CARRY PUMPS

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CARRY
PUMPS/CONTROLS
800-49-CARRY

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COMPANY PROFILE

Dedicated to customer and quality service, Carry Manufacturing, Inc. has been in the manufacturing business since 1987. Carry purchased the Duperon pump division in 1992, and continues to manufacture water-flow management equipment. The company's product lines include the Stainless Steel Axial-Flow Submersible pumps, Fountain Pumps, Bubbler Pumps, Snorkel Pumps, High Volume Axial Flow Submersible Pumps, PVC Line Shaft Pumps, Axial Flow Line Shaft Pumps, Capsule Pump Stations, and a variety of accessories including Control Panels, Variable Frequency Drives, Floats, PVC Fittings, and many others. These products are sold both directly and through a network of distributors throughout the United States and Canada.

Carry Manufacturing is a family owned and operated company dedicated to putting the customer and their unique needs as our first priority. Over the years, we have designed new styles of pumps and accessories to meet these unique needs. For instance, our first Stainless Steel Axial Flow Submersible Pumps were only available in a vertical style. A couple of customer inquiries later and the horizontal style pumps were designed, tested and put into our production line. Similarly, we received a request from a potential customer to create a pump for use in aerial fire fighting efforts. We designed, tested and continue to improve on a Snorkel Pump used on helicopters to battle wildfires on the west coast. Another group of inquires produced the PVC Line Shaft Pumps currently being used in Aquacultural fish farming. As the agricultural market changes, we designed a variable speed pump package to allow our customers more flexibility in the size of their pump tanks and the operation of their pumps based on the flow of water through the tile system. In addition, the soft start and run feature of the variable frequency drives provide longer motor life.

Even our standard accessories have undergone changes over the years. In the beginning, we used Aluminum Strainer screens to compliment our pumps. We developed Stainless Steel screens to be more resilient to corrosion. These were replaced by the PVC/HDPE screens we use today. These screens are lighter and more rigid than the previous versions and last longer in all conditions. We have introduced new 4-bladed impellers on our 4" Stainless Steel Axial Flow Submersible pumps to increase performance and motor longevity. The control panels we offer today, include added protection for the pumps/motors in the guise of a small time delay relay that prevents rapid cycling in fixed speed drainage applications. We continuously review and improve our three phase, multi-pump and custom control panels with new technology and functionality to meet customer needs.

We enjoy the challenge of working with customers to revise and improve our products and services. We welcome your questions, comments and opportunities to assist you with your standard or unusual application needs. Please feel free to contact us for more information.

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GENERAL INFORMATION

STANDARD WARRANTY AND CONDITIONS OF SALE

PRELIMINARY INFORMATION: Any preliminary drawings and illustrative materials used in the specification build-up process show general arrangement and approximate dimensions only. Certified drawings will be submitted after receipt of an order, if required.

PRICES: Any listed price is subject to change without notice. Orders are accepted with the understanding that the product will be billed at the price in effect at the time of shipment, unless otherwise specified by Carry Manufacturing, Inc.

QUOTATIONS: Any quotation 60 days old is subject to change without notice. The price of each order is subject to the resource availability and costs incurred by Carry Manufacturing, Inc. at the time of manufacture.

FREIGHT: F.O.B. Carry's factory in Caro, Michigan. Catalog weights are careful estimates, but they are not guaranteed. No allowance will be made for cartage at destination.

TAXES AND OTHER CHARGES: The prices do not include any Federal, State or Local sales, use or other taxes, or brokerage fees that may be applicable. The amount of any such applicable taxes or fees will be added to the invoice at the rate in effect at the time of shipment.

ACCEPTANCE: No order shall be binding upon Carry Manufacturing, Inc. until accepted in writing by an authorized official at its home office in Caro, Michigan. Any contract for the sale of product and these Conditions of Sale, shall be governed by and construed according to the Uniform Commercial Code as adopted in the State of Michigan.

If the product quoted is not approved by the Consulting Engineer, Carry Manufacturing, Inc. assumes no responsibility to furnish any item manufactured by others.

CREDIT: Credit worthiness of a Purchaser will be determined upon receipt of the contract. Credit terms, if authorized, are subject to change during the life of the contract if the financial condition of the Purchaser changes.

CANCELLATION: Cancellation of orders will be accepted with the understanding that Carry Manufacturing, Inc. will be entitled to reimbursement for expenses incurred at the time of cancellation, including any and all special engineering, design, tooling, manufacturing, storage or transportation costs.

TERMS, PAYMENT & INVOICING: Standard payment terms are COD. Payment is due prior to shipment. For Open Accounts (with approved credit), payment terms are NET 30 days from the date of invoice. Retaining a percentage of the contract sale amount is prohibited without prior, written agreement. Payment must be made in U.S. Funds. An invoice will be rendered as of the date product is ready for shipment. A service fee of 1-1/2% per month on all invoices over 30 days past due will be imposed. In the event of any default by the Purchaser, Carry Manufacturing, Inc. shall have the right to repossess the product as well as all other rights afforded to a conditional seller under the provisions of the Uniform Conditional Sales Act and any other applicable laws.

MANUALS: One (1) owner's/service manuals will be provided with each purchase of a single pump. Additional owner's/service manuals are available for $15.00 per set.

DELIVERY: The estimated shipping date is based on the production time required to process the order commencing with the date the order is accepted by Carry Manufacturing, Inc. In the event it is necessary to revise the design, specifications, or Conditions of Sale, the shipping date shall be automatically extended by the period of time required to achieve the mutually agreed upon correction or adjustments of the design, specifications or Conditions of Sale.

Carry Manufacturing, Inc. reserves the right to make shipment of completed segments of an order and pro rate the invoice for those segments as shipments are made.

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CARRY MANUFACTURING, INC.
GENERAL INFORMATION

STANDARD WARRANTY AND CONDITIONS OF SALE

DELAYS IN DELIVERY: Carry Manufacturing, Inc. shall not be responsible for any delay or for any damages suffered by the Purchaser by reason of any delay due to fires, strikes, riots, Acts of God, priorities, Government orders or restriction, delays in transportation, delays of suppliers of materials or parts, inability to obtain necessary labor, or other causes beyond the control of Carry Manufacturing, Inc. In the event of such a delay, the shipping date shall be extended for a period of time equal to the time lost by reason of such a delay.

Any product held more than three (3) weeks after the estimated shipping date at the Purchaser's request will be stored at the Purchaser's expense unless otherwise agreed upon.

DAMAGE OR LOSS IN TRANSIT: Delivery of the product to a carrier at Carry Manufacturing's plant or other shipping point selected by Carry Manufacturing shall constitute delivery to the Purchaser. Regardless of freight payment, all risk, loss or damage in transit shall pass to the Purchaser at that time. The Purchaser shall make claims for loss or damage to product while in transit, against the carrier and not against Carry Manufacturing, Inc. Carry Manufacturing, Inc. will assist the Purchaser in securing satisfactory adjustment of such claims.

BETWEEN SHIPMENT AND PAYMENT: The Purchaser shall be responsible for the care, maintenance and protection of the material or product after delivery. The Purchaser agrees to provide and maintain adequate insurance for the product or materials shipped to the Purchaser against loss or damage by fire, explosion or other causes during the time between shipment and final payment in an amount fully protecting Carry Manufacturing, Inc.

The title and right of possession to the machinery shall remain with Carry Manufacturing, Inc. and the machinery shall remain personal property irrespective of attachment to, or location on, any foundation or in any structure, until all payments shall have been made in cash. The Purchaser will do all acts necessary to protect the above title and right.

INSTALLATION: Unless specifically stated otherwise, all material or product shall be installed and placed in service by, at the expense of, and under the exclusive responsibility of the Purchaser.

RETURNED PRODUCT: Authorization and shipping instructions for the return of any product must first be obtained by the Purchaser from Carry. Otherwise shipment will be refused. Contact Carry Manufacturing to be issued an RGA form. Complete the form and include a copy with the product to be returned freight pre-paid. Only unused standard product or materials of current design by Carry will be considered for return. Custom products cannot be returned for credit. If the returned product is in sellable condition, a credit memorandum will be issued minus a **minimum restocking charge of 15%** and minus any and all transportation charges paid by Carry.

PUMP WARRANTY REGISTRATION CARD AND PROOF OF PURCHASE: Within 30 days of the purchase of the pump, Purchaser shall mail to Carry by certified mail, return receipt requested, the pump warranty registration card accompanied by proof of purchase from the retail seller indicating the date and purchase price of the pump at issue. This warranty is void unless the warranty registration card and proof of purchase are provided to Carry as set out above and are on file with Carry.

LIMITED WARRANTY: Carry warrants the product sold by it to be free from defects in materials and workmanship for a period of one (1) year from the date of purchase of the pump as verified by the product warranty registration card and proof of purchase provided to Carry by purchaser.

<continued>

CARRY MANUFACTURING, INC.
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STANDARD WARRANTY AND CONDITIONS OF SALE

WARRANTY DISCLAIMER: This warranty does not apply to the product if used in an aquacultural application or to pumps that have been subject to misuse (including use in a manner inconsistent with the design of the pump), abuse, neglect, accident or improper installation or maintenance, or to pumps that have been altered or repaired by anyone other than Carry. The warranties in this agreement are in lieu of all other warranties, express or implied, including without limitation, any warranties of merchantability or fitness for a particular purpose, said warranties being expressly disclaimed.

WARRANTY AMENDMENTS: Prior or subsequent courses of dealing, trade usage and verbal agreements not reduced to a writing signed by Carry, to the extent they differ from, modify, add to or detract from this warranty shall not be binding upon Carry. There are no agreements, promises or understandings, either verbal or written, that are not fully expressed in this warranty. No statements, recommendations or assistance by either party have been relied upon by either party nor shall they be relied upon and shall not constitute a waiver by either party of any of the provisions hereof. This warranty may be amended or altered only if agreed to in writing signed by Carry.

LIMITED REMEDY: Carry and Purchaser agree the repair or replacement of the pump at issue is a commercially reasonable allocation of risk and, therefore, Purchaser agrees that its sole and exclusive remedy against Carry shall be limited to the repair or replacement of the pump at issue. This exclusive remedy shall not be deemed to have failed of its essential purpose so long as Carry is willing and able to repair or replace the pump at issue. In the event Carry is unable to repair or replace the pump at issue in a manner acceptable to purchaser, or in the event it shall be determined by a court having jurisdiction thereof that any provisions of this warranty are unconscionable or fail in its essential purpose, then the maximum liability of Carry shall be that as set forth in the paragraph next following entitled "Limitation on Liability".

LIMITATION ON LIABILITY: Carry shall not be liable for any loss, damage or injury resulting from delay in delivery or installation of the pump or for any failure to perform which is due to circumstances beyond its control. Carry and Purchaser agree it is a commercially reasonable allocation of risk that the maximum liability, if any, of Carry for all damages, including without limitation contract damages and damages for injuries to persons or property, whether arising from Carry's breach of this agreement, breach of warranty, negligence, strict liability or other tort, is limited to an amount not to exceed the purchase price of the pump at issue in the dispute and said liability is so limited. In no event shall Carry be liable to Purchaser for any incidental, consequential or special damages, including without limitation, lost revenues and profits, even if it has been advised of the possibility of such damages.

WARRANTY CLAIM PROCEDURE: This warranty is valid only if the following conditions are complied with by the Purchaser: Purchaser shall notify Carry in writing of the defect in the pump at issue within 30 days of discovery of the defect. The notice shall include with it copies of the warranty card, proof of purchase and the return receipt signed by a representative of Carry as provided above. In the event repair or replacement of the pump at issue is approved by Carry, Purchaser shall, upon written notice by Carry of the approval, return the pump to Carry, freight prepaid. Carry will return the repaired or replaced pump to Purchaser, freight prepaid. The repair or replacement of the pump shall not extend the duration of the one-year warranty term.

GOVERNING LAW: This warranty shall be governed and controlled by and enforced in accordance with the laws of the State of Michigan, U.S.A., in all respects.

FORUM: The parties agree they are of equal bargaining power and irrevocably submit to the jurisdiction and venue of the Circuit Court for the County of Tuscola, State of Michigan or, if original jurisdiction can be established, the United States District Court for the Eastern District of Michigan, Northern Division, with respect to any performance or breach of this agreement. The parties hereby stipulate that the venues referenced in this agreement are convenient to each of them.

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

PRODUCT USE AND SAFETY INFORMATION

* Do not use a Carry Stainless Steel Axial-Flow Submersible Pump in a swimming area.

* The electrical control panel must be installed observing all applicable state and local codes as per the latest revision of the National Electric Code.

* A service entrance rated disconnect may need to be fused depending on the distance it is from the control panel and the presence of the primary power circuit breaker in the control panel. Consult the National Electric Code.

* A good earth ground must be provided at the electrical service entrance by means of a metal grounding stake. The true ground must also be connected to the ground terminal in the electrical control panel.

* A single-phase Carry Stainless Steel Axial-Flow Submersible Pump must be connected to the correct Franklin Electric, or equivalent, pump motor control to validate the warranty.

* A three-phase Carry Stainless Steel Axial-Flow Submersible Pump must be protected by a magnetic starter with extra-quick trip overload relays in all legs to validate the warranty.

* The liquid level control wiring must be encapsulated or low voltage for safety.

* Running a Carry Stainless Steel Axial-Flow Submersible Pump dry (i.e., without water going by the motor to cool the motor) will damage the motor. Running the pump dry will create a no-load situation that will not increase the amperage draw and will not activate any protective device in the electrical control panel (unless your electrical control panel is specially designed to protect the pump with a low-amperage-draw monitor).

* Show caution when operating a pump on manual control not to let the pump run dry. (See warning above.)

* Do not let water freeze around the pump. Damage will result to the pump and motor if water freezes around them.

* Remove the construction debris, muck and sludge from the sump bottom before the initial start-up. These can starve the pump of water and damage the motor.

* If a Carry Strainer Screen is equipped with your Carry Stainless Steel Axial-Flow Submersible Pump, it will provide an effective barrier from debris in storm water and water transfer applications. However, the Carry Strainer Screen will collapse from the suction of the pump as debris, muck or sludge cover more than 95% of its surface.

* Do not remove your pump before the discharge pipe is drained or the liquid blocked, or rapid discharge back into the sump may occur.

USEFUL INFORMATION

The information contained on the following pages has been included to assist in the design and selection process of a pumping system, Capsule Pump Station or purchase of accessories. Included is information on standard measures, useful pumping definitions, formulas, tables for determining cable size, drainage needs, carrying capacity of tile, friction loss, etc.

Not all situations require the use of this information. It has been included in order to assist the non-engineer in designing a pump system with the appropriate equipment and layout to get optimal performance. An example of how to use this information follows.

Application: Farm Drainage

Problem: 40 acre parcel of farmland with a 6" main at a .20 slope (grade) with tile outlet higher than the main.

Solution: Drain the main into a wet well fitted with an axial-flow submersible pump to transfer the water upward to the outlet (a ditch or pond).

Process:

Step 1: Using the *Carrying Capacity of Drain Tile* table on page 11, find the 6" pipe and .20 grade section. Your tile main can transport to your pump pit, a maximum of 94.20 gallons of water every minute. Using the *Equivalents of Capacity or Volume Factors* table on page 7, 1" of standing water on 1 square mile equals 2,323,200 cubic feet of water. This same table tells us that one cubic foot of water equals 7.48 gallons. Therefore: 2,343,200 x 7.48 = 17,377,536 gallons of water 1" deep on a square mile.
However, you are dealing with acres not square miles. There are 640 acres in a square mile. This works out to 27,152.40 gallons of water per acre times 40 for our example. This is 1,086,096 gallons. Of course, your soil, not to mention your crops, will absorb a good portion of this water. Let's say that half of that is soaked up and will stay in the soil and plants. That still leaves you with 543,048 gallons of water to contend with. Your tile main is maxed out at 94.20 gallons per minute. This means it will take 5,764.84 minutes or at least 96 hours for that water to get from the surface of your field to the pump pit.

Step 2: The Carry Pump cycle rate is based on the horsepower and phase of the motor. 1 through 5 Horsepower, single phase pumps have maximum cycles of 100 times per a 24 hour period. 1 through 5 Horsepower, three phase pumps have maximum cycles of 300 times per a 24 hour period. 7-1/2 through 15 Horsepower, single phase pumps have maximum cycles of 50 times per a 24 hour period. 7-1/2 through 15 Horsepower, three phase pumps have maximum cycles of 100 times per a 24 hour period. Pumps run using a Carry VFD package system may double these cycle rates due to the "soft" starting of the Variable Frequency Drives. This means that you need to have enough storage area (distance between on and off floats) to allow the pump to run for at least one minute or more.

<continued>

USEFUL INFORMATION

Process:

Step 2 (continued):

You want a pump to operate at 200 gpm (twice the carrying capacity of your tile), so you would need to store at least 300 gallons before the pump kicks on. Standard DFD float switches are designed with a pumping range of 1" to 48". If you want to set them at the maximum of 48" (or 4'), how big of a holding tank (wet well) would you need? The table on page 10 shows the *Gallon Capacity of Round Tanks*. For 300 gallons in 4', you would need at least 75 gallons per foot in height (300/4=75). According to the table, a 4' diameter tank holds 94 gallons per every foot in height (a 3'6" tank only holds 71.97 gallons: not enough).When sizing the pump pit, remember you have to have a tank wide enough to get the pump, discharge plumbing and floats into.

The height of the tank is determined by the minimum submergence of the pump, the pumping range of the floats and the depth of your tile main. The "off" float should be set no lower than the minimum submergence of the pump; for example three foot. This will keep the pump from running dry (remember this is a submersible pump). You will need another four foot of storage to maintain your pump cycle (the distance between the "on" float and the "off" float as determined earlier). For best results, your tank should be set so that the inlet of your tile main is close to the same level as your pump "on"; in this example lets use a four foot deep main. You will need a tank approximately 10' deep (3+4+4=11). This means you will be lifting the water approximately 8 foot; the distance from the top of the pump to the top of the tank. This is your static lift.

Step 3: Now, we must figure the friction loss. Friction loss is measured in the horizontal distance the water must be pumped and the fittings that are used. This results in greater pressure on the pump. Let us say, for example, that you are pumping up from the pump 8 feet to a 90^{o} long radius elbow and then pumping over to a ditch which is 55 feet from your pit. Using the *Friction Loss Table* on page 21, if you use 4" PVC pipe and fittings at 200 gpm you will have head loss of 2.06 feet for every 100 feet of pipe. Every long radius elbow adds 7' to what the pump "sees". Using the friction loss of 2.06/100 feet, our formula is:

(2.06'/100') (62') = friction loss or 1.2772'

We add this to your static head of 8' and get a total dynamic head of 9.2772'. This is the value you want to use when viewing pump performance curves.

Step 4: You are looking for a pump that will pump 200 gpm at a total dynamic head of 9.2772'. Go to the *Storm Water* section if this catalog and review the pump curves for each model. This is what you will learn:

A 1-1/2 HP pump with a 13° impeller pumps 220 GPM at approximately 9.25'
A 2 HP pump with a 13° impeller pumps 220 GPM at approximately 9.25'
A 2 HP pump with a 17° impeller pumps 340 GPM at approximately 9.25'

Suggestion: At this point, with no other considerations, we would suggest the 1-1/2 HP pump with a 13° impeller. This is slightly over-sized for what your original requirements were, but it would do the job with less wear on the pump. Remember if you change a variable, you will need to repeat the entire process over again with the new numbers. This information is meant only as a guide line and expert help is only a phone call away by calling Carry Manufacturing, Inc.

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

REQUIREMENTS AND EQUATIONS FOR PUMP DRAINAGE

PUMPING CAPACITY

Pump capacity shall be sufficient to remove the design flows as computed from the appropriate sub-surface drainage coefficient, surface drainage curve or special design criteria. Pump installations to remove surface or open ditch drainage should be designed to pump the entire watershed draining to the pump, including seepage. **Installations designed to pump tile water only should have a capacity equal to the maximum discharge capacity of the tile draining to the pump plus 10 percent.**

PUMP CAPACITY CONVERTED FROM DRAINAGE COEFFICIENT TO GALLONS PER MINUTE

Q (Gallons per Minute) equals C x A x .042 x 448.8

Where “C” is the drainage coefficient in inches per 24 hours; "A" is the watershed area in acres; .042 is a factor (1" runoff in 24 hours for one acre = .042 c.f.s.); 448.8 is a factor to change c.f.s. to Gallons per Minute.

WATER STORAGE (DITCH OR TANK)

Sufficient active water storage needs to be provided to reduce the number of pump starts. The active storage is computed as follows: $S = (2Q / n)$

Where: "S" is the Storage volume in cubic feet
"Q" is the pump capacity in Gallons per Minute;
"n" is the number of cycles per hour

PRESSURE

1 foot of water at 62° F. =.433 pound per square inch;
62.355 pounds per square foot;
.883 inch of mercury;
821.2 feet of air and
barometric pressure of 29.92.

EQUIVALENTS OF CAPACITY OR VOLUME FACTORS

1-U.S. gallon of water = 231 cubic inches
1-U.S. gallon of water = .1337 cubic foot
1-cubic foot water = 7.48 U.S. gallons
1- U.S. gallon of water = 3.785 liters
1- liter = .264 U.S. gallon
1- cubic foot water = 28.316 liters
1-cubic foot water = .0283 cubic meter

1-liter = 61.025 cubic inches
1-liter = .0353 cubic foot
1-cubic meter = 264 U.S. gallons
1-cubic meter = 1.308 cubic yards
1-cubic meter = 61,028 cubic inches
1-cubic meter = 35.310 cubic feet
1-inch deep on 1 sq. Mile = 2,323,200 cubic feet

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CARRY MANUFACTURING, INC.
GENERAL INFORMATION

REQUIREMENTS AND EQUATIONS FOR PUMP DRAINAGE

PUMP SYSTEM FORMULAS

Water Horsepower
= (GPM x 8.33 x Head) / 33,000
= (GPM x Head) / 3,960

Where: GPM = Gallons Per Minute
8.33 = Pounds of water per gallon
33,000 = Ft. Lbs. per minute in one HP
Head = Difference in energy head in feet (field head)

Bowl BHP
= (Head x GPM x Sp. Gr.) / (3,960 x Eff.)

Where: GPM = Gallons Per Minute
Head = Lab. Head (including column loss)
Eff. = Lab. Eff. of Pump Bowls (from performance curves)

Field BHP = Laboratory BHP + Shaft Loss

Shaft Loss = HP loss due to mechanical friction of the line shaft bearings.

Total BHP = Bowl BHP + Thrust Bearing Loss+ Shaft Loss

Thrust Bearing Loss = Horsepower Loss in Driver Thrust Bearings (See Note 1.)

Input Horsepower = Total BHP / Motor Eff.

Motor efficiency from motor manufacturer (decimal).

Field Efficiency = Water Horsepower / Total BHP
Water HP as determined above.
Total HP as determined above.

Overall Plan Efficiency = Water Horsepower/ Input Horsepower

Water HP as determined above.
Input HP as determined above.
(See Note 2 on page 9)

ELECTRICAL

Input HP = BHP/ Mtr. Eff.
= (4.826 x K x M x R) / T
= (1.732 x E x I x PF) / 746

Where:
BHP = Brake Horsepower as determined above
Mtr. Eff. = Rated Motor Efficiency
K = Power Company Meter Constant
M = Power Company Meter Multiplier, or Ratio of Current and Potential Transformers Connected with Meter
R = Revolutions of Meter Disk
T = Time in Sec. for R
E = Voltage per Leg Applied to Motor
I = Amperes per Leg Applied to Motor
PF = Power Factor of Motor
1.732 = Factor for 3-phase Motors (This reduces to 1 for single phase motors.)

Kilowatt Input to Motor = .746 x Input HP
= (1.732 x E x I x PF) / 1,000

KW-Hrs Per 1,000 Gallons of Cold Water Pumped Per Hr.
= (Hd. (ft) x 0.00315) / (Pump Eff. x Motor Eff.)

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CARRY MANUFACTURING, INC.
GENERAL INFORMATION

REQUIREMENTS AND EQUATIONS FOR PUMP DRAINAGE

PUMP SYSTEM FORMULAS

MISCELLANEOUS

Discharge Head (in ft. of fluid pumped)
= (Discharge Pressure (PSI) x 2.31) /
Sp. Gr. of Fluid Pumped

Velocity Head = V^2 / 2 G

Where:
V = Velocity of Water (Ft./Sec.)
G = Acceleration Due to Gravity
= 32.17 ft/sec^2

Torque (foot pounds) = (HP x 5.250) / N

Where:
HP = Horsepower
N = RPM

NOTES:

1. Thrust bearing losses in HP per 100 RPM per 1,000 lbs. thrust:

FR.	182TP-215TP-.0059
	254TP -.0071
	256TP-258TP-.0085
	324TP-326TP-.0132
	364TP-365TP-.0148
	404TP-425TP-.0165
	444TP-505TP-.0170 Stacked Brgs.

2. Overall plant efficiency sometimes referred to as "Wire to Water" efficiency.

3. Add 4% to bowl total BHP to cover right angle gear and flexible shaft mechanical losses.

FORMULA FOR CHANGING PUMP SPEED CHANGES IN PERFORMANCE

Pump curves are generally based on standard motor speeds. For performance of pumps at speeds other than those published, it is necessary to calculate new capacity, head, and BHP.

The following ***Affinity Laws*** are used in speed variation calculations:

1. The capacity of a turbine pump varies in direct proportion to the speed.
2. The head of a turbine pump varies in proportion to the square of the speed.
3. The horsepower varies in proportion to the cube of the speed.

In general, it is good engineering practice not to increase the speed of a turbine pump designed for 1770 RPM to more than 2200 RPM. At higher RPM harmonic or shaft vibration may occur causing excessive wear in the pump.

FORMULAS:

$Q_2 = Q_1 (N_2/N_1)$

$H_2 = H_1 (N_2/N_1)^2$

$BHP_2 = BHP_1 (N_2/N_1)^3$

Where: Q = Quantity in GPM
H = Head in Feet
BHP = Brake Horsepower
N_1 = Speed in RPM (published)
N_2 = Speed in RPM (required)
NOTE: Do not exceed minimum trim diameter indicated on standard catalog curve.

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CARRY MANUFACTURING, INC.
GENERAL INFORMATION

U.S. GALLONS IN ROUND TANKS
For One Foot in Depth

Dia. of Tanks	No. U.S. Gals.	Cu. Ft. and Area Sq. Ft.	Dia. of Tanks	No. U.S. Gals.	Cu. Ft. and Area Sq. Ft.	Dia. of Tanks	No. U.S. Gals.	Cu. Ft. and Area Sq. Ft.
1'0"	5.87	.785	7'6"	330.48	44.18	14'0"	1151.50	153.94
1'6"	13.22	1.767	8'0"	376.10	50.27	14'6"	1235.30	165.13
2'0"	23.50	3.142	8'6"	424.48	56.75	15'0"	1321.90	176.71
2'6"	36.72	4.909	9'0"	475.89	63.62	15'6"	1411.50	188.69
3'0"	52.88	7.069	9'6"	530.24	70.88	16'0"	1504.10	201.06
3'6"	71.97	9.621	10'0"	587.52	78.54	16'6"	1599.50	213.82
4'0"	94.00	12.566	10'6"	640.74	86.59	17'0"	1697.90	226.98
4'6"	118.97	15.900	11'0"	710.90	95.03	17'6"	1799.30	240.53
5'0"	146.88	19.630	11'6"	776.99	103.87	18'0"	1903.60	254.47
5'6"	177.72	23.760	12'0"	845.35	113.10	18'6"	2010.80	268.80
6'0"	211.51	28.270	12'6"	918.00	122.72	19'0"	2120.90	283.53
6'6"	248.23	33.180	13'0"	992.91	132.73	19'6"	2234.00	298.65
7'0"	287.88	38.480	13'6"	1070.80	143.14	20'0"	2350.10	314.16

To find the capacity of tanks greater than the largest given in the table, look in the table for a tank of one-half of the given size and multiply its capacity by 4, or one of one-third its size and multiply its capacity by 9, etc.

VOLUME OF RECTANGULAR TANKS

Using Feet: Length x Width x Height x 7.48 = Gallons.
Using Inches: (Length x Width x Height)/231 = Gallons.

<continued>

CARRY MANUFACTURING, INC.

CARRYING CAPACITY OF DRAIN TILE

To determine the gallons per minute produced by drainage tile, use the tables below to find the size of your tile and the slope (grade) of the tile. Using these numbers determine the cubic feet per second (C.F.S) the velocity (FT/SEC) and the gallons per minute (GPM) from the table below. This is the carrying capacity of the drainage tile regardless of the amount of water the acreage will produce. This is the amount of water that particular size tile with that slope will flow through to the drainage ditch or sump well. For example: if you have a slope of 0.20 and a 6" drainage tile, this set-up will produce 94.20 gallons per minute into your sump. You will need to have a pump capable of pumping 94.2 gallons per minute in order to drain the sump.

FALL PER 100 FT. (SLOPE OR GRADE)												
Pipe Size	.05			0.10			0.15			0.20		
	C.F.S	FT/SEC	GPM	C.F.S.	FT/SEC	GPM	C.F.S.	FT/SEC	GPM	C.F.S.	FT/SEC	GPM
5				0.09	0.70	40.40	0.11	0.80	49.40	0.13	1.00	58.30
6	0.11	0.60	49.40	0.15	0.80	67.30	0.19	1.00	85.30	0.21	1.10	94.20
8	0.23	0.70	103.20	0.33	1.00	148.10	0.40	1.20	179.50	0.46	1.30	206.40
10	0.42	0.80	188.50	0.60	1.10	269.30	0.74	1.40	332.10	0.84	1.50	377.00
12	0.69	0.90	309.70	0.97	1.20	435.30	1.20	1.50	538.60	1.38	1.80	619.30

<continued>

CARRY MANUFACTURING, INC.

CARRYING CAPACITY OF DRAIN TILE

FALL PER 100 FT. (SLOPE OR GRADE)												
Pipe Size	0.25			0.30			0.40			0.50		
	C.F.S.	FT/SEC	GPM	C.F.S	FT/SEC	GPM	C.F.S.	FT/SEC	GPM	C.F.S.	FT/SEC	GPM
5	0.15	1.10	67.30	0.16	1.20	71.80	0.18	1.40	80.80	0.21	1.50	94.20
6	0.24	1.20	107.70	0.27	1.40	121.20	0.30	1.60	134.60	0.34	1.70	152.60
8	0.51	1.50	228.90	0.56	1.60	251.30	0.65	1.80	291.70	0.74	2.10	332.10
10	0.96	1.70	430.90	1.03	1.90	462.30	1.21	2.20	543.00	1.34	2.50	601.40
12	1.53	2.00	686.70	1.70	2.20	763.00	1.95	2.50	875.10	2.18	2.80	978.40

FALL PER 100 FT. (SLOPE OR GRADE)												
Pipe Size	0.75			1.00			1.50			2.00		
	C.F.S.	FT/SEC	GPM	C.F.S.	FT/SEC	GPM	C.F.S.	FT/SEC	GPM	C.F.S.	FT/SEC	GPM
5	0.25	1.80	112.20	0.29	2.10	130.20	0.36	2.70	161.60	0.42	3.10	188.50
6	0.42	2.10	188.50	0.48	2.50	215.40	0.59	3.00	264.80	0.68	3.50	305.20
8	0.89	2.60	399.40	1.04	3.00	466.80	1.25	3.60	561.00	1.48	4.20	664.20
10	1.62	3.00	727.10	1.89	3.50	834.80	2.34	4.30	1050.20	2.68	4.90	1202.80
12	2.67	3.40	1198.30	3.08	3.90	1382.30	3.80	4.80	1705.40	4.36	5.60	1956.80

CARRY MANUFACTURING, INC.

ACRES DRAINED DETERMINED BY SIZE AND SLOPE OF DRAIN TILE

To determine the slope and pipe size necessary to drain your field, use the table below based on your acreage and the drainage coefficient for your area. For example: If you have 40 acres and a drainage coefficient of 1/2", using the table below, search the 1/2" coefficient columns of each slope until you encounter one that meets or exceeds your acreage (40). You should use that slope (grade) and the discharge pipe size in the left hand column to tile your acreage.

FALL PER 100 FT. (SLOPE OR GRADE)																								
Pipe Size	.05						0.10						0.15						0.20					
	Drainage Coefficient																							
	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"
5							6	4.5	3	2.3	1.5	1	7	5.4	3.6	2.7	1.8	1.4	8	6	4.2	3	2	1.5
6	7	5	3	2.6	1.8	1.3	10	7	5	4	2.3	1.8	12	9	6	4.5	3	2.3	14	10	7	5	3.4	2.5
8	15	11	7	6	4	3	21	16	11	8	5	4	25	19	13	10	6	4.5	29	22	15	11	7	5.5
10	27	20	14	10	7	5	38	29	19	14	10	7	47	35	24	17	12	9	54	40	27	20	13	10
12	50	33	22	17	11	8	62	47	31	23	16	12	76	57	38	28	19	14	88	66	44	33	22	16

<continued>

CARRY MANUFACTURING, INC.

ACRES DRAINED DETERMINED BY SIZE AND SLOPE OF DRAIN TILE

FALL PER 100 FT. (SLOPE OR GRADE)																								
Pipe Size	0.25						0.30						0.40						0.50					
	Drainage Coefficient																							
	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"
5	9	7	4.7	3.5	2.4	1.8	10	8	5	3.8	2.5	2	12	9	6	4.4	2.9	2.2	14	10	7	5	3.4	2.5
6	15	12	8	5.8	3.9	2.9	17	13	9	6	4.2	3.2	19	15	10	7	5	3.7	23	17	11	8	6	4
8	32	25	16	12	8	6.1	36	27	18	13	9	7	41	31	21	16	10	8	47	36	24	18	12	9
10	61	46	31	23	15	11	65	50	33	25	16	12	77	58	39	29	19	13	84	64	43	32	21	14
12	97	73	49	37	24	18	108	82	54	41	27	20	124	94	62	47	31	23	139	105	70	52	35	26

FALL PER 100 FT. (SLOPE OR GRADE)																								
Pipe Size	0.75						1.00						1.50						2.00					
	Drainage Coefficient																							
	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"	3/8"	1/2"	3/4"	1"	1.5"	2"
5	16	12	8	6	4	3	19	14	9	7	5	3.4	23	18	12	9	6	4.3	27	20	14	10	7	5
6	28	20	13	10	7	5	32	23	15	12	8	6	40	29	19	14	9	7	45	33	22	16	11	8
8	58	43	28	21	14	11	66	50	33	25	17	12	83	63	40	30	20	15	94	71	47	36	24	18
10	103	78	52	39	26	19	120	91	60	45	30	23	149	112	75	56	37	28	170	129	86	64	43	37
12	170	128	85	64	43	32	196	148	98	74	49	37	242	183	121	91	61	46	278	210	139	105	70	52

POWER CONSUMPTION OF ELECTRIC MOTORS

There are two methods commonly used to check the power consumption of an electric motor. The first of these requires the use of an ampmeter and voltmeter. The following formula is then used utilizing the instrument readings:

Kilowatts = (I x E x P.F. x C)/1000

Where: I = amperes (meter reading)
E = volts (meter reading)
P.F. = Power Factor (See manufacturer's published operating characteristics for vertical motors.)
C = 1 for single phase current
= 2 for two phase, four wire control
= 1.73 for three phase current

The second method commonly used to determine power consumption utilizes the watt-hour meter in the power line. The exact time for a given number of revolutions of the meter disc is measured with a stopwatch and the following formula used:

Kilowatts = 3.6 x K x M x R/t

Where: K = Disc constant, representing watt-hours per revolution. This factor is found on the meter nameplate or painted on the disc.
M = Product of current transformer ratio and potential transformer ratio.(When either transformer is not used the equivalent ratio is 1.)
R = Total revolutions of watt-hour meter disc.
t = Time for total revolutions of disc in seconds.

COST OF PUMPING USING AN ELECTRIC MOTOR

The cost of operating a vertical turbine pump may be determined by several different methods.

1. If the cost of operation per hour is desired, the power consumption as determined by use of the methods previously described may be used:
   Cost/hour of operation = KW's consumed x cost per KWh.

2. The cost of operation may be estimated by determining the input horsepower and converting it to kilowatts:
   Cost/hour of operation = 1 HP x .746 x cost per KWh.

3. A somewhat less accurate estimate may be made by using the following formula:
   Cost/hr. of operation = (GPM x Tot. Hd. x .746 x Cost/KWh)/ (3960 x Pump Eff. x Motor Eff.)

<continued>

COST OF PUMPING USING AN ELECTRIC MOTOR.(cont'd)

4. It is often desirable to express the cost of operating a pump in terms of "cost per 1,000 gallons". To do this the above figures of cost per hour of operation may be used with the rated capacity of the pump as follows:

   Cost per 1,000 Gallons = Cost per Hour / 1,000

5. For convenience the following table may be used to estimate power consumption and cost of operation when the overall efficiencies are known. The table gives power consumed pumping 1,000 GPM at one foot total head at various overall pump efficiencies.

OVERALL EFFICIENCY PUMP UNIT	KILOWATTS PER 1000 GALLONS AT ONE FOOT T.H.	OVERALL EFFICIENCY PUMP UNIT	KILOWATTS PER 1000 GALLONS AT ONE FOOT T.H.	OVERALL EFFICIENCY PUMP UNIT	KILOWATTS PER 1000 GALLONS AT ONE FOOT T.H.
32	.00980	53	.00592	74	.00424
33	.00951	54	.00581	75	.00418
34	.00922	55	.00570	76	.00413
35	.00896	56	.00560	77	.00407
36	.00871	57	.00550	78	.00402
37	.00848	58	.00541	79	.00397
38	.00826	59	.00532	80	.00392
39	.00804	60	.00523	81	.00387
40	.00784	61	.00514	82	.00382
41	.00765	62	.00506	83	.00378
42	.00747	63	.00498	84	.00373
43	.00730	64	.00490	85	.00369
44	.00713	65	.00482	86	.00365
45	.00697	66	.00475	87	.00360
46	.00682	67	.00468	88	.00356
47	.00667	68	.00461	89	.00352
48	.00653	69	.00454	90	.00348
49	.00640	70	.00448		
50	.00627	71	.00442		
51	.00615	72	.00435		
52	.00603	73	.00430		

Overall efficiency, as indicated, is the input-output efficiency including all losses in the pump unit, pumping 1,000 gallons of clear water one foot of total head. Therefore, in determining the kilowatts per 1,000 gallons pumped, it is only necessary to multiply the factor corresponding to the overall efficiency by the number of feet head at which the total dynamic head has been calculated.

EXAMPLE: Assume an overall efficiency of 65% and a total head of 200 feet.
Kilowatts per 1,000 gallons = .00482 x 200 = .964

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

COST OF PUMPING USING AN ELECTRIC MOTOR

An alternate method of calculating the cost of an electric motor is to use the maximum kilowatts used from the following table. Note: average rate per kilowatt hour may vary from location to location. Use your local average rate per kilowatt hour multiplied by the maximum kilowatts used to determine the cost of operating a Carry pump in your local area.

HP	PHASE	MAX KW USED	AVE. RATE/KW/HR.	COST PER HOUR
1/2	1/115V	.960	0.1000	0.0960
1/2	1/230V	.960	0.1000	0.0960
1/2	3	.860	0.1000	0.0860
3/4	1	1.310	0.1000	0.1310
3/4	3	1.150	0.1000	0.1150
1	1	1.600	0.1000	0.1600
1	3	1.440	0.1000	0.1440
1-1/2	1	2.080	0.1000	0.2080
1-1/2	3	1.890	0.1000	0.1890
2	1	2.555	0.1000	0.2555
2	3	2.430	0.1000	0.2430
3	1	3.400	0.1000	0.3400
3	3	3.360	0.1000	0.3360
5	1	5.570	0.1000	0.5570
5	3	5.400	0.1000	0.5400
7-1/2	1	8.800	0.1000	0.8800
7-1/2	3	8.000	0.1000	0.8000
10	1	11.300	0.1000	1.1300
10	3	10.800	0.1000	1.0800
15	1	16.200	0.1000	1.6200
15	3	15.800	0.1000	1.5800
20	3	20.900	0.1000	2.0900
25	3	25.700	0.1000	2.5700

CABLE SELECTION

1 ϕ & 3 φ MOTOR MAXIMUM CABLE LENGTH (Motor to Service Entrance)**

Motor Rating **Copper Wire Size ***

VTS	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000
115 1φ	1/2	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230 1φ	1/2	400	650	1020	1610	2510	3880	480	5880	7170	8720			
	3/4	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870		
	1	250	400	630	990	1540	2380	2960	3610	4410	5360	6520		
	1-1/2	190	310	480	770	1200	1870	2320	2850	3500	4280	5240		
	2	150	250	390	620	970	1530	1910	2360	2930	3620	4480		
	3	120*	190	300	470	750	1190	1490	1850	2320	2890	3610		
	5	0	0	180*	280	450	710	890	1110	1390	1740	2170	2680	
	7-1/2	0	0	0	200*	310	490	610	750	930	1140	1410	1720	
	10	0	0	0	0	250*	390	490	600	750	930	1160	1430	1760
	15	0	0	0	0	170*	270*	340	430	530	660	820	1020	1260
200 3φ	1/2	710	1140	1800	2840	4420								
	3/4	510	810	1280	2030	3160								
	1	430	690	1080	1710	2670	4140	5140						
	1-1/2	310	500	790	1260	1960	3050	3780						
	2	240	390	610	970	1520	2360	2940	3610	4430	5420			
	3	180	290	470	740	1160	1810	2250	2760	3390	4130			
	5	110*	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440
	7-1/2	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150
	10	0	0	0	230*	370	570	720	880	1090	1330	1640	1970	2390
	15	0	0	0	160*	250*	390	490	600	740	910	1110	1340	1630
	20	0	0	0	0	190*	300*	380	460	570	700	860	1050	1270
	25	0	0	0	0	0	240*	300*	370	460	570	700	840	1030
230 3φ	1/2	930	1490	2350	3700	5760	8910							
	3/4	670	1080	1700	2580	4190	6490	8060	9860					
	1	560	910	1430	2260	3520	5460	6780	8290					
	1-1/2	420	670	1060	1670	2610	4050	5030	6160	7530	9170			
	2	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780		
	3	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680
	5	140*	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870
	7-1/2	0	160*	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160
	10	0	0	190*	310	490	760	950	1170	1440	1760	2160	2610	3160
	15	0	0	0	210*	330	520	650	800	980	1200	1470	1780	2150
	20	0	0	0	0	250*	400	500	610	760	930	1140	1380	1680
	25	0	0	0	0	0	320*	400	500	610	750	920	1120	1360

<continued>

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

CABLE SELECTION

1 ϕ & 3 φ MOTOR MAXIMUM CABLE LENGTH (Motor to Service Entrance)**

Motor Rating **Copper Wire Size ***

VTS	HP	14	12	10	8	6	4	3	2	1	0	00	000	0000
460 3φ	1/2	3770	6020	9460										
	3/4	2730	4350	6850										
	1	2300	3670	5770	9070									
	1-1/2	1700	2710	4270	6730									
	2	1300	2070	3270	5150	8050								
	3	1000	1600	2520	3970	6200								
	5	590	950	1500	2360	3700	5750							
	7-1/2	420	680	1070	1690	2640	4100	5100	6260	7680				
	10	310	500	790	1250	1960	3050	3800	4680	5750	7050			
	15	0	340*	540	850	1340	2090	2600	3200	3930	4810	5900	7110	
	20	0	0	410*	650	1030	1610	2000	2470	3040	3730	4880	5530	
	25	0	0	0	530*	830	1300	1620	1990	2450	3010	3700	4470	5430
575 3φ	1	3630	5800	9120										
	1-1/2	2620	4180	6580										
	2	2030	3250	5110	8060									
	3	1580	2530	3980	6270									
	5	920	1480	2330	3680	5750								
	7-1/2	660	1060	1680	2650	4150								
	10	490	780	1240	1950	3060	4770	5940						
	15	330*	530	850	1340	2090	3260	4060						
	20	0	410*	650	1030	1610	2520	3140	3860	4760	5830			
	25	0	0	520*	830	1300	2030	2530	3110	3840	4710			

CAUTION: Use of wire size smaller than listed will void warranties.

FOOTNOTES:

Lengths without the asterisk * meet the U.S. National Electrical Code ampacity for either individual conductors or jacketed 60ºC Cable.

Lengths marked * meet the NEC ampacity only for individual conductor 60ºC cable in free air or water, not in conduit. If cable rated other than 60ºC is used, lengths remain unchanged, but the minimum size acceptable for each rating must be based on the NEC Table column for that temperature cable.

Flat molded cable is considered to be jacketed cable.

Maximum lengths shown maintain motor voltage at 95% of service entrance voltage, running at maximum nameplate amperes. If service entrance voltage will be a least motor nameplate voltage under normal load conditions, 50% additional length is permissible for all sizes.

This table is based on copper wire. If aluminum wire is to be used; it must be two sizes larger. Example: if the table calls for #12 copper wire, #10 aluminum wire would be required.

The portion of the total cable length which is between the supply and single phase control box with line contactor should not exceed 25% of the total maximum allowable, to ensure reliable contactor operation. Single phase control boxes without line contactors may be connected at any point in the total cable length.

The portion of the total cable between the service entrance and a Three Phase motor starter should not exceed 25% of the total maximum length to assure reliable started operation.

Lengths represent a 5% voltage drop. If 3% is required, multiply by .6 for maximum feet.

Contact factory for 75ºC or 90ºC cable lengths.

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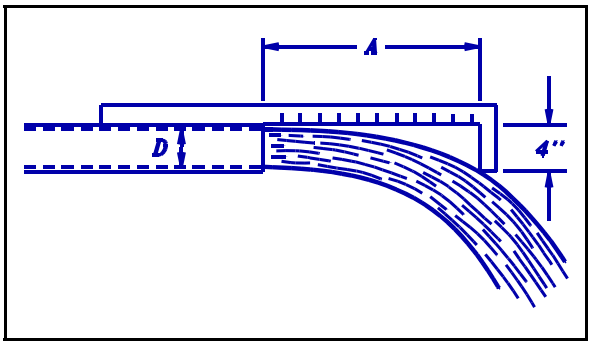
CARRY MANUFACTURING, INC.
GENERAL INFORMATION

ESTIMATING THE OUTPUT FROM A PIPE BY THE HORIZONTAL OPEN DISCHARGE METHOD

Construct an L-shaped gauge like that shown to the right, with the short leg 4 inches long. Make the long leg to suit the pipe sizes and capacities for which the gauge will be used (refer to table), and mark it in inches.



Lay the gauge along the top of the pipe with the short leg barely touching the stream of water, and note distance A. Read the discharge rate from the table on the following page.

EXAMPLE: D = 3"; A = 15"
Q = 183 GPM
Table is based on $Q = 1.28 \times A \times (D)^2$

A	NOMINAL SIZE OF PIPE (D) in inches												Ave. Velocity ft/sec
	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	10	12	
in.	DISCHARGE RATE (Q) - Gallons Per Minute												
4	5.7	9.8	13.3	22.0	31.3	48.5	83.5						2.1
5	7.1	12.2	16.6	27.5	39.0	61.0	104	163					2.6
6	8.5	14.7	20.0	33.0	47.0	73.0	125	195	285				3.1
7	10.0	17.1	23.2	38.5	55.0	85.0	146	228	334	580			3.7
8	11.3	19.6	26.5	44.0	62.5	97.5	166	260	380	665	1060		4.2
9	12.8	22.0	29.8	49.5	70.0	110	187	293	430	750	1190	1660	4.7
10	14.2	24.5	33.2	55.5	78.2	122	208	326	476	830	1330	1850	5.3
11	15.6	27.0	36.5	60.5	86.0	134	229	360	525	915	1460	2020	5.8
12	17.0	29.0	40.0	66.0	94.0	146	250	390	570	1000	1600	2220	6.2
13	18.5	31.5	43.0	71.5	102	158	270	425	620	1080	1730	2400	6.9
14	20.0	34.0	46.5	77.0	109	170	292	456	670	1160	1860	2590	7.4
15	21.3	36.3	50.0	82.5	117	183	312	490	710	1250	2000	2780	7.9
16	22.7	39.0	53.0	88.0	125	196	334	520	760	1330	2120	2960	8.4
17		41.5	56.5	93.0	133	207	355	550	810	1410	2260	3140	9.1
18			60.0	99.0	144	220	375	590	860	1500	2390	3330	9.7
19				110	148	232	395	620	910	1580	2520	3500	10.4
20					156	244	415	650	950	1660	2660	3700	10.6
21						256	435	685	1000	1750	2800	3890	11.4
22							460	720	1050	1830	2920	4060	11.8
23								750	1100	1910	3060	4250	12.4
24									1140	2000	3200	4440	13.0

<continued>

FRICTION LOSS

Friction loss is used to determine the total dynamic head (TDH) of a pumping system.

For Example:

Use a pump system with 6" PVC Schedule 40 PVC Pipe and Fittings. The design has 6' of static head (the distance straight up from the pump), a 90° Long Radius Elbow, a Swing Check Valve and 10' of horizontal discharge piping. Use the following tables to determine the total dynamic head of the system and help you size the pump.

Fittings: (refer to the table - this is the length of straight pipe which will give you the same friction loss as the listed fitting). In this example:

1 - 6" 90° Long Radius Elbow	11'
1 - 6" Swing Check Valve	40'
Total Equivalent length	51'
Discharge Pipe length	10'
(what the pump sees)	61' total

Use the friction loss chart and the required gallons per minute of the system to determine the friction loss factor per 100' of straight pipe. For this example, using 750 GPM the friction loss is 3.35' per 100' of straight pipe.

(3.35'/100') (61') = friction loss or 2.0435'

Therefore in our pump system:

static head	= 6.0000'
friction head	= 2.0435'
TDH	= 8.0435'

Our system will require a pump that produces 750 GPM at 8.04' of TDH.

Length of straight pipe which will give same friction loss as listed valves and fittings:

Pipe Size	Standard Elbow	Long Radius Elbow	45° Elbow	Tee Through Side	Gate Valve Open	Swing Check Valve Open
4"	11'	7'	5'	22'	2.3'	27'
6"	16'	11'	7.7'	33'	3.5'	40'
8"	21'	14'	10'	43'	4.5'	53'
10"	26'	17'	13'	56'	5.7'	67'

(Add to actual pipe length to get equivalent length for use with friction factor from following table.)

<continued>

CARRY MANUFACTURING, INC.
GENERAL INFORMATION
FRICTION OF WATER IN PLASTIC PIPE (cont'd.)
(where C = 150) Schedule 40 Pipe

Flow US GPM	4" Pipe		6" Pipe		8" Pipe		10" Pipe	
	Velocity ft/sec	Head loss ft/100 ft.	Velocity ft/sec	Head loss ft/100 ft.	Velocity ft/sec	Head loss ft/100 ft.	Velocity ft/sec	Head loss ft/100 ft.
20	.52	.03						
30	.77	.06						
40	1.02	.10						
50	1.28	.16	.57	.02				
60	1.53	.22	.68	.03				
70	1.79	.30	.79	.04				
80	2.04	.38	.91	.05				
90	2.30	.47	1.02	.07				
100	2.55	.57	1.13	.08				
120	3.06	.80	1.36	.11				
140	3.57	1.07	1.59	.15	.90	.04		
160	4.08	1.37	1.80	.19	1.02	.05		
180	4.60	1.70	2.04	.24	1.15	.06		
200	5.11	2.06	2.22	.28	1.28	.07		
220	5.62	2.44	2.44	.31	1.40	.08	.90	.03
240	6.13	2.91	2.67	.41	1.53	.10	.98	.03
260	6.64	3.28	2.89	.47	1.66	.12	1.06	.04
280	7.15	3.85	3.11	.54	1.79	.13	1.15	.04
300	7.66	4.37	3.33	.62	1.91	.15	1.22	.05
320	8.17	4.93	3.56	.69	2.05	.17	1.31	.06
340	8.58	5.50	3.78	.76	2.18	.19	1.39	.07
360	9.10	6.15	4.00	.86	2.30	.21	1.47	.07
380	9.59	6.58	4.22	.94	2.43	.24	1.55	.08
400	10.10	7.52	4.43	1.03	2.60	.25	1.63	.09
450	11.49	9.31	5.00	1.29	2.92	.32	1.84	.11
500	12.60	11.30	5.56	1.36	3.19	.39	2.04	.13
550	13.00	13.50	6.11	1.86	3.52	.46	2.24	.16
600	15.10	15.80	6.65	2.19	3.85	.54	2.45	.18

<continued>

CARRY MANUFACTURING, INC.
GENERAL INFORMATION
FRICTION OF WATER IN PLASTIC PIPE (cont'd.)
(where C = 150) Schedule 40 Pipe

Flow US GPM	4" Pipe		6" Pipe		8" Pipe		10" Pipe	
	Velocity ft/sec	Head loss ft/100 ft.	Velocity ft/sec	Head loss ft/100 ft.	Velocity ft/sec	Head loss ft/100 ft.	Velocity ft/sec	Head loss ft/100 ft.
650	16.40	18.30	7.22	2.53	4.16	.63	2.65	.21
700	17.60	21.10	7.78	2.92	4.46	.72	2.86	.24
750	18.90	24.00	8.34	3.35	4.80	.82	3.06	.28
800	20.20	26.80	8.90	3.74	5.10	.99	3.26	.31
850	21.40	31.10	9.45	4.21	5.48	1.03	3.47	.35
900	22.70	33.40	10.00	4.75	5.75	1.16	3.67	.39
950			10.50	5.26	6.06	1.35	3.88	.43
1000			11.10	5.66	6.38	1.40	4.08	.48
1100			12.20	6.84	7.03	1.65	4.49	.56
1200			13.30	8.04	7.66	1.96	4.90	.66
1300			14.40	8.60	8.30	2.28	5.31	.76
1400			15.60	10.60	8.95	2.59	5.71	.88
1500			16.70	12.00	9.58	2.93	6.12	1.00
1600			17.80	12.60	10.21	3.29	6.53	1.12
1800					11.50	4.13	7.35	1.39
2000					12.78	5.03	8.16	1.69
2200					14.05	6.00	8.98	1.99
2400					15.32	6.70	9.80	2.37
2600							10.61	2.73
2800							11.41	3.15
3000							12.24	3.58
3200							13.05	3.70
3500							14.30	4.74
3800							15.51	6.30

Data shown is calculated from Williams and Hazen formula:

$H = (3.023/(C \times 1.852)) \times ((V \times 1.852)/(D \times 1.167))$ using C - 150. For water at 60° F.

Where H = head loss, V = fluid velocity ft./sec., D = diameter of pipe, ft., C = coefficient representing roughness of pipe interior surface.

GLOSSARY OF PUMP DEFINITIONS

THE DATUM shall be taken as the elevation of that surface from which the weight of the pump is supported. This is normally the elevation of the underside of the discharge head or head base plate.

THE SETTING is the nominal vertical distance in feet (meters) from the datum to the column pipe connection at the bowl assembly.

THE STATIC WATER LEVEL is the vertical distance in feet (meters) from the datum to the level of the atmospheric surface while no water is being drawn from the pool.

THE PUMPING WATER LEVEL is the vertical distance in feet (meters) from the datum to the level of the atmospheric surface while the specified fluid flow is being drawn from the pool.

DRAWDOWN is the difference in feet (meters) between the pumping water level and the static water level.

SPECIFIC YIELD, expressed in U.S. gallons per minute per foot of drawdown (liters per second per meter of drawdown) is the rate of flow being pumped from the well divided by the total drawdown as measured during the metered flow rate.

THE CAPACITY OF THE PUMP is the volume rate of flow, Q, expressed in gpm (m^3/h) produced by the pump, calculated for specified conditions.

THE PUMP SPEED OF ROTATION, n, is the rate of rotation of the pump shaft, expressed in revolutions per minute (rpm) or revolutions per second (rps).

HEAD is the quantity used to express the energy content of the liquid per unit weight of the liquid, referred to any arbitrary datum. In terms of foot-pounds (meter-kilograms) of energy per pound (kilogram) being pumped, all head quantities have the dimension of feet (meters) of liquid.

HEAD BELOW DATUM, h_b, is the vertical distance in feet (meters) between the datum and the pumping water level.

HEAD ABOVE DATUM, h_a, is the head measured above the datum, expressed in feet (meters) of liquid, plus the velocity head at the point of measurement.

VELOCITY HEAD, h_v, is the kinetic energy per unit weight of the liquid at a given section expressed in feet (meters) of liquid. Velocity head is specifically defined by the expression $\mathbf{h_v = v^2 / 2g}$ in which g is 32.17 ft/s^2 (9.81 m/s^2) and v is velocity in ft/s (m/s).

SUCTION HEAD, h_s, (closed system) is the algebraic sum of the pressure in feet (meters) of liquid (measured at the pump suction connection) and the velocity head at that point. Pump suction connection is that point at which the suction piping is attached to the pump bowl assembly or its enclosing vessel. Note that a negative suction head will add to the vertical distance from the datum due to the algebraic subtraction of a negative quantity.

PUMP TOTAL HEAD, H, is the bowl assembly head minus the column loss and discharge head loss. This is the head generally called for in pump specifications.

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GLOSSARY OF PUMP DEFINITIONS (cont'd.)

ON WET PIT INSTALLATIONS, pump total head, H, is the sum of the head below datum and the head above datum.

ON DRY PIT INSTALLATIONS, pump total head, H, is the above datum, h_a, plus the vertical distance in feet (meters) from the datum tot he pump suction connection minus the suction head, h_s.

BOWL ASSEMBLY HEAD, h_1, is the energy imparted to the liquid by the pump bowl assembly, expressed in feet (meters) of liquid. It is the head developed at the discharge connection of the bowl assembly and is an integral multiple of the head per stage as shown on the catalog rating chart, depending on the number of stages in the bowl assembly.

THE COLUMN LOSS, h_c, is the value of the head loss, expressed in feet (meters), caused by the flow friction in the column pipe.

DISCHARGE HEAD LOSS, h_e, is the value of the head loss expressed in feet (meters), caused by the flow friction in the discharge head assembly.

THE LINE SHAFT LOSS is the power, expressed in horsepower, (kW), required due to the rotation friction of the line shaft. This value is added to the bowl assembly input to predict the pump input.

POWER is expressed in units of horsepower, (kW). One horsepower is equivalent to 550 ft-lb per second, 33,000 ft-lb per minute, 2545 Btu per hour, or 0.746 (kW).

PUMP POWER INPUT is the power delivered to the top shaft by the driver, expressed in horsepower, (kW).

DRIVER POWER INPUT is the power input to the driver, expressed in horsepower, (kW).

BOWL ASSEMBLY POWER INPUT is the power delivered to the bowl assembly shaft, expressed in horsepower, (kW).

PUMP POWER OUTPUT is defined as **QH / 3960** for water having a specific weight of 62.4 lb per cubic foot (relative density of 1.0). It is expressed in horsepower **(hp x 0.746 = kW)** when Q is in gallons per minute and H is in feet of water.

BOWL OUTPUT is defined as $\mathbf{Qh_1 / 3960}$ for water having a specific weight of 62.4 lb per cubic foot (relative density of 1.0) It is expressed in horsepower **(hp x 0.746 = kW)** when Q is in gallons per minute and h_1 is in feet of water.

PUMP EFFICIENCY, E_p, is the ratio of pump power output to pump input, expressed in percent.

OVERALL EFFICIENCY, E, is a ratio of pump power output to prime mover power input, expressed in percent.

DRIVER EFFICIENCY, E_g, is the ratio of the driver power output of the driver power input, expressed in percent.

BOWL ASSEMBLY EFFICIENCY, E_1, is the ratio of the bowl output to the bowl assembly input, expressed in percent. This is the efficiency that is usually shown on catalog rating charts.

GLOSSARY OF SYSTEM TERMS

ACCESS COVER - A removable device to provide access to wet well and/or valve box. Includes frame, doors, and accessories.

BEST EFFICIENCY POINT (BEP) - The combination of head and flow at which a given pump operates most efficiently.

BRAKE HORSEPOWER (BHP) - The horsepower required by the pump; pump input.

CAPACITY - The quantity of liquid that can be contained, or the rate of liquid flow that can be carried.

CAVITATION - The action resulting from forcing a flowing stream to change direction, in which reduced internal pressure causes dissolved gases to expand, creating negative pressure. Cavitation frequently causes pitting of the hydraulic structure affected.

CLEAR WATER - Treated, filtered water; the discharge from a water treatment plant.

CLOSE-COUPLED - A pump directly connected to its power unit without any reduction gearing or shafting.

CYCLE TIME - The total time period from when the pump turns On to when it turns Off.

DISCHARGE - The flow or rate of flow from a pump or pumping system.

DISCHARGE PIPE - The pipe that exits the wet well or valve box.

DRY WELL - A dry compartment in a pumping station, near or below pumping level, where the pumps are located.

DUPLEX - A pumping station containing two pumps.

DYNAMIC HEAD - The head (or pressure) against which a pump works.

EDDIES - A circular movement occurring in flowing water, caused by currents set up on the water by obstructions.

EFFLUENT - Wastewater or other liquid, partially or completely treated, flowing out of a septic tank or treatment plant.

FLOOD-PRONE - An area subject to frequent flooding.

FORCE MAIN - A pressure pipe joining the pump discharge at a water or wastewater pumping station with a point of gravity flow.

FREE BOARD - The vertical distance between the normal maximum level of liquid in a septic tank and the top of the tank.

FRICTION LOSS - The head loss of liquid flowing in a piping system as the result of the disturbances set up by the contact between the moving liquid and the system components

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GLOSSARY OF SYSTEM TERMS (cont'd.)

GRINDER PUMPS - Specialized submersible pumps which macerate sewage. Used in pressurized systems.

GROUND WATER - Subsurface water occupying the saturation zone. In a strict sense, the term applies only to water below the water table.

GUIDE RAIL SYSTEM - A device which allows the pump-motor unit to be installed in or removed from the wet well, without disconnecting any piping and without anyone having to enter the wet well.

H_{20} WHEEL LOADING - Refers to the type of construction used in the fabrication of access doors or covers for wet wells or valve boxes that must withstand vehicular traffic. Rating is 16,000 lbs. per sq. ft. live load.

HEAD - The height of the free surface of fluid above any point in a hydraulic system; a measure of the pressure or force exerted by the fluid.

HYDRAULIC GRADIENT - The slope of the hydraulic grade line, the rate of change of pressure head; the ratio of the loss in the sum of the pressure head and position head to the flow distance.

IMPELLER - A rotating set of vanes designed to impel rotation of a mass of fluid.

INFILTRATION - The quantity of ground or near-surface water that leaks into a pipe or wet well through joints, porous walls, or breaks.

IN FLOW - The extraneous flow which enters a sanitary sewer from sources other than infiltration.

INTAKE - The flow or rate of flow into a pump or pump station.

LIFT STATION - A structure that contains pumps and appurtenant piping, valves, and other mechanical and electrical equipment for pumping water or wastewater. Also called *pumping station.*

LIQUID LEVEL CONTROLS - In-station devices which start or stop the pump when contacted by liquid or losing contact with liquid within the well. Connected to the control panel.

LAG PUMP - A succeeding or backup pump in a pump system. Control systems usually alternate pump operation.

LEAD PUMP - The first pump to start in a pump cycle.

NET POSITIVE SUCTION HEAD (NPSH) - The net positive suction head is the total suction head in feet of liquid absolute determined at the suction nozzle and the referred datum less the vapor pressure of the liquid in feet absolute.

NET POSITIVE SUCTION HEAD AVAILABLE (NPSHA) - The absolute pressure of the liquid at the inlet of the pump.

NET POSITIVE SUCTION HEAD REQUIRED (NPSHR) - Based on the need of a specific pump. Remains unchanged for a given head, flow, rotational speed and impeller diameter; changes with wear and liquids.

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GLOSSARY OF SYSTEM TERMS (cont'd.)

NON-CLOG - A pump designed to pass solids of a specific size. For example, a submersible pump with a 4-in. discharge may be capable of passing 3-in. spherical solids.

PEAK FACTOR - A variable multiplier used with average flow to determine required pump capacity for wastewater lift stations or potable water booster stations. Variation is determined by the size and type of facility.

PEAK FLOW - Maximum flow.

PUMP CASING - See *Volute.*

PUMP DISCHARGE SIZE - The nominal inside diameter of the discharge opening of a pump. On small sewage pumps, this may have a relationship to solids capability.

PUMP RELEASE SYSTEM - See *Guide Rail Systems.*

RAW WATER - Untreated water; usually the water entering the first treatment unit of a water treatment plant.

SANITARY WASTEWATER - Wastewater discharging from the sanitary conveniences of dwellings, including apartment houses, hotels, office buildings, industrial plants, or institutions.

SCUM - The extra or foreign matter which rises to the surface of a liquid and forms a layer or film.

SEALING FLANGE - The connection between the pump discharge and force main when used with guide rail systems.

SEDIMENTATION - The process of subsidence and decomposition of suspended matter carried by water, wastewater or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material.

SEPTIC TANK - An underground vessel for treating wastewater for a single dwelling or building by a combination of settling and anaerobic digestion. Effluent is usually disposed of by leaching. Settled solids are pumped out periodically and hauled to a treatment facility for disposal.

SEWAGE - Household or commercial wastewater that contains human waste. Distinguished from industrial wastewater.

SIMPLEX - A pumping station containing one pump.

SLUDGE - The accumulated solids which separate from liquids, such as water or wastewater, during processing.

SIPHON - The potential for atmospheric pressure to force a liquid through an inverted "U"-shaped tube from one point to another lower point over the barrier created by the inverted "U".

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GLOSSARY OF SYSTEM TERMS (cont'd.)

SOLIDS-HANDLING - The capability of a pump to pass solids of a specific size, such as 3-in. spherical solids.

SPECIFIC SPEED - An index number used to classify rotational pumps into three basic categories related to their vane and hydraulic configurations. $N_S = (GPM / RPM) / H^{3/4}$ The pump types are radial flow, mixed flow and axial flow.

N_S = 500 to 4,500 as radial flow
N_S = 4,500 to 10,000 as mixed flow
N_S = 10,000 to 15,000 as axial flow

STATIC ELEVATION (STATIC HEAD) - The vertical distance between the level of the source of supply and the high point in the force main or the level of the surface.

STORM WATER - Surface water from rain, snow, or melting ice which runs out from the surface of a drainage area. It is normally collected in sewers separate from the sanitary sewers, and receives minimal, if any treatment, prior to discharge to a receiving water. When collected in a combined sewer system, the resulting mixture of sewage and storm water is called combined wastewater.

SUBMERGENCE - The number of feet or inches of fluid above the center line of the volute on a vertical submersible pump. Requirements will vary depending on the nature of the fluid and the hydraulic configuration of the sump.

SUBMERSIBLE PUMPS - Submersible wastewater pumps are vertical, close-coupled, extra-heavy duty pump-motor units which are designed to operate under the liquid they are pumping. They are non-clogging, usually have a 3-in. or larger discharge, and are also called *submersible sewage pumps.* See also *Grinder Pumps.*

SUMP - See *Wet Well*

SYSTEM HEAD CURVE - A graph showing the relationship of static head and friction head at various flow rates through a given piping system.

TOPOGRAPHY STUDY - A study that relates to the shape of the land surface and to the characteristics of the underlying soil and rocks.

TOTAL DYNAMIC HEAD (TDH) - The difference between the elevation corresponding to the pressure at the discharge flange of a pump and the elevation corresponding to the vacuum or pressure at the suction inlet of the pump, corrected to the same datum plane, plus the velocity head at the discharge flange on the pump, minus the velocity head at the suction inlet of the pump.

TRIPLEX - A pumping station containing three pumps.

VALVE BOX - A metallic or concrete box or vault adjacent to the wet well containing valving, to allow access to valving for service and maintenance without having to enter the wet well.

VAPOR PRESSURE - That portion of pressure above atmospheric pressure that is required to maintain a liquid state for a given fluid at a specified temperature.

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GLOSSARY OF SYSTEMS TERMS (cont'd.)

VELOCITY - The speed at which a liquid is moving. Usually referred to in feet per second

VOLUTE - The casing of a centrifugal pump made in the form of a spiral or volute as an aid to the partial conversion of the velocity energy into pressure head as the water leaves the impeller.

VORTEX (VORTICES) - A revolving mass of water in which the streamlines are concentric circles and in which the total head of each streamline is the same.

WASTEWATER - The spent or used water of a community or industry which contains dissolved and suspended matter.

WATER HAMMER - A series of shocks within a piping system when the flow of liquid is stopped suddenly, with a sound like hammer blows.

WET WELL - A tank or pit which receives drainage, stores it temporarily, and from which the discharge is pumped.

GLOSSARY OF ELECTRICAL TERMS

ALTERNATING CURRENT (AC) - A current which reverses in regularly recurring intervals of time and which has alternative positive and negative values, and occurring a specified number of times per second. The number is expressed in cycles per second or hertz (Hz).

ALARM LIGHT - A light which is used to attract attention when a problem occurs in the system.

ALTERNATOR - A relay device designed for alternating the run cycle or duplexing action of two or more motors automatically. There are two basic types. One mechanically changes its contacts each time the operating coil is de-energized. The second is a solid state unit with an output relay. The alternator is used in the automatic control circuit to the motor starters to rotate the duty cycle of each motor.

AMBIENT TEMPERATURE - Temperature of the surroundings in which the equipment is used or operated.

AMMETER - Meter for measuring the current in an electrical circuit, measured in amperes.

AMPERE - The unit of electric current flow. One ampere will flow when one volt is applied across a resistance of one ohm.

AUDIBLE ALARM - Horn, siren, bell or buzzer which is used to attract the attention of the operator when a problem occurs in the system.

AUXILIARY CONTACTS - Contacts of a switching device in addition to the main current contacts that operate with the movement of the latter. They can be normally open (NO) or normally closed (NC) and change state when operated.

CAPACITOR - A device which introduces capacitance into an electrical circuit. The capacitor, when connected in an alternating current circuit, causes the current to lead the voltage in time phase. The peak of the current wave is reached ahead of the peak of the voltage wave. This is the result of the successive storage and discharge of electric energy.

CIRCUIT BREAKER - A mechanical switching device capable of making, carrying and breaking currents under normal conditions. Also making, carrying for a specific time, and automatically breaking currents under specified abnormal circuit conditions, such as those of short circuit. Circuit breakers have an ampere trip rating for normal thermal overload protection and a maximum magnetic ampere interrupting capacity (AIC) for short circuit protection.

COMMERCIAL POWER - The term applied to power furnished by electric power utility.

CONDENSATION HEATER - A device that warms the air within an enclosure and prevents condensation of moisture during shut-down periods. Also known as a *space heater.*

CONDUCTOR - A wire, cable or bus bar designed for the passage of electrical current.

CONTACTOR - An electro-mechanical device that is operated by an electric coil and allows automatic or remote operation to repeatedly establish or interrupt an electrical power circuit. A contactor provides no overload protection as required for motor loads

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GLOSSARY OF ELECTRICAL TERMS (cont'd.)

CONTACTS - Devices for making and breaking electrical circuits, which are a part of all electrical switching devices.

CURRENT - The amount of electricity measured in amps which is flowing in a circuit.

CYCLE - A given length of time - see *Alternating Current.* In the U.S., most electric current is 60 cycle.

CYCLE TIMER - A timer that repeatedly opens and closes contacts according to pre-set time cycles.

DELTA CONNECTION - A common three-phase connection shaped schematically like the Greek Delta. The end of one phase is connected to the beginning of the next phase, or vice versa.

DEVICE, ELECTRICAL - A unit of an electrical system that is intended to carry but not utilize electric energy.

DISCONNECTING MEANS (DISCONNECT) - A device or group of devices, or other means whereby all the ungrounded conductors of a circuit can be disconnected simultaneously from their source of supply.

ELAPSED TIME METERS - The recording of the time that each pump has run. One elapsed time meter is used per pump.

ELECTRIC UTILITIES - All enterprises engaged in the production and/or distribution of electricity for use by the public.

EMERGENCY POWER (ALTERNATE SOURCE OF POWER) - An independent reserve source of electric power which, upon failure or outage of the normal power source, provides electric power.

ENCLOSURE - The cabinet or special designed box in which electrical controls and apparatus are housed. It is required by the NEC to protect persons from live electrical parts and limit access to authorized personnel. It also provides mechanical and environmental protection. An enclosure should be designed to provide the required protection and sized to provide good, safe wire access and replacement of components. It can be manufactured of steel, galvanized or stainless steel, aluminum, or fiberglass.

EXPLOSION-PROOF MOTOR - A motor in a special enclosure. The purpose of the enclosure is twofold:

1. If an explosive vapor (gas) should explode inside the motor, the frame of the motor would not be affected.
2. The enclosure is so constructed that no such explosion will ignite vapors outside the motor.

FACTORY MUTUAL (FM) - Independent U.S. agency which tests for safety.

FREQUENCY - The number of complete cycles of an alternating voltage or current per unit of time, usually per second, and expressed in cycles per second or hertz (Hz).

FULL LOAD CURRENT - The greatest current that a motor or other device is designed to carry under specific conditions; any additional is an overload.

FUSE - An over-current protective device which consists of a conductor that melts and breaks when current exceeds rated value beyond a pre-determined time**.**

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GLOSSARY OF ELECTRICAL TERMS (cont'd.)

GENERAL PURPOSE RELAY - A relay that is adaptable to a wide variety of applications as opposed to a relay designed for a specific purpose or specific application.

GENERATOR - A machine for converting mechanical energy into electrical energy or power.

GENERATOR RECEPTACLE - A contact device installed for the connection of a plug and flexible cord to supply emergency power from a portable generator or other alternate source of power. Receptacles are rated in voltage, amps, number of wires, and by enclosure.

GROUND - A connection, either intentional or accidental, between an electric circuit and the earth or some conducting body serving in place of the earth.

GROUND FAULT INTERRUPTION (GFI) - A unit or combination of units which provides protection against ground fault currents below the trip levels of the breakers of a circuit. The system must be carefully designed and installed to sense low magnitude insulation breakdowns and other faults that cause a fault ground current path. The GFI system must be capable of sensing the ground fault current and disconnecting the faulted circuit from the source voltage.

GROUNDED NEUTRAL - The common neutral conductor of an electrical system which is intentionally connected to ground to provide a current carrying path for the line to neutral load devices.

GROUNDING CONDUCTOR - The conductor that is used to establish a ground and that connects equipment, a device, a wiring system, or another conductor (usually the neutral conductor) with the grounding electrode.

HAND-OFF-AUTOMATIC (H.O.A.) - Selector switch determining mode of system operation. *H* is the hand mode only. *O* is system Off. *A* is automatic operation, normally with pump alternation.

HAZARDOUS LOCATIONS - Those areas where a potential for explosion and fire exist because of flammable gasses, vapors or finely pulverized dusts in the atmosphere, or because of the presence of easily ignitable fibers or flyings.

HERTZ (Hz) - A unit of frequency, also known as cycles per second.

HIGH POTENTIAL TEST - A test which consists of the application of a voltage higher than the rated voltage between windings and frame, or between two or more windings, for the purpose of determining the adequacy of insulating materials and spacing against breakdown under normal conditions. It is not the test of the conductor insulation of any one winding.

HORSEPOWER - The rate at which work is done. It is the result of the work done (stated in foot-pounds) divided by the time involved.

IN-RUSH CURRENT - See *Locked Rotor Current.*

INTERLOCK - Interrelates with other controllers. An auxiliary contact. A device connected in such a way that the motion of one part is held back by another part.

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GLOSSARY OF ELECTRICAL TERMS (cont'd.)

INTRINSICALLY SAFE - A term used to define a level of safety associated with the electrical controls used in some lift stations. Intrinsically safe equipment and wiring is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a hazardous atmospheric mixture - without the need for explosion-proof enclosures in the hazardous area. Any associated devices must be outside the hazardous area with an approved seal-off fitting used as an isolating barrier.

KILOWATT (KW) - A unit of measure of electrical power. One kilowatt equals 1000 watts. Used where larger units of electrical power are measured.

LIGHTNING ARRESTOR - A protective device for limiting surge voltages on equipment by discharging or bypassing surge current; it prevents continued flow of follow current to ground, and is capable of repeating these functions as specified. Also known as a *surge arrestor*.

LOCKED ROTOR CURRENT - The current drawn by an electrical motor at the instant of power application or start-up. Current diminishes as the motor starts, unless rotation is prevented due to a bound or "locked" rotating element.

LOCKOUT - A mechanical device which may be set to prevent the operation of a pushbutton or other device.

MANUAL TRANSFER SWITCH - A switch designed so that it will disconnect the load from one power source and reconnect it to another source while at no time allowing both sources to be connected to the load simultaneously.

MEGGER OR MEGOHMETER - A high resistance range ohmmeter utilizing a power source for measuring insulation resistance.

MEGOHM - A unit of resistance equal to one million ohms.

MOTOR CIRCUIT PROTECTOR - A molded case disconnect switch specifically designed for motor circuits. It has a trip unit that operates on the magnetic principle only, sensing current in each of the three poles with an adjustable trip point. It provides short circuit protection, required by the NEC. It differs from a standard breaker in that it does not have a thermal overload unit.

MOTOR EFFICIENCY - A measure of how effectively the motor turns electrical energy into mechanical energy. Motor efficiency is never 100%. It is a variable that depends on a given motor's performance. Tabulated at 100, 75, and 50% load. It is the ratio of power input to power output.

MOTOR, ELECTRIC - A rotating device which converts electrical power into mechanical power.

NEC - The National Electrical Code is the standard of the National Board of Fire Underwriters for electric wiring and apparatus, as recommended by the National Fire Protection Association.

NEMA - National Electrical Manufacturers Association, a non-profit trade association supported by the manufacturers of electrical apparatus and supplies. NEMA promulgates standards to facilitate understanding between the manufacturers and users of electrical products.

<continued>

GLOSSARY OF ELECTRICAL TERMS (cont'd.)

NFPA - National Fire Protection Association, of which the National Electric Code (NEC) is a chapter.

NEUTRAL - The point common to all phases of a polyphase circuit, a conductor to that point, or the return conductor in a single phase circuit. The neutral in most systems is grounded at or near the point of service entrance only and becomes the grounded neutral.

NORMALLY OPEN and NORMALLY CLOSED - The terms "Normally Open" and "Normally Closed" when applied to a magnetically operated switching device - such as a contactor or relay, or to the contacts thereof - signify the position taken when the operating magnet is de-energized. These terms pertain to all switches.

OHM - Unit of electrical resistance. One volt will cause a current of one ampere to flow through a resistance of one ohm.

OHMMETER - A device for measuring electrical resistance expressed in ohms. OVERLOAD PROTECTION - Overload protection is the effect of a device operative on excessive current, but not necessarily on short circuit, to cause and maintain the interruption of current flow to the device being governed. Re-set may be manual or automatic.

OVERLOAD RELAY - A relay that responds to electric load and operates at a pre-set value of overload. The unit senses the current in each line to the motor and is either bi-metallic, melting alloy or solid state actuated. It may be of the non-compensated or ambient-compensated type, and of a standard or fast-trip design.

PHASE MONITOR - A device in the control circuit of motors which monitors the three phase voltage and protects against a phase loss (single phasing), under voltage (brown outs) and phase reversal (improper phase sequence). Most are adjustable to set the nominal voltage and some have a LED indicator to indicate acceptable voltage and phase conditions. The output contacts are used to control the motor starters and provide signaling for telemetering.

PILOT DEVICE - Directs operation of another device:

Float Switch - A pilot device responding to liquid levels.
Limit Switch - A pilot device operated by response of a mechanical operation.
Pressure Switch - A pilot device operated in response to pressure levels.
Temperature Switch - A pilot device operated in response to temperature values.

All of the above switches cause a contact change of the switch at pre-set or adjustable points.

PILOT LIGHT - A lamp available with various colored lens designed to operate on a control voltage. They are each turned On and Off to provide the required indication for specific functions or alarm conditions. They are available in various sizes and voltage ratings. They are each designed for a specific bulb style and base configuration and some have an integral transformer to allow the use of low voltage bulbs. Full voltage incandescent bulbs are most common, but neon bulbs are also used.

POWER FACTOR - The ratio of the true power to the volt-amperes in an alternating current circuit. Power factor is expressed in a percent of unity either lagging for inductive loads or leading for capacitive loads. Resistive loads produce a unity power factor.

<continued>

GLOSSARY OF ELECTRICAL TERMS (cont'd.).

PUSHBUTTON - Part of an electrical device, consisting of a button that must be pressed to effect an operation.

RATED VOLTAGE - The voltage of electrical apparatus at which it is designed to operate.

REDUCED VOLTAGE AUTO-TRANSFORMER STARTER - A starter that includes an auto-transformer to furnish reduced voltage for starting an alternating current motor. It includes the necessary switching mechanism. This is the most widely used reduced voltage starter because of its efficiency and flexibility.

RELAY - An electric device that is designed to interpret input conditions in a prescribed manner and, after specified conditions are met, to respond and cause contact operation or similar abrupt changes in associated electric control circuits.

RELAY, ELECTROMAGNETIC - A relay controlled by electromagnetic means, to open and close electric contacts.

RELAY, SOLID STATE - A completely electronic switching device with no moving parts or contacts.

REMOTE CONTROL - Control function initiation or change of electrical device from a remote point
.
RESISTANCE - The non-reactive opposition which a device or material offers to the flow of direct or alternating current.

SAFETY SWITCH - An enclosed, manually-operated disconnecting switch, which is horsepower and current rated. Disconnects all power lines simultaneously.

SEAL FAILURE ALARM - The sensing and indication of the intrusion of water in the oil-filled seal chamber between the inner and outer shaft seal of a submersible pump.

SELECTOR SWITCH - A multi-position switch which can be set to the selected mode of operation.

SERVICE FACTOR - A safety factor designed and built into some motors which allows the motor, when necessary, to delivery greater than its rated horsepower.

SINGLE PHASE - A circuit that differs in phase by 180 degrees. Single phase circuits have two conductors, one of which may be a neutral, or three conductors, one of which is neutral.

STANDBY POWER SUPPLY - The power supply that is available to furnish electric power when the normal power supply is not available.

STAR CONNECTION - Same as a "Y" or "Wye" connection. This three-phase connection is so called because, schematically, the joint of the "Y" points looks like a star.

STARTER - A device used to control the electrical power to motors and provide overload protection as required by the NEC. The starter can be operated manually, electrically, or by automatic pilot devices. A starter has two basic parts: a contactor for power switching and an overload relay for protection.

GLOSSARY OF ELECTRICAL TERMS (cont'd.)

STARTING RELAY - A relay - actuated by current, voltage or the combined effect of current and voltage - which is used to perform a circuit-changing function in the primary winding of single phase induction motor within a pre-determined range of speed as the motor accelerates; and to perform the reverse circuit-changing operation when the motor is disconnected from the supply line. One of the circuit changes that is usually performed is to open or disconnect the auxiliary winding (starting) circuit.

SUBMERSIBLE MOTOR - A motor whose housing and terminal box is so designed that the motor can run underwater - completely submerged at an allowable temperature.

SWITCH - A device for making, breaking, or changing connections in a circuit.

TELEMETERING - The transmitting of alarm and control signals to and from remote lift station controls and a central monitoring location.

TERMINAL BLOCK - An insulating base equipped with terminals for connecting wires.

THREE PHASE CIRCUIT - A combination of circuits energized by alternating electromotive sources which differ in phase by one third of a cycle - that is, 120 degrees. A three-phase circuit may be three wire or four wire with the fourth wire being connected to the neutral point of the circuit which may be grounded.

TIME CLOCK - A device used to schedule electrical On and Off operations based on the time of day. A time clock is usually driven by a synchronous motor and must be manually set. Some clocks use 15 minute increments and some have up to six per day minimum 20 minute cycles.

TIME DELAY RELAY (TDR) - A device with either relay or solid state output contacts that performs a timing function upon energization or control signal.

TRANSDUCER - A device to condition and transform an analog signal to a specific variable output electrical signal proportional to the input signal. Typical inputs include variable pressure, level, voltage or current. Some common outputs are 0-1ma, 4-20ma, and various MVDC signals. A transducer must be specifically designed to be compatible with the input/output requirements of the total system.

TRANSFORMER - A static electric device consisting of a single winding, or two or more coupled windings, used to transfer power by electromagnetic induction between circuits at the same frequency, usually with changed values of voltage and current.

UL - Underwriters Laboratories, Inc. An independent, non-profit U.S. organization that tests products for safety.

VOLTAGE - The potential or electrical magnetic force (EMF) in an electrical circuit, similar to pressure in a water system.

VOLTMETER - An instrument for measuring voltage.

WATT - A unit of measure of electrical power.

WYE CONNECTION - See *Star Connection*.

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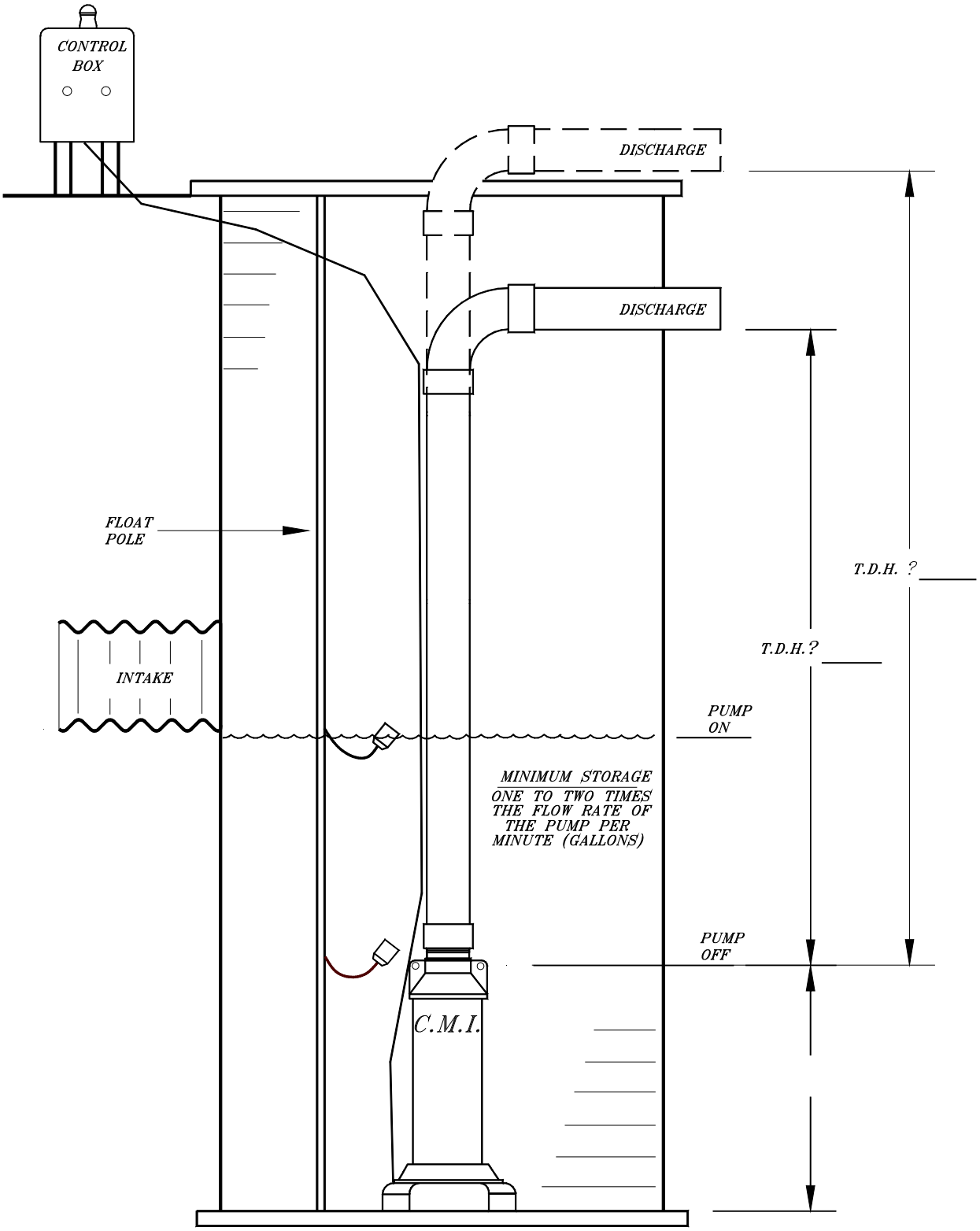
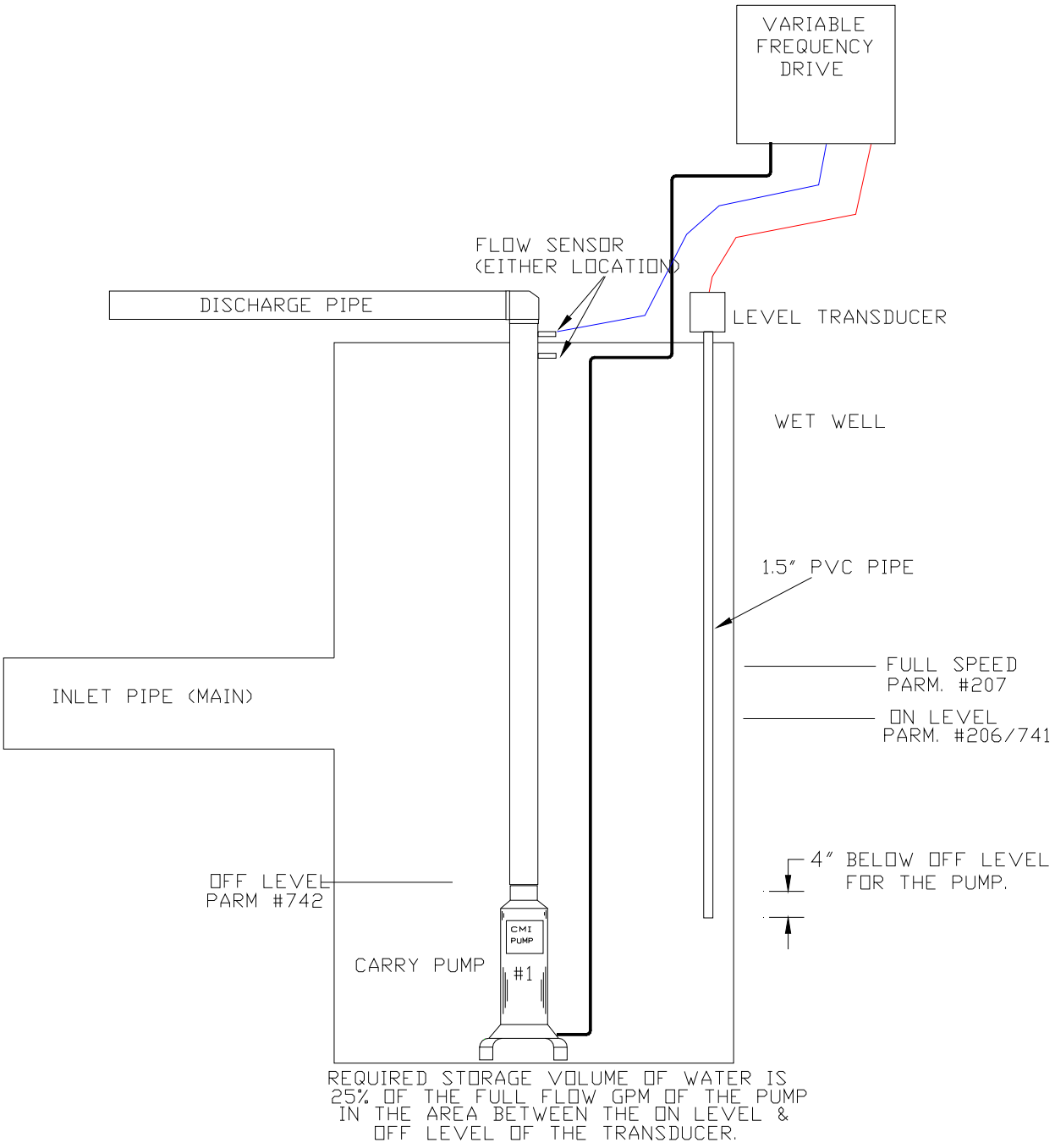
CARRY MANUFACTURING, INC.
GENERAL INFORMATION

FIXED SPEED PUMPING APPLICATION



CARRY MANUFACTURING, INC.
GENERAL INFORMATION

VARIABLE SPEED PUMPING APPLICATION



CARRY MANUFACTURING, INC.
GENERAL INFORMATION

ORDERING INFORMATION

See the diagram on the previous page for a sample pumping station set-up. This has been provided to assist you in the design of your pumping station.

To order call: **800-49-CARRY (492-2779) or FAX at 888-502-8289.**

When ordering Carry Stainless Steel Axial-Flow Submersible Pumps, please include the model number, which will indicate the impeller number, the voltage, horsepower and phase. Also include the motor model number. Since each of the Carry Stainless Steel Axial-Flow Submersible Pumps are available with a variety of specialty motors, this will ensure that you receive the correct pump for your application.

Capsules Stations require a quote from the factory. Use the design forms in each section to determine the components and options you need and call Carry for a quote.

CARRY
PUMPS/CONTROLS
800-49-CARRY

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CARRY MANUFACTURING, INC.
GENERAL INFORMATION

STANDARD 4" MODEL NUMBER EXPLANATION

Example No. **401-12X-31H**

4 = Pump Size: **(4) =** 4" Pump Discharge

01 = Horsepower:
(00) = 1 Horsepower
(01) = 1-1/2 Horsepower
(02) = 2 Horsepower
(03) = 3 Horsepower

1 = Phase:
(1) = Single Phase
(3) = Three Phase

2 = Voltage:
(2) = 200 or 230 Volt
(4) = 460 or 575 Volt

X = Impeller No.: **(X) =** 9° or 11° 3-blade Impeller
13°, 17° or 23° 4-blade Impeller
No. 1, 2, 3 or 4 3-blade Impeller (old style)

3 = Power Lead: **(3) =** 30 Feet (Standard)

1 = Application:
(1) = Storm Water Motor
(2) = 316 SS Motor

H = Orientation:
(Blank) = Vertical
(H) = Horizontal

Thus a 401-12X-31H is a 4" Discharge pump with a:
1-1/2HP, Single Phase, 230 Volt Motor
17° 4-blade Impeller (specified at time of order)
30' Power Lead
Storm Water Application
Horizontal Style

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

STANDARD 6" MODEL NUMBER EXPLANATION

Example No. **605-32X-31H**

6 = Pump Size: **(6)** = 6" Pump Discharge

05 = Horsepower: **(05)** = 5 Horsepower
(07) = 7-1/2 Horsepower
(10) = 10 Horsepower
(15) = 15 Horsepower

3 = Phase: **(1)** = Single Phase
(3) = Three Phase

2 = Voltage: **(2)** = 200 or 230 Volt
(4) = 460 or 575 Volt

X = Impeller No.: **(X)** = No. 1, No. 2, No. 3, No. 4 or No. 4+ Impeller

3 = Power Lead: **(3)** = 30 Feet (Standard)

1 = Application: **(1)** = Storm Water Motor
(2) = 316 SS Motor

H = Orientation: **(Blank)** = Vertical
(H) = Horizontal

Thus a 605-321-31H is a 6" Discharge pump with a:
5HP, Three Phase, 230 Volt Motor
#1 Impeller (specified at time of order)
30' Power Lead
Storm Water Application
Horizontal Style

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

FOUNTAIN PUMP MODEL NUMBER EXPLANATION

Example No. **F20150-123H**

F = Fountain Pump

2 = Discharge:
(2) = 2" Pump Discharge
(3) = 3" Pump Discharge
(4) = 4" Pump Discharge
(6) = 6" Pump Discharge

0150 = Horsepower:
(0075) = 3/4 HP
(0150) = 1-1/2 HP
(0200) = 2 HP
(0300) = 3 HP
(0500) = 5 HP
(0750) = 7-1/2 HP
(1500) = 15 HP

1 = Phase:
(1) = Single Phase
(3) = Three Phase

23 = Voltage:
(20) = 200V (Three Phase)
(23) = 230V (Single or Three Phase)

H = Orientation:
(V) = Vertical
(H) = Horizontal

1 = Stages
( ) = Blank (not defined)
(1) = Single Stage
(2) = Two Stage

Thus a F20150-123H is a Fountain Pump with a 2" Discharge with:
1-1/2 Horsepower, Single Phase, 230 Volt Motor
Horizontal Style

Please Note: All Carry Fountain Pumps come standard with a 30' power lead. Other lengths are available upon request.

CARRY MANUFACTURING, INC.
GENERAL INFORMATION

HIGH VOLUME (CP) PUMP MODEL NUMBER EXPLANATION

Example No. **CP06-0150-323-X**

CP06	**= Pump Size:**	**(CP06**) = 6" Pump Discharge (**CP08)** = 8" Pump Discharge
0150	**= Horsepower:**	**(0075)** = 7-1/2 Horsepower **(0100)** = 10 Horsepower **(0150)** = 15 Horsepower (**0200)** = 20 Horsepower **(0250)** = 25 Horsepower
3	**= Phase:**	**(1)** = Single Phase (available on CP06 only) **(3)** = Three Phase
23	**= Voltage:**	**(20)** = 200 Volt **(23)** = 230 Volt **(46)** = 460 Volt **(57)** = 575 Volt
X	**= Impeller No.:**	**(X)** = 8.5°, 10°, 12°, 14° or 18° Impeller (CP06) 10°, 13° or 16° Impeller (CP08)
	= Orientation:	**( )** = Blank is Vertical **(H)** = Horizontal

Thus a CP06-0150-323-X is a High Volume (CP06) pump with a 6" Discharge:
15 Horsepower, Three Phase, 230 Volt Motor
16° Impeller (specified at time of order)
Vertical Style

Please Note: All Carry High Volume pumps come standard with a 30' power lead. Other lengths are available upon request.

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