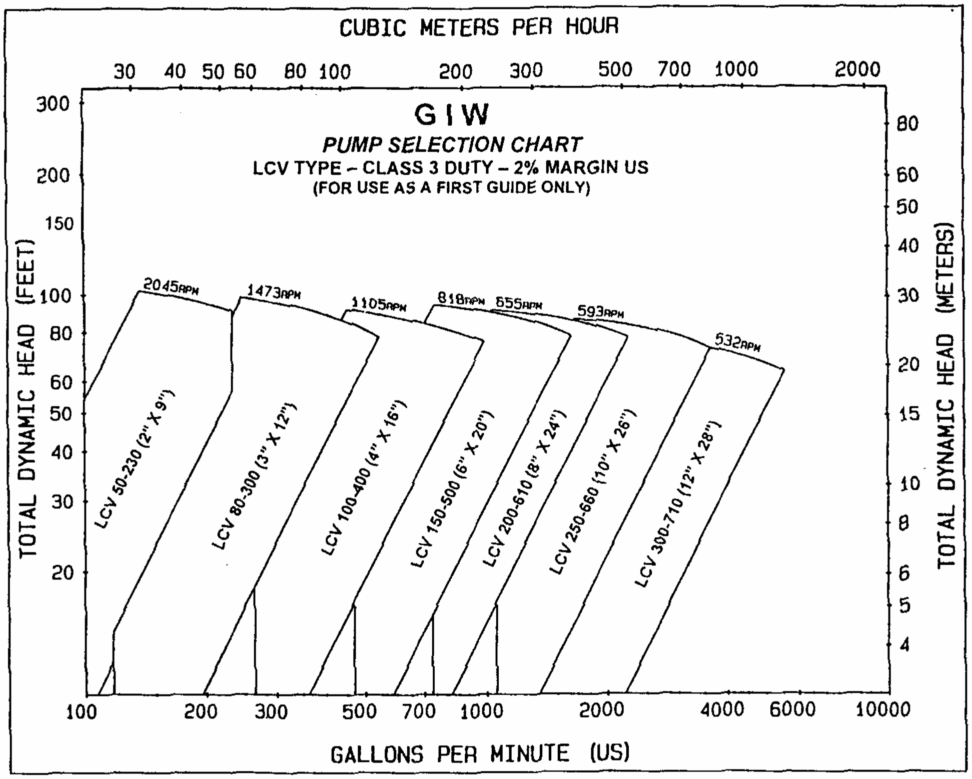


Figure 4. LCV Head-Flow Selection Chart for Class 3 Duty

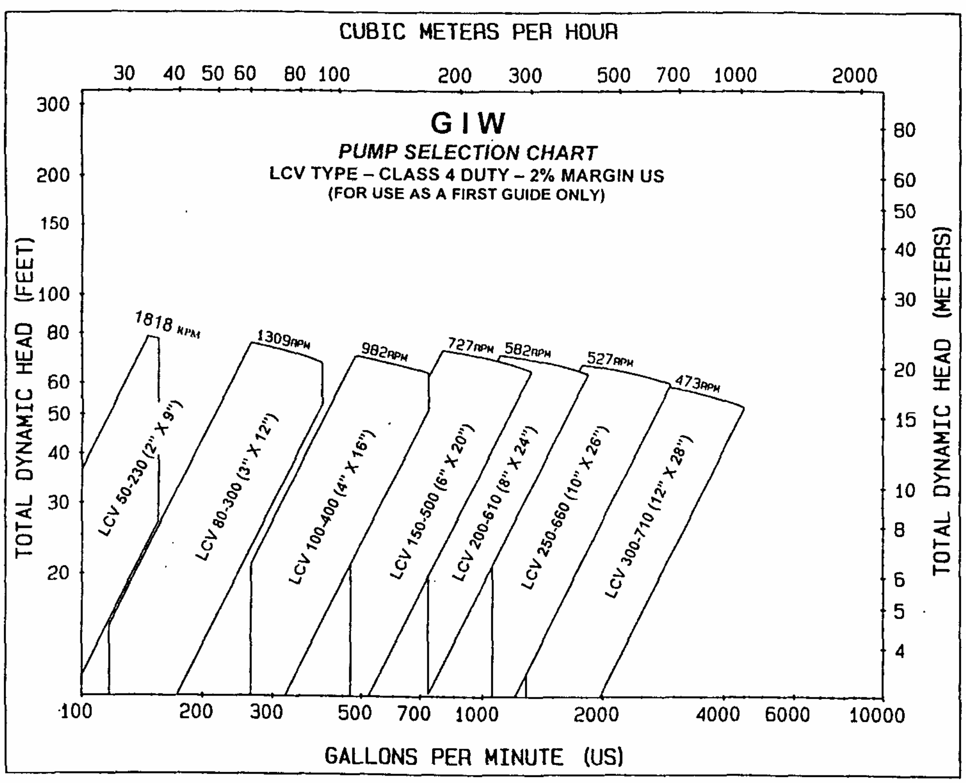


Figure 5. LCV Head-Flow Selection Chart for Class 4 Duty

4.3 Pressure and Temperature Limits

Figures 6 and 7 give pressure and temperature limitations for the standard LCV range of pumps. Higher pressures and temperatures may be possible through the use of special materials or methods of construction. Contact your GIW / KSB sales office for the availability of custom options.

Nominal Pump Size		Std. Metal bar	Std. Metal psi
50 - 230	(2"x 9")	11	160
80 - 300	(3"x 12")	10.5	150
100 - 400	(4"x 16")	9.5	140
150 - 500	(6"x 20")	9	130
200 - 610	(8"x 24")	8.5	120
250 - 660	(10"x26")	7.5	110
300 - 710	(12"x28")	7	100

Figure 6. LCV Pressure Limitations

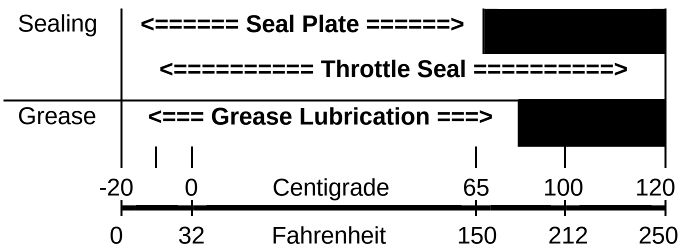


Figure 7. LCV Temperature Limitations

4.4 Shaft Limitation Charts

Slurry pump duties cover a wide range of pump rotational speeds and slurry specific gravities. As a result, it is desirable to have a range of shaft sizes available to permit the optimization of each application.

The LCV range of pumps allows for two or three different shaft sizes to be applied to each hydraulic size. Selection of a shaft size is based on four parameters: critical speed, shaft deflection, bearing life and shaft strength.

In the charts Appendix A, these parameters are defined for each standard length of cantilever and standard combinations of LCV hydraulics and mechanical end. The charts cover a range of operating conditions from 25% to 125% of the best efficiency flowrate at three discrete slurry specific gravities: 1.0, 1.25, and 1.5.

In selecting a shaft size, one plots the various duties of head and flow on each chart to determine the acceptability of the limiting criteria. Shown are the maximum operating speed, first critical speed zone, acceptable shaft deflection and bearing life. Shaft strength is not shown since it is adequate when limited by the above.

1.) *Maximum Operating Speed.* The limit on revolutions per minute are given in the lines.

2.) *First Critical Speed.* Lines are given for the first critical speed zone (FC) when the critical speed is below the maximum operating speed. Operating within these bounds may cause unacceptable vibration which can be severe, depending on the application and stiffness on the installation. Operating above the first critical speed zone may also cause severe vibration as the pump comes up to speed through the first critical speed zone.

3.) *Shaft Deflection at the Shaft Seal.* Lines are given for allowable deflection at the shaft seal. Exceeding these limits may lead to contact of rotating components with stationary components.

4.) *Bearing Life.* Lines are given for 100,000 hours which is considered standard for LCV applications. This high value is required in order to limit heat generation and resultant re-lubrication intervals in the vertical application.

4.5 Effects of Solids on Head and Efficiency

In slurry pumping, the interaction of the solids with the liquid results in friction losses that reduce the operating head and efficiency of the pump. The magnitude of this effect is governed by particle size, specific gravity, volumetric concentration, percentage of fines and the properties of the carrier liquid. In many typical slurry pumping applications, it ranges from zero to 15%, although values exceeding 30% are possible. Three typical cases are:

	Case 1	Case 2	Case 3
Solids type	coal	silica	silica
Solids S.G.	1.7	2.65	2.65
Solids D50	1 mm	0.2 mm	10 mm
Slurry S.G.	1.2	1.2	1.4
% Fines	< 5%	< 5%	< 5%
Liquid type	water	water	water
Pump	150-500 (6" x 20")	150-500 (6" x 20")	150-500 (6" x 20")
% Head reduction	8.4 %	2.6 %	13.0 %
% Efficiency reduction	10.3 %	2.6 %	14.5 %

Solids effect should always be accounted for in the selection a slurry pump. For solids effect values for a specific application, consult the GIW Slysel program; the book, "Slurry Transport Using Centrifugal Pumps", or contact your GIW / KSB sales office.

5 Construction

The construction of the slurry pump is designed to give maximum resistance to solids while simplifying maintenance. Since the slurry pump is required to cover a wide range of duties from fine to coarse, dilute to dense, and inert to corrosive, several types of construction are available

5.1 Wet End

Two standard, wet-end configurations are available in the LCV range:

1.) Hard Metal. (Figure 8). Single-wall casing, impeller and suction liner of high-chrome white iron. Suitable for high-discharge head, all particle sizes up to maximum sphere passage and mildly corrosive slurries. Custom materials available for highly corrosive slurries.

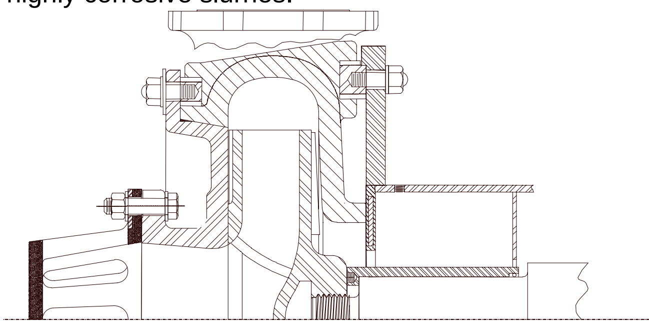


Figure 8. LCV Hard Metal Wet End

5.1.1 Casing

All casings carry 125 pound, ANSI flange bolting patterns. Adapters for conversion to DIN flanges are available. Average wear material thicknesses are given in Figure 10.

Nominal Pump Size	Hard Metal Casing	
	Belly	Side Wall
50-230 (2"x 9")	18 (0.7)	18 (0.7)
80-300 (3"x12")	20 (0.8)	20 (0.8)
100-400 (4"x16")	25 (1.0)	25 (1.0)
150-500 (6"x20")	30 (1.2)	30 (1.2)
200-610 (8"x24")	30 (1.2)	30 (1.2)
250-660 (10"x26)	35 (1.4)	35 (1.4)
300-710 (12"x28)	45 (1.75)	45 (1.75)

Figure 10. Casing Thicknesses in mm (inches)

5.1.2 Impeller

Standard impeller designs are available in closed shroud or open shroud designs. Their interchangeability with the basic wet-end types is shown in Figure 11.

Pump size	Plug	Closed Shroud	Open Shroud
LCV 50-230	1.75"	6178D	4538C
LCV 80-300	1.75"	6179D	4539C
LCV 100-400	1.75"	6180D	4540C
LCV 150-500	S9194	5216D	4541C
LCV 200-610	3.50"	6181D	4542C
LCV 250-660	3.50"	6182D	4543C
LCV 300-700	3.50"	6183D	4544C

Figure 11. Impeller Selection Chart

Standard impellers are double shrouded with sphere passage and vane thickness as shown in Figure 12.

Nominal Size	Impeller Version	
	Standard Metal	
	Sphere Passage	Vane Thickness
50-230 (2"x 9")	33 x 23 (1.3x0.9)	16 (0.63)
80-300 (3"x12")	51 x 25 (2.0x1.0)	21 (0.83)
100-400 (4"x16")	61 x 38 (2.4x1.5)	25 (0.98)
150-500 (6"x20")	89 x 76 (3.5x3.0)	19 (0.75)
200-610 (8"x24")	107x102 (4.2x4.0)	21 (0.81)
250-660 (10"x26")	142x122 (5.6x4.8)	22 (0.88)
300-710 (12"x28")	180x132 (7.1x5.2)	25 (1.0)

Figure 12. Impeller Sphere Passage and Average Vane Thickness in mm (inches)

Nominal Size	Design Version	
	Standard Metal	
	Dry	Water Filled
50-230 (2" x 9")	0.063 (1.49)	0.067 (1.60)
80-300 (3" x 12")	0.263 (6.19)	0.281 (6.66)
100-400 (4" x 16")	0.822 (19.5)	0.893 (21.2)
150-500 (6" x 20")	1.54 (36.7)	1.97 (46.9)
200-610 (8" x 24")	4.72 (112)	5.94 (141)
250-660 (10"x26)	7.63 (181)	9.99 (237)
300-710 (12"x28)	13.7 (324)	17.5 (416)

Figure 13. Full Size Impeller Mass Moments of Inertia in: kg*m^2 (lbm*ft^2)

Impellers $wr^2 = (wr^2_{SG=1} - wr^2_{dry}) * SG + wr^2_{dry}$

5.1.3 Side Liner

The hard-metal wet end uses a one-piece, hard iron, suction wear plate on all sizes.

5.2 Mechanical End

Pump Size	**Cantilever Dwg #**	**Cantilever**	**Cantilever Length (mm)**	**FRAME 1**		**FRAME 2**		**FRAME 3**		**FRAME 4**
SHAFT				90mm	110mm	110mm	130mm	150mm	170mm	200mm
LCV 50-230		900	713	**2200X**						
2X3 LCV-9	4455C	1200	1013	**2201X**						
		1500	1313		**2202X**					
LCV 80-300		900	695			**3200X**				
3X4 LCV-12	7738D	1200	980			**3201X**				
		1500	1280				**3202X**			
LCV 100-400		900	705			**3203X**				
4X6 LCV-16	7591D	1200	1005			**3204X**				
		1500	1305				**3205X**			
LCV 150-500		1200	850					**4201X**		
6X8 LCV-20	7762D	1500	1150					**4202X**		
		1800	1450					**4203X**		
		2100	1750						**4204X**	
LCV 200-610		1200	776.5					**4205X**		
8X10 LCV-24	4379C	1500	1076.5					**4206X**		
		1800	1376.5						**4207X**	
		2100	1676.5							**5203X**
LCV 250-660		1200	661							**5204X**
10X12 LCV-26	4563C	1500	961							**5205X**
		1800	1261							**5206X**
		2100	1561							**5207X**
LCV 300-700		1200	651							**5208X**
12X14 LCV-28	4566C	1500	951							**5209X**
		1800	1251							**5210X**

5.2.1 Support Column

The support column is made of mild steel piping and plate. The bottom of the mounting plate is urethane coated. Concentric fits between the bearing assembly and shaft seal provide alignment without the need for shimming. It also supports the standard motor mount.

5.2.2 Bearings and Lubrication

The bearing arrangement is shown in Figure 14. A double row, taper roller bearing carries the drive load and hydraulic axial thrust. A double row, spherical roller bearing carries the impeller end radial load. Bearings are pressed to the shaft, which then slides into the housing from the drive end.

The bearings are lubricated with grease. Recommended shaft speed limitations are given below. See the *LCV Maintenace Manual* for more information regarding lubrication.

Nominal Frame Size	Limiting Speed for Grease Lubrication (rpm) Class 1	Class 2	Class 3	Class 4
1	2500	2100	1800	1500
2	1800	1650	1450	1200
3	1350	1200	1000	850
4	1000	875	750	625

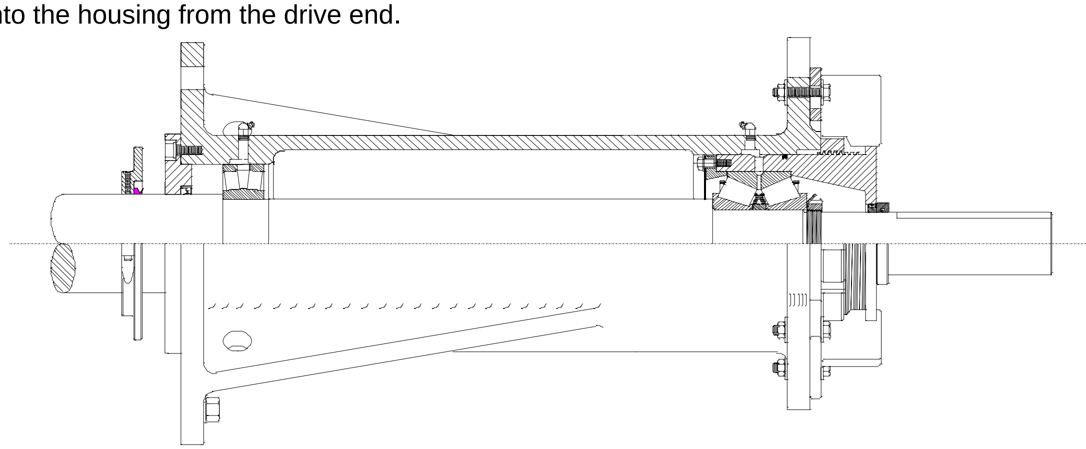


Figure 14. LCV Bearing Assembly

The bearing housing seal on the thrust end are Inpro® VBX style bearing isolators. In addition to the standard Inpro® features, these isolators contain an internal o-ring that provides a seal against contamination while the pump is not running then spins free by centrifugal force during operation. Impeller end sealing has optional Inpro seal (Fig. 15) or lip seal (Fig.16).

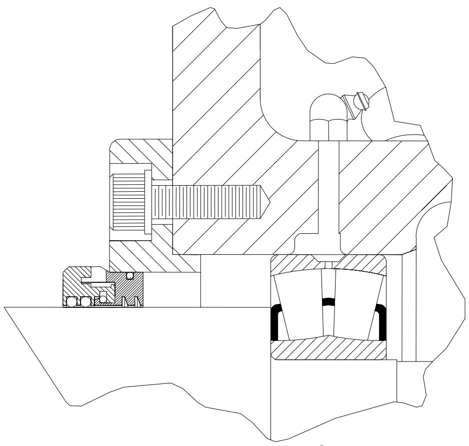


Figure 15. Optional LCV Inpro® Bearing Isolator

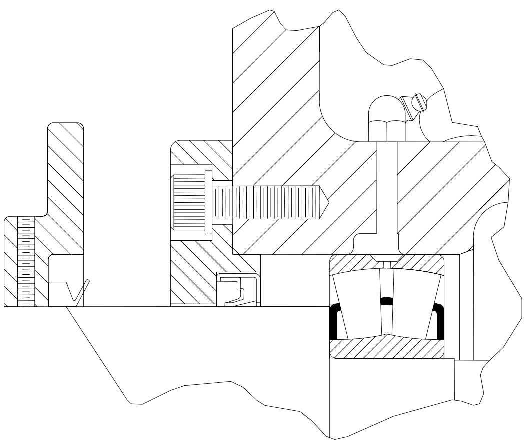


Figure 16. Standard Lip Seal with Flinger

5.2.3 Shaft Seal Design

Incidental high shaft deflections due to long cantilever length, require use of non-contacting wet end sealing. The standard seal plate prevents excess leakage of the pumped fluid that would effect pump performance. However a certain amount of the pumped fluid will be recirculated back into the sump. The seal plate is constructed of a urethane coated steel plate. The radial seal clearances are shown below:

	Frame 1	Frame 2	Frame 3	Frame 4
Seal Clearance	.188”	.188”	.250”	.250”

The optional throttle bushing maintains the same clearances as the seal plate. It is constructed of hard metal (28G or T90G). It is advisable to use the throttle bushing in highly abrasive or corrosive materials, or when the S.G. exceeds 1.25.

5.3 Allowable Flange Loadings

Allowable flange loadings are according to a modified version of French Standard NF E 44-145 as shown in Figure 18.

5.3.1 Suction Extension Piping

The standard pump is configured with a suction strainer. However an extension pipe can be installed if adequately supported. Due consideration should be given to flange loadings, additional vibration and performance penalties due to entrance losses.

5.4 Drive Arrangements

The standard drive arrangement for LCV slurry pumps is side mounted v-belt. Dimensional charts for this is shown in section 9.

The standard mount is a low cost design with limitations on motor size, weight and center distance. A diagram of the motor mounting limitations can be found in section 9.

6 Materials

6.1 Material Combinations

The table below shows some of the standard material combinations available for the LCV range. Other materials may be available. Consult your GIW / KSB sales office for more information.

Part No.	Item	Standard Metal	Corrosion Resistant Metal
101	Shell	Gasite ® 28G	Gasite ® T90G
13-19	Suction Liner	Gasite ® 28G	Gasite ® T90G
16-1	Suction Plate	Fab Steel	Fab Steel or Stainless Steel
16-3	Suction Wear Plate	Gasite ® 28G	Gasite ® T90G
18-2	Support Column	Mild Steel	
210	Shaft	4150 Steel	4150 or Stainless Steel
230	Impeller	Gasite ® 28G	Gasite ® T90G
350	Bearing Housing	Class 40 Gray Iron	
451	Seal Plate	Urethane Coated Mild Steel	
451	Throttle Seal	Gasite ® 28G or T90G	
524	Shaft Sleeve	Carbide Coated Steel	Carbide Coated or Stainless Steel

1) Throttle seal recommended for severe duty.

Figure 17. LCV Materials Combinations

6.2 Materials Selection

In selecting the appropriate materials for each slurry duty, one must consider the size, concentration and abrasivity of the solids as well as the chemical nature of the slurry. General guidelines for these are given below. For more information pertaining to specific applications, contact the GIW / KSB sales office.

Also important are the temperature and pressure limitations as given in Figures 6 and 7.

6.2.1 Gasite 28G® High Chrome White Iron

This is the standard hard-metal material for LCV slurry pumps. It is highly resistant to abrasive wear, having a typical performance of 5 to 10 times that of hardened steel. Suitable for all particle sizes, concentrations and abrasivities, and for most chemical solutions within 3 to 13 pH. Suitable for flue gas desulfurization duties of 4 pH with 10,000 to 20,000 PPM chlorides.

6.2.2 Gasite T90G® Corrosion Resistant White Iron

Provides performance superior to 28% chrome white iron and CD4MCu class alloys in slurry environments which are both erosive and corrosive. Suitable for all particle sizes, concentrations and abrasivities, and for most chemical solutions within 1 to 15 pH. Suitable for flue gas desulfurization duties of 1 pH with up to 100,000 PPM chlorides.

6.2.5 Polyurethane

A two part elastomer resin of higher hardness and strength than most rubbers, this is the standard material for LCV elastomer lined impellers. Its strength provides superior resistance to mechanical damage during operation. It also exhibits excellent resistance to abrasion of fine particles, and good chemical resistance.

7 Spare Parts

Due the erosive action of the slurry, many of the wetted components of the pump may require replacement in the course of normal maintenance. Inspection or overhaul of the mechanical components may also lead to the replacement of certain parts.

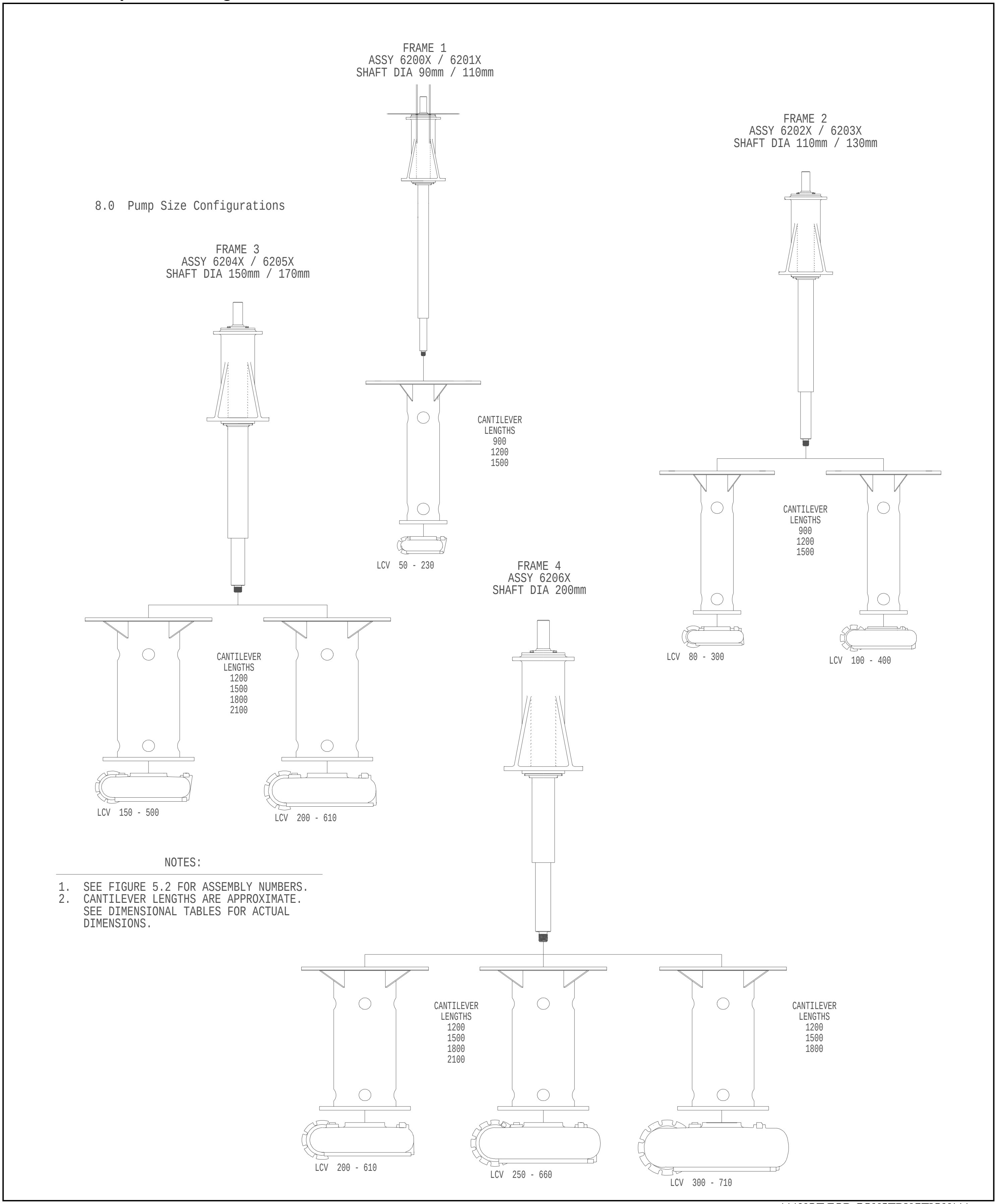
The following are recommended lists of parts to have on hand for normal maintenance and inspection. The quantities of parts kept in store will depend upon the severity of the slurry duty and the number of units operating. Maintenance practices may also favor keeping fully built sub-assemblies or complete pumps on hand in some cases. Previous experience in similar duties often provides the best experience. If in doubt, contact the GIW / KSB sales office for specific recommendations.

Wet End
- Casing
- Impeller
- Side Liner
- Gasket Kit

Wet End Sealing
- Shaft Sleeve
- Seal Plate or Optional Trottle Seal
- Gasket Kit

Bearing Assembly
- Bearings
- Gasket Kit

8.0 Pump Size Configurations



NOT FOR CONSTRUCTION

A. Appendix A - Shaft Selection Charts

The following 26 pages contain the shaft selection charts described in Section 4.4. Please refer to Section 4.4 and read the instructions below before using these charts. (For electronic link see page 1 Appendix A.)

In each case, lines for determining the limits of application for the standard LCV pump size / shaft size combinations are given over a range of slurry specific gravities (SG) and flowrates:

- Specific gravities: 1.0, 1.25, and 1.5.
- Flowrates: 25% to 125% of best efficiency flow.

A maximum rpm line is also given on each chart. This line represents the maximum class 1 operating speed. The actual maximum operating speed for your application may be lower due to wear life considerations, or pressure limitations which are not addressed by these charts. For more information see Sections 4.1, 4.2 and 4.3

To use the charts:

1. Go to the set of charts for the pump size, shaft diameter and length of cantilever combination of your choice.

2. Determine your duty point flowrates, heads and slurry specific gravities (SG). Any operating point at which the pump will remain for an extended period of time should be considered. 500,000 shaft revolutions may be used as a generic definition of "extended time". To convert this to hours:

   Hours = 8,333 / (duty RPM)

3. If working in metric units, convert your duty point flowrates and heads to the U.S. units used in these charts:

   feet = meters x (3.28)
   GPM = (meters^3 / hour) x (4.40)
   GPM = (liters / sec) X (15.9)

4. Plot your duty points (flow and head) on each chart of interest. You may wish to make extra copies of the charts for this purpose.

5. On the selected chart, locate the maximum operating speed (rpm limit). If your duty is above this line then to attain the needed performance will require going to a bigger pump.

6. Determine if a first critical speed zone (FC) exists at your duty. If such is the case then an alternate running speed or length of cantilever should be selected. Operating within these bounds may cause unacceptable vibration, which can be severe, depending on the application and stiffness on the installation. Operating above the first critical speed zone may also cause severe vibration as the pump comes up to speed through the first critical speed zone.

6. On each chart, locate the line of constant SG corresponding to your duty. If your duty SG is not equal to one of the three given values, interpolate a line. If your duty SG line does not appear on the chart, then it is above the maximum RPM line and all applications below the maximum RPM line are acceptable. If your SG is above 1.5, contact your GIW / KSB representative.

7. For BEAM DEFLECTION AT SHAFT SEAL:
   If all of your duty points fall *below* the constant SG line for deflection, then this shaft size is acceptable for your application.

   If not, a larger shaft size or shorter length of cantilever must be selected.

8. For BEARING LIFE:
   If all of your duty points fall *below* the constant SG line for bearing life, then this shaft size is acceptable for your application.

   If not, a larger frame size or a lower bearing life tolerated.

NOTES:

11. Performance Book

Multiple-speed clear water performance curves for The LCV Series Slurry Pump are found in the LCV Performance Curve Booklet