CHAPTER 11

SELECTING AND PURCHASING PUMPS

Vinod Patel

Trygve Dahl

STEPS IN THE PROCESS

After the initial decision that pumping equipment is required, purchasing of the equipment can be divided into the following general steps.

- Engineering of the pumping system
- Selection of the pump and driver type
- Pump specification and data sheet preparation
- Inquiry and quotation
- Evaluation of bids and negotiation
- Purchase of the selected pump and driver

In the process of specifying pumping equipment, the engineer must determine system requirements and system head curves, select pump type, write the pump specification, complete the pump data sheet, determine testing, inspection and vendor drawing and data submittal requirements and develop all the data necessary to define the required equipment from the supplier.

Having completed this phase of work, the engineer is then ready to take the steps necessary to purchase the equipment. These steps include issuing the pump inquiry to the bidders, technical and commercial evaluation of pump bids, selection of the supplier, and release of data necessary to issue the purchase order. The ultimate result of this process is the selection of a pump/driver combination that satisfies both the process and mechanical requirements.

ENGINEERING OF PUMPING SYSTEM REQUIREMENTS

The first step is to define the requirements and conditions under which the equipment will operate.

Fluid Type A thorough description of the fluid to be handled must be developed. This includes properties such as viscosity, density, vapor pressure, corrosiveness, erosiveness, volatility, flammability, and toxicity. Depending on the process and the system, some or all of these properties may have an important effect on the pump and system design. For example

- The corrosiveness of the fluid will influence the materials of construction.
- If the fluid contains solids in suspension, suitable types of pump seal designs and abrasion-resistant pump construction must be considered.
- Erosion due to high particle content may cause premature performance decline. Large particles may favor open impeller design.
- Fluid toxicity may necessitate the use of dual (tandem or double) mechanical seals due to government regulations or safety considerations.
- Entrained gases may affect the pump's ability to produce the required differential pressure.

The specified fluid physical and chemical properties must cover the entire expected operating range of the pumping system. Influences such as varying temperatures and pressures must also be defined.

System Head Curves The engineer must have a clear understanding of the process and system in which the pumping equipment will operate. A preliminary design of the system should be made and should include an equipment layout and a P&ID (piping and instrument diagram). These preliminary drawings will show the various fluid flow paths for system operation, preliminary pipe diameters and lengths, relative elevations of system components and all valves and other piping components that will be used to establish the system head losses. These drawings will be used by the engineer to calculate the final piping sizes and pumping system head requirements.

With this information, the engineer can develop system head curves that show the relationship between flow rate and hydraulic losses in the piping system. In determining the hydraulic losses, the engineer must include adequate allowances for future corrosion and scale deposits in the piping system over the plant life.

Because hydraulic losses are a function of flow rate, pipe size, and layout, each individual flow path alignment in a given system will have its own characteristic operating curve. Care must be taken when specifying the required pump characteristics to take into account all possible system operating flow paths. It is convenient to add the effects of static pressure and elevation differences in the system to form a combined system head curve. This combined curve shows the total head required of the pumping equipment to overcome system resistance as well as differential static pressure and elevation. The pump head must be at or above the combined system curve at all required operating points and fluid conditions for the various system flow paths. Refer to Sections 8.1, 8.2, 9.1, and 9.2 for guidance in constructing system head curves.

Modes of System Operation System operating modes are important considerations when specifying pumping equipment. Will the pump be used in continuous or intermittent operation? Will the pump operate in parallel or series with other pumps? Will there be significant differences in head or flow rate requirements in different system alignments? Will a single pump be used as a common spare for two different pumping applications? These and other questions arising from analyzing the different modes of operation will help influence decisions as to the number of pumps needed, heads and capacities and whether booster pumps are desirable in some system alignments. It should be noted that unnecessarily conservative hydraulic requirements may increase pump complexity (such as the selection of a more elaborate multistage or double suction pump in place of simpler single stage, overhung pump) and cost.

The engineer should also consider the length of time between plant maintenance expected of the pumping system. This factor will influence the decision of quantity, pump type, requirement for installed spare(s), and the manufacturing quality required of the specified pumps. Frequently, due to the critical nature of a pumping service where high reliability is necessary, installed spares are provided. In some cases, 2–100% pumps are provided. When system flowrate requirements fluctuate, 3–50% pumps may be called for. When reduced flowrates will not adversely affect operations, 2–50% pumps can be specified. Plant operating philosophies will dictate if automatic start of a spare pump is required.

Pump Flow/Head Margins Pumps are normally specified with a capacity margin above what has been determined necessary for the process. In addition, the calculated system head losses are also determined conservatively. The reasons for this include the following:

- During system design, many assumptions are made while determining pump requirements, some of which might eventually be determined to be incorrect.
- During the plant life cycle, process conditions are likely to change due to aging catalyst, changes in feed stock, seasonal feed temperature variations, and so on.
- Final piping design may be significantly different from preliminary design.
- System hydraulic losses may change due to corrosion, and so on.

During preliminary system design, these potential future changes in head/capacity must be studied to determine the required design margin. Because a pump should be selected to operate close to its best efficiency point, it is important to minimize the selected margin. Margins of 5 to 10% on flow are typical but even 20% is common, for example, in reflux tower service. In cases where the process is well proven and understood, and system operating requirements are well defined, a zero margin is sometimes appropriate.

Plans for future capacity increase may be foiled if the piping system does not provide for adequate net positive suction head at the future flow conditions.

Care must be taken when applying margins to ensure that the purchased pump is not oversized. If the total head produced is too large, impellers may be trimmed within the allowable range of the pump model provided. If the flow is significantly oversized, a costly energy penalty can result over the life of the plant. This is caused by lower pump operating efficiency at off-design flow rates and discharge throttling losses that may be necessary to control the flow rate to the desired value.

Type of Pump Control The type of control for the required pump is also an important consideration for pump specification and selection. Since the actual piping system usually incorporates a design margin, a control valve is normally employed in centrifugal pump applications. This control valve (not supplied by the pump manufacturer) is used to adjust the system curve over the life of the unit. Flow sensing control provides the most stable operation for most systems. Pressure control can have very large swings in flow when operating in a flat or drooping area of a centrifugal pump curve. For this reason, most centrifugal pump specifications incorporate the requirement for the centrifugal pump operating curve to rise continually to pump discharge valve shut in (also known as the pump shut off).

Both temperature and level sensing control can lead to a pump running at shut off or at the end-of-curve condition during upset or failure modes. Centrifugal pumps with a 10% to 20% head rise between the specified operating point and the shut off point may be preferred for some services such as for parallel pump operation.

Pumps that may operate in the shut off condition may need a continuously open bypass to prevent pump damage. Pump manufacturers will advise of the minimum required flow for an offered pump, but many end users require an additional margin above the manufacturers recommended minimum flow. If a continuous flow bypass is incorporated in the system design, this additional flow must be added to the specified pump requirement. Refer to Section 2.3.4 for bypass designs.

Future System Changes A final factor to be considered is the possibility of providing for future system changes. When future system changes can be predicted with a degree of certainty, the system can be designed with this in mind. Rather than selecting a pump that is operating at the high end of its preferred operating region, a larger impeller diameter or the next larger size pump operating at the beginning of its preferred operating range might be considered. In addition, the capability for installing a larger diameter impeller to handle future higher head requirements must be considered. Because minimizing capital costs for a project is usually the prime consideration, oversizing a pump for future operations is not normal practice. Pumps are expected to operate efficiently and reliably in the present system, and this fact should be noted during the selection progress.

SELECTION OF PUMP, DRIVER, AND AUXILIARIES

As stated previously, the selection of pump type for a particular application is influenced by such factors as the fluid characteristics, required materials of construction, system flow/head requirements, intended equipment life, energy cost, and availability of certain utilities, such as cooling water. Accuracy in these areas is critical for proper selection of pumps.

Pump Types There are several different types of basic pump designs. Each design can be used for a range of flow and head combinations. Figure 1 gives a general overview of the type of pump that can be used for various heads and flow rates.

In addition to capacity and head considerations, other operating characteristics of a pump will help the engineer to select a pump type for a given application. Some of the considerations are detailed in the following sections.

Self Priming Requirement If a pump is taking suction from a source below the pump suction nozzle, a self-priming capability may be necessary. Positive displacement pumps

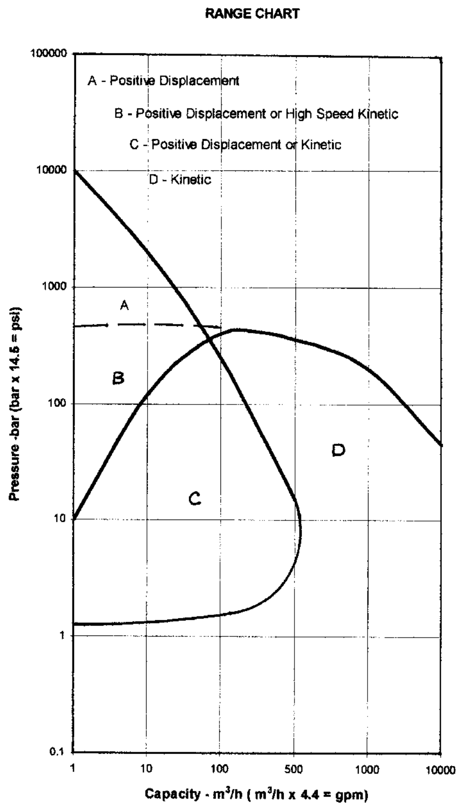

FIGURE 1 General pump overview

such as a piston pump or a rotary screw or gear pump are able to self-prime within limits in the smaller capacity range. There are also special centrifugal pump designs that will self-prime in this situation.

Variable Head/Flow Requirement Centrifugal and axial flow pumps are able to operate in variable head/flow conditions. By reviewing the pump curve for a given pump, the head/flow range capability for these types of pumps can easily be determined. Refer to centrifugal pump operating curve, Figure 2. For a specific impeller size, a centrifugal pump will produce any flow rate within its head-flow rate characteristic curve which corresponds to the system head curve (see Figure 2), if sufficient *NPSH* is available. The system head characteristics can be changed to vary the flow by discharge throttling or by varying pump speed.

High Head Required (Above Single Stage Centrifugal Pump Ability) Depending on the required flow rate, either a centrifugal or a piston pump may fulfill the need for high differential head. If a relatively small flow is required, either an integrally geared high-speed centrifugal pump or a piston pump may be applied. When selecting between these two choices, other questions to ask might be

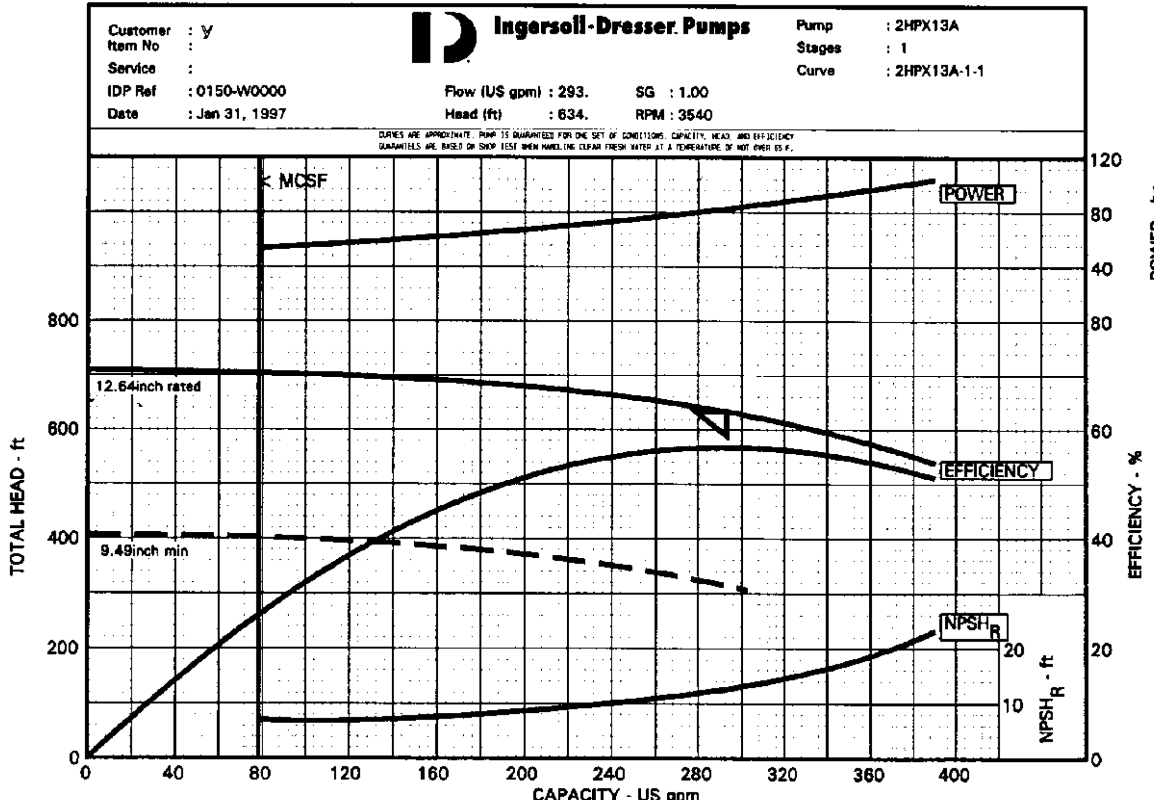

FIGURE 2 Typical centrifugal pump characteristic curves versus flow rate or capacity. (m³/h = 0.277 × gpm; m = 0.305 × ft; kW = 0.746 × hp) (Flowserve Corporation

- Will the pulsating flow of a piston pump be detrimental to system operation? Will a pulsation dampener take care of this problem?
- Is the liquid clean enough to avoid premature wear on pistons and cylinders?

For high flow and high head combinations, a multi-stage centrifugal pump can be used. Various designs of this type of pump are available with a wide range of prices reflecting special designs for a whole range of applications (high temperature, cryogenic, water, hydrocarbon, and so on).

Low Flow with Precise Flow Adjustment Ability For low-flow applications where accurate flow metering is necessary, a proportioning pump is appropriate. This type of pump can also be provided with variable flow capability. Certain types of gear, plunger, and diaphragm pumps can also be used in combination with a variable speed drive for flow rate regulation.

Low Available Net Positive Suction Head If the available net position suction head (*NPSHA*) is low, specially designed centrifugal pumps can be considered. Depending upon how low the *NPSHA* is, either a horizontal end suction with a suction inducer or a horizontal double suction arrangement may be applied. A vertical turbine pump may also be used, either immersed in the process fluid (possibly in a tank or vessel) or in a specially designed vessel (known as a suction can) that can be installed below grade to increase the *NPSHA*.

Code and Industry Standard Requirements The design, construction, rating, and testing of most pumps used in refining and chemical industries are governed by standards such as API (American Petroleum Institute), ASME (American Society of Mechanical Engineers), the Hydraulic Institute, NFPA (National Fire Protection Association), PIP (Process Industry Practices), ISO (International Organization for Standardization) and various other international standards. The severity of the service in which the pump will be applied, as well as the location of the plant, will determine which industry standard (or standards) will be used, if any.

In the case of a fire pump service, NFPA compliance might be mandatory to meet the user's insurance company requirements. If a pump will be installed in an oil refinery or chemical plant, either API or ASME standards will be applied depending on the severity of the service and client preferences. International standards such as DIN (German), BS (British), JIS (Japanese), or ISO can also be used. These standards are intended to provide a pump with a level of quality to match the needs and expectations of the end user of the equipment. It is obvious that the quality requirement for an emergency feed water pump in a nuclear power plant needs to be much more stringent than a potable water booster pump in an office building. The quality issues covered by these codes/standards ranges from detailed design issues to inspection and performance testing requirements.

Fluid Characteristics Fluid characteristics such as viscosity, density, vapor pressure, volatility, chemical stability, solid content, and entrained gases are important factors to be considered for proper pump selection. Pumps are available to handle a full range of fluid types. A positive displacement progressing cavity pump can be used to pump toothpaste, peanut butter and shampoo, but it will not usually be a good choice for pumping water or gasoline. A rotary, variable displacement piston pump is a good choice for a hydraulic control system, but not for a potable water application. A rotary sliding vane pump can be successfully applied for pumping hot asphalt and for limited application in a lube oil system.

Making the best pump selection for a certain fluid application is often difficult. Previous successful experience is usually the best guideline for proper pump selection. This information can be obtained from end users, from process licensers, and from pump manufacturers. Recommendations from all of these sources should be carefully considered.

Pump Materials Material selection is affected both by the pumped fluid and the environment. Resistance to corrosion and erosion are of prime importance. The engineer must determine which material is most suitable and economical for a particular service. This requires that an evaluation be made comparing the more expensive longer life material to a less expensive material, which may provide a shorter pump life. Requirements such as continuous or intermittent operation, critical or non-critical service and plant life cycle should be considered when selecting materials.

Pumps are commonly available in cast iron, ductile iron, bronze, carbon steel, alloy steels, and in some cases composite materials or special alloys such as Monel, Hastelloy, or Titanium. In addition to the importance of pump design life, safety must also be considered when selecting materials. Cast iron construction is not used for pressure casing parts of pumps that are to handle flammable or hazardous liquids because cast iron is brittle and subject to fracture when thermally shocked. For these services, pressure-casing parts must be high strength ductile materials such as carbon or alloy steel.

Driver Selection The choice of driver type for a pumping service is as important as the pump selection. Factors that affect the driver choice are capital cost, driver type availability, operating reliability and the availability and cost of utilities.

Constant speed electric motors are most economical when only the first cost is considered. Often there is excess steam available within a facility that, when compared to the cost of electricity, will justify the extra cost of a steam turbine. Reliability requirements may necessitate the use of both a steam driven main pump and an electric motor driven back-up pump. In the case of firewater pumps, a battery-start, diesel-fueled internal combustion engine is needed to be completely independent of plant utilities. More expensive variable speed electric motors can sometimes be justified if the pump is operated well below its design conditions and there is the potential for significant savings in power.

There are other factors that should be considered when selecting the pump driver. The capital cost as well as the installation cost is more expensive for a steam turbine due to required piping. Steam turbines also require more maintenance during plant life, which may be undesirable to the owner. Selection based on past proven performance and selection to match existing plant equipment to minimize spare part inventory is a common consideration.

Air-operated diaphragm-type pumps are available in relatively small capacities, and these can be particularly effective in hazardous area classifications where use of electric motors may be undesirable.

Other Equipment Supply Decisions For both technical and commercial reasons, the purchaser may decide to purchase the pump/driver combination in various ways.

The pump and driver may be purchased separately. This may be advantageous if either the pump or driver (but not both) can be purchased locally. This will save shipping costs and possibly allow the purchaser to meet client requirements for locally manufactured content for a project. Separate purchase of drives on large capital projects can also lead to quantity price discounts and limited spare part inventories.

The purchaser must consider the risk associated with the separate purchase of the pump and driver. Equipment installation and alignment problems (with resulting start-up delay) are more probable than when the pump vendor takes single source responsibility for the purchase and skid mounting of all components.

If the decision is made to purchase the driver separately from the pump, the pump manufacturer can provide the equipment for block mounting or provide a skid on which the driver can be installed in the field. Either way, additional shop inspection is recommended to verify dimensions for field interface. It should be noted that pump manufacturers may purchase a high volume of electric motors and obtain greater discounts than most operating companies and engineering contractors.

PUMP BID REQUISITION

It is obviously necessary to fully define the scope of supply for the desired piece of equipment. To do so requires the right amount of documentation provided by the purchaser (no more, no less) to match the type of equipment being purchased. This is easier said than done, but the engineer needs to be conscious of the fact that a bid requisition package should be clear and concise as possible. One industry joke relates the cost of a piece of equipment to the weight of the paper included in the bid requisition.

Requisition A bid requisition is a document that requests a vendor or series of vendors provide a quote for a specified item. This can also be called an inquiry or request for quotation or simply an RFQ.

The bid requisition can be as simple as a one-page listing of the pump requirements. It can also be a document that incorporates data sheets, technical specifications, shipping specifications, purchasing terms and conditions, vendor drawing requirements, and any other document that will help define the full requirements of the intended purchase. A fully detailed requisition for a complicated pumping service might include over 100 pages of requirements.

As a minimum, the requisition must include a clear scope of supply, applicable specifications and data sheets, and commercial terms and conditions. In addition, the requisition can be used to specify additional requirements that have not been adequately addressed in other documents.

Commercial Terms and Conditions The requisition should include the following commercial terms and conditions:

- Name of buyer, place to which proposals must be delivered, information on ownership of documents, time allotted for submission of bids, governing laws and regulations
- Location of plant site
- Site storage conditions and anticipated length of storage (preparation requirements)
- Schedule for submittal of drawings/documentation, and pump delivery
- Guaranty/warranty requirements
- Instruction on minimum information to include in the proposal, number of copies that vendor must provide, status of alternative offerings, and a statement on the owners right to accept or reject bids that are not in accordance with the bid package
- Acceptable terms of payment
- Method of transportation to site that establishes the vendor's responsibility. If the vendor will not be responsible for providing shipping, he must be requested to provide enough information in the quote for others to estimate shipping costs
- Customer shop inspection requirements
- Any penalty or bonus related to late or early shipping, and so on

The list of specifications and data sheets must include document name or description, document number, revision number, and revision date. This will provide a record of what documents have been sent to a vendor. See Figure 3 for an example of a requisition format that might be used to request bids for pumps in an oil refinery or petrochemical plant.

Pump Technical Specification As discussed previously, there are many different designs of pumps that can be purchased. Engineering and operating companies may have standard technical specifications for all categories of equipment that are commonly purchased. When a pump service is being prepared for bids, a technical specification can be used in standard form, or updated to incorporate special requirements based on client or other project specific needs.

A technical specification is usually written to cover a wide range of equipment within a given category. Because many variations exist within any equipment category, the technical specification is usually written to be applicable to this range of equipment. Data sheets may be used to provide the specific requirements not covered in the technical specification.

Most technical specifications are written as performance specifications rather than design specifications. Care must be exercised to ensure that the pump manufacturer (not

REQUISITION

Requisition Number	Rev. No.

Type of Order:

Client:

Plant Location:

Level of Technical Data Sufficient for:

Vendor Inquiry
Place Purchase Order

Technical Review Required:

P.O. #:

Vendor:

Line Ref	Item No.	Quantity	Material & Attachment Description	Budget	
				Unit	Extension
Originator		Ext.	Approved By:	Total Budget (US)	

FIGURE 3 Example of a requisition format

the purchaser) is responsible for the actual equipment design. If design requirements rather than performance requirements are specified, the vendor may claim that he is not responsible when performance requirements are not met. Care must be taken to assure that the equipment selected is from qualified vendors with proven design experience in similar applications. The purchaser must resist the temptation to force the vendor to modify a proven design and build a pump with which the vendor does not have proven experience.

As a minimum, a technical specification must list the following:

1. Industry codes and standards to which the pump must be designed, constructed, and tested. It is also possible to create a technical specification that stands alone and does

not reference (or minimally references) codes and standards. This stand-alone technical specification will require a more thorough listing of needed requirements than one that references common design, fabrication, and testing standards.

2. A list of desired deviations and preferences from the main technical standards used to help define the pump requirements.
3. A definition of any technical terms used in the specifications that are not defined in referenced standards. This will help prevent misunderstandings between the purchaser and pump vendors.
4. A list of documents to be submitted by the successful bidder, both with the quotation and after the order is placed.

Pump Data Sheets As stated previously, a data sheet is used to list specific requirements for each individual pump service. These requirements are not general enough to be listed in the technical specification. Each pump service requires its own data sheet. As a minimum, the following items must be included on the data sheets for each service:

1. Pump name and item number
2. All required system design conditions and pump performance values needed to fully define the pump operating requirements, including any known turndown, start-up, or upset conditions
3. Materials of construction (unless the vendor is free to recommend standard materials)
4. All accessory requirements (unless the vendor is free to offer the standard selections) such as driver, coupling, seal, and packaging needs
5. Utility conditions available
6. Intended site location and annual environmental conditions in this location
7. Electrical hazardous area classification
8. Instrumentation and control requirements (usually out of the vendors scope)
9. Noise requirements
10. Any specific preferences that deviate from requirements of the technical specifications
11. Inspection and testing requirements

In addition, the vendor should be advised to fill in the applicable blanks in the data sheet and submit the proposal. The manufacturer's data will help define the offering. See Figures 4a to 4e for the API-610, 8th edition, data sheet.

Other Requisition Documents and Requirements A purchaser may include many additional options in the bid requisition. These requirements may be included in the requisition narrative or data sheets. Some possible options are addressed in the following paragraphs.

Alternates It is extremely difficult for a specification to cover all possible pumps offered by various manufacturers. In addition, the pump industry constantly updates their products due to competition and revisions to industry standards. Because of this, it is good practice to allow manufacturers to offer alternatives to the specified pumping equipment. This allows manufacturers to present their best offerings and gives the purchaser the advantage of obtaining commercially and technically attractive alternate offerings. However, the choice of whether to accept an alternative is retained by the purchaser.

Energy Evaluation The purchaser may choose to include operating costs in the equipment evaluation. If so, the vendor needs to be informed of this requirement so the most

PAGE 1 OF 5

API 610, 8TH EDITION
CENTRIFUGAL PUMP DATA SHEET
SI UNITS / ISO STANDARDS (1.2.2)

JOB NO. ______ ITEM NO. ______
REQ / SPEC NO. ______ / ______
PURCH ORDER NO. ______ DATE ______
INQUIRY NO. ______ BY ______
REVISION ______ DATE ______

APPLICABLE TO: O PROPOSAL O PURCHASE ☒ AS BUILT
FOR ______ UNIT ______
SITE ______ SERVICE ______
NO. REQ ______ PUMP SIZE ______ TYPE ______ NO. STAGES ______
MANUFACTURER ______ MODEL ______ SERIAL NO. ______
NOTE: O INDICATES INFORMATION COMPLETED BY PURCHASER ☐ BY MANUFACTURER ☒ BY MANUFACTURER OR PURCHASER

O GENERAL (3.1.1)

PUMPS TO OPERATE IN (PARALLEL) NO. MOTOR DRIVEN ______ NO. TURBINE DRIVEN ______
(SERIES) WITH ______ PUMP ITEM NO. ______ PUMP ITEM NO. ______
GEAR ITEM NO. ______ MOTOR ITEM NO. ______ TURBINE ITEM NO. ______
GEAR PROVIDED BY ______ MOTOR PROVIDED BY ______ TURBINE PROVIDED BY ______
GEAR MOUNTED BY ______ MOTOR MOUNTED BY ______ TURBINE MOUNTED BY ______
GEAR DATA SHEET NO. ______ MOTOR DATA SHEET NO. ______ TURBINE DATA SHEET NO. ______

OPERATING CONDITIONS

O CAPACITY, NORMAL ______ (m^3/h) RATED ______ (m^3/h)
OTHER ______
O SUCTION PRESSURE MAX/RATED ______ / ______ (kPa)
O DISCHARGE PRESSURE ______ (kPa)
O DIFFERENTIAL PRESSURE ______ (kPa)
O DIFFERENTIAL HEAD ______ (m) NPSHA ______ (m)
O PROCESS VARIATIONS ______ (3.1.2)
O STARTING CONDITIONS ______ (3.1.3)
SERVICE: O CONTINUOUS O INTERMITTENT(START/DAY) ______
O PARALLEL OPERATION REQ'D (2.1.11)

SITE AND UTILITY DATA

LOCATION: (2.1.29)
O INDOOR O HEATED O UNDER ROOF
O OUTDOOR O UNHEATED O PARTIAL SIDES
O GRADE O MEZZANINE O ______
O ELECTRICAL AREA CLASSIFICATION (2.1.22 / 3.1.5)
CL ______ GR ______ DIV ______
O WINTERIZATION REQ'D O TROPICALIZATION REQ'D
SITE DATA (2.1.29)
O ALTITUDE ______ (m) BAROMETER ______ (kPa abs)
O RANGE OF AMBIENT TEMPS: MIN/MAX ______ / ______ (°C)
O RELATIVE HUMIDITY: MIN/MAX ______ / ______ (%)
UNUSUAL CONDITIONS (2.1.23) O DUST O FUMES
O OTHER ______
O UTILITY CONDITIONS:
STEAM: DRIVERS HEATING
MIN ______ (kPa) ______ (°C) ______ (kPa) ______ (°C)
MAX ______ (kPa) ______ (°C) ______ (kPa) ______ (°C)
ELECTRICITY: DRIVERS HEATING CONTROL SHUTDOWN
VOLTAGE ______ ______ ______ ______
HERTZ ______ ______ ______ ______
PHASE ______ ______ ______ ______
COOLING WATER: (2.1.17)
TEMP INLET ______ (°C) MAX RETURN ______ (°C)
PRESS NORMAL ______ (kPa) DESIGN ______ (kPa)
MIN RETURN ______ (kPa) MAX ALLOW DP ______ (kPa)

SITE AND UTILITY DATA (CONT.)

WATER SOURCE ______
CHLORIDE CONCENTRATION (PPM) ______ (3.5.2.6)
INSTRUMENT AIR: MAX/MIN PRESS ______ / ______ (kPa)

LIQUID

O TYPE/NAME OF LIQUID ______
O PUMPING TEMPERATURE:
NORMAL ______ (°C) MAX ______ (°C) MIN ______ (°C)
O VAPOR PRESSURE ______ (kPa abs) @ ______ (°C)
O RELATIVE DENSITY (SPECIFIC GRAVITY):
NORMAL ______ MAX ______ MIN ______
O SPECIFIC HEAT, Cp ______ (kJ/kg °C)
O VISCOSITY ______ (cP) @ ______ (°C)
O MAX VISCOSITY ______ (cP)
O CORROSIVE/EROSIVE AGENT ______ (2.11.1.8)
O CHLORIDE CONCENTRATION (PPM) ______ (3.5.2.6)
O H_2S CONCENTRATION (PPM) ______ (2.11.1.11)
LIQUID (2.1.3) O HAZARDOUS O FLAMMABLE
O OTHER ______

PERFORMANCE

PROPOSAL CURVE NO. ______ ☐ RPM ______
☐ IMPELLER DIA RATED ______ MAX ______ MIN ______ (mm)
☐ RATED POWER ______ (BHP) EFFICIENCY ______ (%)
☐ MINIMUM CONTINUOUS FLOW:
THERMAL ______ (m^3/h) STABLE ______ (m^3/h)
☐ PREFERRED OPERATING REGION ______ TO ______ (m^3/h)
☐ ALLOWABLE OPERATING REGION ______ TO ______ (m^3/h)
☐ MAX HEAD @ RATED IMPELLER ______ (m)
☐ MAX POWER @ RATED IMPELLER ______ (kW)
☐ NPSH REQUIRED AT RATED CAP ______ (m) (2.1.8)
☒ SUCTION SPECIFIC SPEED ______ (2.1.9)
O MAX SOUND PRESS. LEVEL REQ'D ______ (dBA)(2.1.14)
☐ EST MAX SOUND PRESS. LEVEL ______ (dBA)(2.1.14)
REMARKS ______

FIGURE 4A API 610 data sheet, page 1 of 5 (Courtesy American Petroleum Institute)

attractive proposal can be offered. In this case, the overall equipment cost will be a combination of first cost and the differential cost of energy used over a specified period of time.

This evaluation is often calculated to a cost per horsepower penalty that includes all economic factors. If so, the vendor must be informed of the present worth payback time for this analysis (such as three years), cost of a unit of energy, and the number of hours per

PAGE 2 OF 5

API 610, 8TH EDITION
CENTRIFUGAL PUMP DATA SHEET
SI UNITS / ISO STANDARDS (1.2.2)

JOB NO. ______ ITEM NO. ______
REQ / SPEC NO. ______ / ______
PURCH ORDER NO. ______ DATE ______
INQUIRY NO. ______ BY ______
REVISION ______ DATE ______

CONSTRUCTION

APPLICABLE STANDARD:
○ API 610 8TH EDITION
○ OTHER ______ (SEE REMARKS)
PUMP TYPE: (1.1.2)

☐ OH2	☐ BB1	☐ VS1	☐ VS6
☐ OH3	☐ BB2	☐ VS2	☐ VS7
☐ OH6	☐ BB3	☐ VS3	☐ OTHER
	☐ BB4	☐ VS4	
	☐ BB5	☐ VS5	

☐ NOZZLE CONNECTIONS: (2.3.2)

	SIZE	RATING	FACING	POSITION
SUCTION				
DISCHARGE				
BALANCE DRUM				

PRESSURE CASING CONNECTIONS: (2.3.3)

	NO.	SIZE (NPS)	TYPE
☐ DRAIN			
☐ VENT			
☐ PRESSURE GAUGE			
☐ TEMP GAUGE			
☐ WARM-UP			
☐ BALANCE / LEAK-OFF			

○ CYLINDRICAL THREADS REQUIRED (2.3.3)
CASING MOUNTING: (SEE SEPARATE SHEET FOR VERTICALS)
☐ CENTERLINE ☐ NEAR CENTERLINE
☐ FOOT ☐ SEPARATE MOUNTING PLATE
☐ IN-LINE
CASING SPLIT:
☐ AXIAL ☐ RADIAL
CASING TYPE:
☐ SINGLE VOLUTE ☐ MULTIPLE VOLUTE ☐ DIFFUSER
☐ OVERHUNG ☐ BETWEEN BEARINGS ☐ BARREL
CASE PRESSURE RATING:
☐ MAX ALLOWABLE WORKING PRESSURE ______ (kPa)
@ ______ (° C)
☐ HYDROTEST PRESSURE ______ (kPa)
○ SUCTION PRESS. REGIONS MUST BE DESIGNED FOR MAWP (2.2.4)
ROTATION: (VIEWED FROM COUPLING END)
☐ CW ☐ CCW
○ IMPELLERS INDIVIDUALLY SECURED (5.2.2.2)
REMARKS: ______
○ BOLT OH3 PUMP TO PAD/FOUNDATION (5.1.2.4)
SHAFT:
☐ SHAFT DIAMETER AT COUPLING ______ (mm)

CONSTRUCTION (CONT)

☐ SHAFT DIAMETER BETWEEN BEARINGS ______ (mm)
☐ SPAN BETWEEN BEARING CENTERS ______ (mm)
☐ SPAN BETWEEN BEARING & IMPELLER ______ (mm)
REMARKS ______

COUPLINGS: (3.2.2) DRIVER - PUMP
○ MAKE ______
☐ MODEL ______
☐ CPLG RATING (kW/100 RPM) ______
○ LUBRICATION ______
☐ LIMITED END FLOAT REQUIRED ______
☐ SPACER LENGTH ______ (mm)
☐ SERVICE FACTOR ______
DRIVER HALF COUPLING MOUNTED BY:
○ PUMP MFR. ○ DRIVER MFR. ○ PURCHASER
○ COUPLING PER API 671 (5.2.7)
BASEPLATES:
☐ API BASEPLATE NUMBER ______ (APPENDIX M)
○ NON-GROUT (CONSTRUCTION: (3.3.13/5.3.8.3.5)
REMARKS: ______

MATERIAL

○ APPENDIX H CLASS ______ (2.11.1.1)
○ MIN DESIGN METAL TEMP (2.11.4.5) ______ (° C)
☐ BARREL/CASE ______ IMPELLER ______
☐ CASE/IMPELLER WEAR RINGS ______
☐ SHAFT ______
☐ DIFFUSERS ______
☐ COUPLING SPACER/HUBS ______
☐ COUPLING DIAPHRAGMS (DISKS) ______
REMARKS ______

BEARINGS AND LUBRICATION

BEARING (TYPE/NUMBER):
☐ RADIAL ______ / ______
☐ THRUST ______ / ______
○ REVIEW AND APPROVE THRUST BEARING SIZE (5.2.5.2.4)
LUBRICATION: (2.10)
☐ GREASE ☐ FLOOD ☐ RING OIL
☐ FLINGER ○ PURGE OIL MIST ○ PURE OIL MIST
○ CONSTANT LEVEL OILER PREFERENCE (SEE REMARKS) (2.9.2.2)
○ PRESSURE LUBE SYS (5.2.6) ○ API-610 ○ API-614
☐ OIL VISC. ISO GRADE (5.2.6.5) ______

FIGURE 4B API 610 data sheet, page 2 of 5 (Courtesy American Petroleum Institute)

year that the equipment will operate. Based on the differential power consumed over the payback period and the energy cost of this differential, the penalty or credit can be easily calculated. (See Table 1 for an example of utility cost comparison.)

Life Cycle Cost Evaluation A more sophisticated Life Cycle Cost (LCC) evaluation method is starting to gain acceptance in the industry. Traditionally, cost evaluations have

PAGE 3 OF 5

API 610, 8TH EDITION
CENTRIFUGAL PUMP DATA SHEET
SI UNITS / ISO STANDARDS (1.2.2)

JOB NO. ______ ITEM NO. ______
REQ / SPEC NO. ______ / ______
PURCH ORDER NO. ______ DATE ______
INQUIRY NO. ______ BY ______
REVISION ______ DATE ______

BEARINGS AND LUBRICATION (cont)

☐ OIL HEATER REQ'D ○ ELECTRIC ○ STEAM (2.9.2.9/5.2.6.3)
○ OIL PRESS TO BE GREATER THAN COOLANT PRESS (5.2.6.2.b)
REMARKS ______

MECHANICAL SEAL OR PACKING

SEAL DATA: (2.7.2)
○ SEE ATTACHED API-682 DATA SHEET
○ NON-API 682 SEAL (2.7.2)
○ APPENDIX H SEAL CODE ______ (2.11.1.1)
☐ SEAL MANUFACTURER ______
☐ SIZE AND TYPE ______ / ______
☐ MANUFACTURER CODE ______
SEAL CHAMBER DATA: (2.1.6/2.1.7)
☐ TEMPERATURE ______ (° C)
☐ PRESSURE ______ (kPa)
☐ FLOW ______ (m³/h)
☐ SEAL CHAMBER SIZE (TABLE 2.3) ______
☐ TOTAL LENGTH ______ (mm) ☐ CLEAR LENGTH ______ (mm)
SEAL CONSTRUCTION:
☐ SLEEVE MATERIAL ______
☐ GLAND MATERIAL ______
○ AUX SEAL DEVICE (2.7.3.20) ______
☐ JACKET REQUIRED (2.7.3.17)
GLAND TAPS: (2.7.3.14)
☐ FLUSH (F) ☐ DRAIN (D) ☐ BARRIER/BUFFER(B)
☐ QUENCH (Q) ☐ COOLING (C) ☐ LUBRICATION (G)
☐ HEATING (H) ☐ LEAKAGE ☐ PUMPED FLUID (P)
☐ BALANCE FLUID (E) ☐ EXTERNAL FLUID INJECTION (X)
SEAL FLUIDS REQUIREMENT AND AVAILABLE FLUSH LIQUID:
NOTE: IF FLUSH LIQUID IS PUMPAGE LIQUID (AS IN FLUSH PIPING PLANS 11 TO 41), FOLLOWING FLUSH LIQUID DATA IS NOT REQ'D.
○ SUPPLY TEMPERATURE MAX/MIN ______ / ______ (° C)
○ RELATIVE DENSITY (SPECIFIC GRAVITY) ______ @ ______ (° C)
○ NAME OF FLUID ______
○ SPECIFIC HEAT, Cp ______ (kJ/kg ° C)
○ VAPOR PRESSURE ______ (kPa abs) @ ______ (° C)
○ HAZARDOUS ○ FLAMMABLE ○ OTHER ______
☐ FLOW RATE MAX/MIN ______ / ______ (m³/h)
☐ PRESSURE REQUIRED MAX/MIN ______ / ______ (kPa)
☐ TEMPERATURE REQUIRED MAX/MIN ______ / ______ (° C)
BARRIER/BUFFER FLUID (2.7.3.21):
○ SUPPLY TEMPERATURE MAX/MIN ______ / ______ (° C)
○ RELATIVE DENSITY (SPECIFIC GRAVITY) ______ @ ______ (° C)
○ NAME OF FLUID ______

MECHANICAL SEAL OR PACKING (CONT)

○ VAPOR PRESSURE ______ (kPa abs) @ ______ (° C)
○ HAZARDOUS ○ FLAMMABLE ○ OTHER ______
☐ FLOW RATE MAX/MIN ______ / ______ (m³/h)
☐ PRESSURE REQUIRED MAX/MIN ______ / ______ (kPa)
☐ TEMPERATURE REQUIRED MAX/MIN ______ / ______ (° C)
QUENCH FLUID:
○ NAME OF FLUID ______
☐ FLOW RATE ______ (m³/h)
SEAL FLUSH PIPING: (2.7.3.19 AND APPENDIX D)
○ SEAL FLUSH PIPING PLAN ______
☐ TUBING ☐ CARBON STEEL
☐ PIPE ☐ STAINLESS STEEL
○ AUXILIARY FLUSH PLAN ______
☐ TUBING ☐ CARBON STEEL
☐ PIPE ☐ STAINLESS STEEL
○ PIPING ASSEMBLY: (3.5.2.10.1)
☐ THREADED ☐ UNIONS ☐ SOCKET WELDED
☐ FLANGED ☐ TUBE TYPE FITTINGS
☐ PRESSURE SWITCH (PLAN 52/53) TYPE ______
○ PRESSURE GAUGE (PLAN 52/53)
☐ LEVEL SWITCH (PLAN 52/53) TYPE ______
○ LEVEL GAUGE (PLAN 52/53)
○ TEMP INDICATOR (PLANS 21, 22, 23, 32, 41)
○ HEAT EXCHANGER (PLAN 52/53)
REMARKS ______
PACKING DATA: (APPENDIX C)
MANUFACTURER ______
TYPE ______
SIZE ______ NO. OF RINGS ______
☐ PACKING INJECTION REQUIRED
☐ FLOW ______ (m³/h) @ ______ (° C)
☐ LANTERN RING ______

STEAM AND COOLING WATER PIPING

☐ COOLING WATER PIPING PLAN ______ (3.5.4.1)
☐ COOLING WATER REQUIREMENTS
SEAL JACKET/BRG HSG ______ (m³/h) @ ______ (kPa)
SEAL HEAT EXCHANGER ______ (m³/h) @ ______ (kPa)
QUENCH ______ (m³/h) @ ______ (kPa)
TOTAL COOLING WATER ______ (m³/h)
○ STEAM PIPING: ○ TUBING ○ PIPE
REMARKS ______

FIGURE 4C API 610 data sheet, page 3 of 5 (Courtesy American Petroleum Institute)

been limited to the cost of the initial capital equipment plus some evaluation for the cost of energy. LCC evaluations include the following major cost categories:

- Purchase price of the pump set (including pump(s), motor, motor starter, and so on)
- Placement cost (includes installation costs such as foundations, electrical installation, piping, isolation valves, and so on)
- Energy cost (usually electricity because most pumps are driven by electric motors)

PAGE 4 OF 5

API 610, 8TH EDITION
CENTRIFUGAL PUMP DATA SHEET
SI UNITS / ISO STANDARDS (1.2.2)

JOB NO. ______ ITEM NO. ______
REQ / SPEC NO. ______ / ______
PURCH ORDER NO. ______ DATE ______
INQUIRY NO. ______ BY ______
REVISION ______ DATE ______

INSTRUMENTATION

VIBRATION:
○ NONCONTACTING (API 670) ○ TRANSDUCER
○ PROVISION FOR MOUNTING ONLY (2.9.2.11)
○ FLAT SURFACE REQ'D (2.9.2.12)
○ SEE ATTACHED API-670 DATA SHEET
○ MONITORS AND CABLES (3.4.3.3)
REMARKS ______

TEMPERATURE AND PRESSURE:
☑ RADIAL BRG METAL TEMP ○ THRUST BRG METAL TEMP
○ PROVISION FOR INSTRUMENTS ONLY
○ SEE ATTACHED API-670 DATA SHEET
○ TEMP GAUGES (WITH THERMOWELLS) (3.4.1.3)
OTHER ______
○ PRESSURE GAUGE TYPE (3.4.2.2) ______
LOCATION ______
REMARKS ______

SPARE PARTS (TABLE 6.1)

○ START-UP ○ NORMAL MAINTENANCE
○ SPECIFY ______

MOTOR DRIVE (3.1.5)

☑ MANUFACTURER ______
☐ ______ (kW) ☐ ______ (RPM)
☑ HORIZONTAL ☑ VERTICAL
☐ FRAME ______
☑ SERVICE FACTOR ______
☑ VOLTS/PHASE/HERTZ ______ / ______ / ______
○ TYPE ______
☑ ENCLOSURE ______
○ MINIMUM STARTING VOLTAGE (3.1.6) ______
○ TEMPERATURE RISE ______
☑ FULL LOAD AMPS ______
☑ LOCKED ROTOR AMPS ______
☑ INSULATION ______
☑ STARTING METHOD ______
☑ LUBE ______
☐ VERTICAL THRUST CAPACITY
UP ______ (N) DOWN ______ (N)
BEARINGS (TYPE / NUMBER):
☐ RADIAL ______ / ______
☐ THRUST ______ / ______

MOTOR DRIVE (cont) (3.1.5)

REMARKS ______

SURFACE PREPARATION AND PAINT

○ MANUFACTURER'S STANDARD
○ OTHER (SEE BELOW)
PUMP:
○ PUMP SURFACE PREPARATION ______
○ PRIMER ______
○ FINISH COAT ______
BASEPLATE: (3.3.18)
○ BASEPLATE SURFACE PREPARATION ______
○ PRIMER ______
○ FINISH COAT ______
SHIPMENT: (4.4.1)
○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQUIRED
○ OUTDOOR STORAGE MORE THAN 6 MONTHS
SPARE ROTOR ASSEMBLY PACKAGED FOR:
○ HORIZONTAL STORAGE ○ VERTICAL STORAGE
○ TYPE OF SHIPPING PREPARATION ______
REMARKS ______

☐ WEIGHTS

MOTOR DRIVEN:
WEIGHT OF PUMP (kg) ______
WEIGHT OF BASEPLATE (kg) ______
WEIGHT OF MOTOR (kg) ______
WEIGHT OF GEAR (kg) ______
TOTAL WEIGHT (kg) ______
TURBINE DRIVEN:
WEIGHT OF BASEPLATE (kg) ______
WEIGHT OF TURBINE (kg) ______
WEIGHT OF GEAR (kg) ______
TOTAL WEIGHT (kg) ______
REMARKS ______

OTHER PURCHASER REQUIREMENTS

○ COORDINATION MEETING REQUIRED (6.1.3)
○ REVIEW FOUNDATION DRAWINGS (2.1.27)
○ REVIEW PIPING DRAWINGS
○ OBSERVE PIPING CHECKS
○ OBSERVE INITIAL ALIGNMENT CHECK
○ CHECK ALIGNMENT AT OPERATING TEMPERATURE
○ CONNECTION DESIGN APPROVAL (2.11.3.5.4)

FIGURE 4D API 610 data sheets, page 4 of 5 (Courtesy American Petroleum Institute)

- Auxiliary services (includes operating costs such as cooling water, steam heating, centralized oil lubrication systems, and so on)
- Maintenance (includes routine servicing and unplanned repairs)
- Potential loss of income due to unplanned downtime (sometimes neglected if a spare pump is included in purchase price)
- Disposal (to dispose of the equipment, in an environmentally responsibly way)

PAGE 5 OF 5

API 610, 8TH EDITION
CENTRIFUGAL PUMP DATA SHEET
SI UNITS / ISO STANDARDS (1.2.2)

JOB NO. ____________ ITEM NO. ____________
REQ / SPEC NO. ____________ / ____________
PURCH ORDER NO. ____________ DATE ____________
INQUIRY NO. ____________ BY ____________
REVISION ____________ DATE ____________

OTHER PURCHASER REQUIREMENTS (cont)

- O RIGGING DEVICE REQ'D FOR TYPE OH3 PUMP (5.1.2.7)
- O HYDRODYNAMIC THRUST BRG SIZE REVIEW REQ'D (5.2.5.2.4)
- ☒ LATERAL ANALYSIS REQUIRED (5.1.4.3/5.2.4.1)
- ☒ ROTOR DYNAMIC BALANCE (5.2.4.2)
- ☒ MOUNT SEAL RESERVOIR OFF BASEPLATE (3.5.1.4)
- ☒ INSTALLATION LIST IN PROPOSAL (6.2.3L)
- O SPARE ROTOR VERTICAL STORAGE (5.2.9.2)
- O TORSIONAL ANALYSIS/REPORT (2.8.2.6)
- O PROGRESS REPORTS REQUIRED (6.3.4)

REMARKS: ____________

QA INSPECTION AND TEST

- O REVIEW VENDORS QA PROGRAM (4.1.7)
- O PERFORMANCE CURVE APPROVAL
- O SHOP INSPECTION (4.1.4)
- ☒ TEST WITH SUBSTITUTE SEAL (4.3.3.1.2)

TEST	NON-WIT	WIT	OBSERVE
HYDROSTATIC (4.3.2)	O	O	O
PERFORMANCE (4.3.3)	O	O	O
NPSH (4.3.4.1)	O	O	O
COMPLETE UNIT TEST (4.3.4.2)	O	O	O
SOUND LEVEL TEST (4.3.4.3)	O	O	O
O CLEANLINESS PRIOR TO FINAL ASSEMBLY (4.2.3.1)	O	O	O
O NOZZLE LOAD TEST (3.3.6)	O	O	O
O BRG HSG RESONANCE TEST (4.3.4.5.)	O	O	O
O REMOVE/INSPECT HYDRODYNAMIC BEARINGS AFTER TEST (5.2.8.5)	O	O	O
O AUXILIARY EQUIPMENT TEST (4.3.4.4)	O	O	O
O ____________	O	O	O
O ____________	O	O	O

- O MATERIAL CERTIFICATION REQUIRED (2.11.1.7)
  - O CASING O IMPELLER O SHAFT
  - O OTHER ____________
- O CASTING REPAIR PROCEDURE APPROVAL REQ'D (2.11.2.5)
- O INSPECTION REQUIRED FOR CONNECTION WELDS (2.11.3.6)
  - O MAG PARTICLE O LIQUID PENETRANT
  - O RADIOGRAPHIC O ULTRASONIC
- O INSPECTION REQUIRED FOR CASTINGS (4.2.1.3)
  - O MAG PARTICLE O LIQUID PENETRANT
  - O RADIOGRAPHIC O ULTRASONIC

QA INSPECTION AND TEST (cont)

- O ADDITIONAL INSPECTION REQUIRED FOR: ____________ (4.2.1.3)
  - O MAG PARTICLE O LIQUID PENETRANT
  - O RADIOGRAPHIC O ULTRASONIC
- O ALTERNATIVE ACCEPTANCE CRITERIA (SEE REMARKS) (4.2.2.1)
- O HARDNESS TEST REQUIRED FOR: ____________ (4.2.3.2)
- O WETTING AGENT HYDROTEST (4.3.2.5)
- O VENDOR SUBMIT TEST PROCEDURES (4.3.1.2/6.2.5)
- O RECORD FINAL ASSEMBLY RUNNING CLEARANCES
- O INSPECTION CHECK-LIST (APPENDIX N) ____________ (4.1.6)

REMARKS ____________

GENERAL REMARKS

REMARK 1: ____________

REMARK 2: ____________

REMARK 3: ____________

REMARK 4: ____________

REMARK 5: ____________

REMARK 6: ____________

FIGURE 4E API 610 data sheets, page 5 of 5 (Courtesy American Petroleum Institute)

A life cycle cost equation, representing each of these cost components, is readily developed as follows:

$$LCC = C_{ic} + C_{in} + C_e + C_{aux} + C_m + C_l + C_d$$

The LCC is usually discounted to a present value, based on an assumed discount rate, inflation rate, and expected equipment life.

TABLE 1 Utility cost comparison

Job No.:	1 2 3 4		
Client: Super Awesome			
Location: Lake Charles, Louisiana			
Subject: Job No. XXX, utility cost comparison for item low pressure boiler Feed S01/JA/JB/JC, water pumps			
2 pumps normally operate—one motor / one turbine			
	Vendor “A”	Vendor “B”	Vendor “C”
Motor drive:			
Normal BHP	100	110	90
Δ BHP	10	20	0
Penalty ($750/hp*)	$7500	$15000	0
Turbine drive:			
Normal BHP	100	110	0
Δ BHP	10	20	0
Norm. Stm. Rate (lb/BHP − hr)	15	14	16
Δ STM. USED lb/hr	150	280	0
Penalty ($73.5/lb/hr**)	$11,025	$20,580	0
Total Penalty (Motor + Turbine)	$18,525	$35,580	0

*Motor drive penalty basis:

$/hp = ($0.039/kWhr) × 8200 hr/yr × 3 yr × (0.746 kw/hr input)/(0.95 hp/hp input)
≅ $750/hp [for 3 yr]

**Turbine drive penalty basis:

$/(lb/hr) = ($0.003/hr)/(lb/hr) × 8200 hr/yr × 3 yr
≅ 73.5/(lb/hr) [for 3 yr]

Assumptions

1. Utility evaluation is based on normal operating point.
2. Pay-out period is for three years (one year = 8200 operating hours)
3. Utility cost expressed as a penalty against equipment less efficient than the lowest utility consumer.
4. Estimated motor efficiency is 95%.

Vendor Data Requirement (VDR) Form For complicated equipment where many different documents are requested for submittal by the purchaser, a list of these documents is usually included in the requisition. This list should include a listing of each generic document, the number of copies required and the time after placement of purchase order that the document is required by the purchaser. Figures 5a and 5b are copies of typical VDR forms for an API-610 pump service.

It should be noted that requirements for drawings are significantly different for an end user maintenance group and an engineering contractor. Because documentation can add a significant amount to the purchase cost, care should be taken when specifying required drawings and drawing quantities.

Inspection and Testing Checklist For critical and special pump applications, the purchaser may require significant shop inspection and testing of the equipment above the vendor's standard procedures. This might include materials certification, NDE, welding inspections, rotor balancing, inspection reports, and mechanical/performance tests.

Figures 6a to 6c show typical Inspection and Testing documents that might be used for ASME, API-610, and other types of centrifugal pumping services. These documents allow the purchaser's representative to maintain a record of requirements for such items as the following:

pselvdr.xls	TYPICAL **CENTRIFUGAL PUMPS** **Vendor Drawing and Data Requirements**	Page 1 Of 2

Drawings & Documents shall be submitted on agreed dates and as per specification.	Job Number: XYZ	Vendor:	Rev. No.	0	1
	Requisition No.: XYZ-1A/B-01		Date		
	P.O. Number:		Originator		
	Client: Chemical Company		Rev /Appr		
	Item / Tag No(s) : P-1A/B				

	Drawings and Documents Description	Preliminary with Bidders Proposal	Quantity to be Supplied After Award – Incoming Status: PR	CF	AB	SCHEDULE – Lead Time for CF Drawings After Commitment: Req'd Weeks	Prom'd Weeks	Agreed Date
	Completed Data Sheets for Pump,	✓						
	Driver and Noise							
A.1	Dimensioned Outline Drawings (Note1)							
	a) Pump & Driver (w / Major & Minor							
	Connections)							
	b) Pump & Driver (w/o Minor Connections)	✓						
	c) Auxiliary Equipment (Supplied but not							
	mounted)							
	d) Customer connection list							
	e) Allowable Piping Forces and Moments							
	f)							
A.2	Foundation Loading Diagrams	✓						
A.3	Schematic Wiring and/or Flow Diagrams							
	a) Switch/Alarm Summary and Set Points							
	b) Seal Systems Diagrams							
	c) Lube Oil Diagrams							
	d) Cooling Water Diagrams							
	e) Bill of Material (BOM)							
	f) Motor Wiring							
B.1	Detail Drawings							
	a) Pump Cross Section	✓						
	b) Coupling Cross Section							
	c) Mechanical Seal Cross Section							
	d) Gage Boards							
	e)							
	f)							
B.2	Erection/Assembly Drawings							
B.3	Predicted Performance Curves	✓						
C.1	Manufacturer's Data Reports							
	a) Test Procedures							
	b) Rotor Balance Reports							
	c) Hydrotest Certificates							
	d) Material Certificates							
	e)							

Incoming Status: PR = Preliminary, CF = Certified, AB = As Built
Drawings / Documents: P = Paper Print, R = Reproducible (Sepia)

FIGURE 5A VDR form, page 1 of 2

- Witness test requirements
- Test procedures and approvals
- Preliminary test results before a witness travels to the vendor's shop
- Acceptability of test results
- Vibration limits

	TYPICAL **CENTRIFUGAL PUMPS** **Vendor Drawing and Data Requirements**	Page 2 Of 2

Drawings & Documents shall be submitted on agreed dates and as per specification.			
Job Number: XYZ Vendor:	Rev. No.	0	1
Requisition No.: XYZ-1A/B-01	Date		
P.O. Number:	Originator		
Client: Chemical Company	Rev /Appr		
Item / Tag No(s) : P-1A/B			

	Drawings and Documents Description	Preliminary with Bidders Proposal	Quantity to be Supplied After Award Incoming Status PR	CF	AB	SCHEDULE Lead Time for CF Drawings After Commitment Req'd Weeks	Prom'd Weeks	Agreed Date
C.2	Performance Test Reports							
C.3	Installation-Maintenance-Operating Instructions							
	Manuals							
C.3	Lubrication Data Sheets							
C.4	Governmental or 3rd Party Requirements							
	a) Material Safety Data Sheets (OSHA Form 20)							
D.1	Recommended Spare Parts Lists:							
	a) Erection & Commissioning for Pump Driver,	✓						
	and Aux. Equipment							
	b) 2 Years Operation for Pump, Driver and Aux.	✓						
	Equipment							

Incoming Status PR = Preliminary, CF = Certified, AB = As Built	Drawings / Documents P = Paper Print, R = Reproducible (Sepia)

FIGURE 5B VDR form, page 2 of 2

- Verification of recommended minimum flow
- *NPSH* test results
- Material test certificates

Noise Data Sheet If the equipment is large enough or of a type known to be a noise concern, the purchaser may specify the maximum allowable noise level attributable to the

PUMP INSPECTION AND TESTING CHECKLIST

REVISIONS	0	1	2	3	4
Number	0	1	2	3	4
Date					
Originator					
Reviewed					
Approved					

Job No.	XYZ Page 1 of 3
Client	Chemical Company
Location	Anywhere
Unit	Utilities
Item No.	P-1A/B
Service	Boiler Feedwater Pump
Requisition No.	XYZ-P1A/B-01

pumpinsp.xls

Inspection & Testing Requirements

Legend:
R = Report required, non-witnessed
O = Observed
W = Witnessed
E = Examine
X = Required
NW = Not witnessed

	DESCRIPTION OF EXAMINATION	Item Numbers						Comments
1								
2	**Inspection Level**							
3								
4	1. Pump							
5								
6	2. Driver							
7	a. Electric Motor							
8	b. Steam Turbine							
9								
10	3. Auxiliaries							
11	a. Base Plate							
12	b. Piping							
13	c. Seal System							
14	d. Lube System							
15								
16								
17	**Fabrication Inspection**							
18								
19	4. Pre-Inspection Meeting							
20	a. Manufacturing Schedule							
21	b. NDT Procedure							
22	c. Test Procedures							
23	d. Sub-Order (provide copies of sub-orders)							
24	e. Weld Repair Procedures- Repair plan must be							
25	approved prior to start of repair.							
26								
27								
28	**Shop Inspection**							Includes all components
29								
30	5. Visual and Dimensional							Done at pump vendor's shop
31	a. Customer connections within piping tolerances							
32	b. Foundation foot print							
33	c. Fit-up of seal flush and/or lube oil piping							
34	d. Initial Alignment Check							
35	e. Nameplate data							
36								
37								
38	6. Miscellaneous							
39	a. Impeller Balance Pump							
40	b. Coupling Balance							
41								

FIGURE 6A Typical inspection and testing documents, page 1 of 3

equipment being purchased. One way to accomplish this is to include a noise data sheet that lists the allowable levels for the equipment provided. This data sheet should be designed to require the vendor to fill in the expected noise level for the equipment being offered. If the expected noise is greater than the specified maximum value, the vendor should be directed to provide special design options (that is, noise enclosure, WP II motor special noise ducting, and so on) to lower the expected noise level. See Figure 7 for a typical noise data sheet.

Bidders List Preparation The preparation of a bidders list for the required equipment on a project is of utmost importance. This list is comprised of suppliers that the client and purchaser agree are qualified to supply the needed equipment.

PUMP INSPECTION AND TESTING CHECKLIST

REVISIONS	Number	0	1	2	3	4
	Date					
	Originator					
	Reviewed					
	Approved					

Job No.	XYZ	Page 2 of 3
Client	Chemical Company	
Location	Anywhere	
Unit	Utilities	
Item No.	P-1A/B	
Service	Boiler Feedwater Pump	
Requisition No.	XYZ-P1A/B-01	

pumpinsp.xls

Inspection & Testing Requirements

DESCRIPTION OF EXAMINATION	Item Number						Legend: R = Report required, non-witnessed O = Observed W = Witnessed E = Examine X = Required NW = Not witnessed **Comments**
7. Non-Destructive Examination							
a. Visual Weld Inspection							
b. MT or LPT Pressure Castings							
c. Radiography - Pump Nozzle							
8. Pressure Tests							
a. Hydrostatic Casing							
b. Hydrostatic Piping							
9. Material Test Certificate (MTR)							
a. Pressure Castings							
b. Impeller							
c. Piping							
10.Alloy Verification							
a. Casing							
b. Impeller							
11.Painting/Coatings							
12.Preparation For Shipment							
a. Release certificate							
Testing							Test results require approval by customer
							prior to shipping
13.Pump							
a. Performance							
b. NPSH							
c. Vibration measurement							
d. Bearing temperature measurement							
e. Dis-assembly inspection (bearings only)							
f. Sound level check							
g. Certified copies of test data							
14. Driver							

FIGURE 6B Typical inspection and testing documents, page 2 of 3

Qualification requirements may include a variety of categories such as the following:

- Vendor proven successful experiences supplying similar equipment
- Vendor ability to meet required delivery schedule
- Vendor ability to support field installation
- ISO 9001 certification standing
- Location of manufacture or material supply
- After sales service, spare parts supply, and so on

PUMP INSPECTION AND TESTING CHECKLIST

REVISIONS	0	1	2	3	4
Number	0	1	2	3	4
Date					
Originator					
Reviewed					
Approved					

Job No.	XYZ	Page 3 of 3
Client	Chemical Company	
Location	Anywhere	
Unit	Utilities	
Item No.	P-1A/B	
Service	Boiler Feedwater Pump	
Requisition No.	XYZ-P1A/B-01	

pumpinsp.xls

Inspection & Testing Requirements

Legend:
R = Report required, non-witnessed
O = Observed
W = Witnessed
E = Examine
X = Required
NW = Not witnessed

	DESCRIPTION OF EXAMINATION	Item Numbers						Comments
83	a. Turbine							
84	Mechanical run							
85								
86								
87	b. Motor							
88	Routine test							
89	Complete test							
90								
91								
92	**Notes:**							
93								
94	1. Levels Of Inspection							
95	#1: Final inspection only and issue of inspection release							
96	certificate.							
97	#2: Pre-inspection meeting, random inspection, witness							
98	major tests, review documentation, and issue							
99	inspection release certificate.							
100	#3: Same as level #2 except regular inspection visits are							
101	more frequent. Witness/hold points will be as agreed							
102	at the pre-inspection meeting.							
103	#4: Resident company inspector continuously monitoring							
104	the work (in addition to the activities outlined in							
105	level # 2).							
106	2. Repair plan must be reviewed by purchaser prior							
107	to start of repairs.							
108	3. Test results shall be reviewed by purchaser prior							
109	to equipment shipping.							
110								
111								

FIGURE 6C Typical inspection and testing documents, page 3 of 3

If a proposed vendor is not known to the purchaser, a shop survey may be required to satisfy the purchaser of a potential supplier's ability. This type of survey will usually include an inspection and assessment of the manufacturer's shops, engineering and design facility, and quality assurance organization. The complexity of the required equipment and the project needs will determine the level of qualification required of the vendors. Remember that a vendor is required to provide not only the specified equipment, but also civil, piping, and electrical interface information required for project design. A vendor must possess the skills necessary to support all of these requirements.

The number of vendors that are to receive bid requests is usually between three and five. This number will provide for effective competition and will limit the quantity of quotes that require evaluation.

Pump alliance agreements, or the need to duplicate existing equipment, may reduce the list to a single bidder. In addition, unique design or vendor experience may dictate a sole source supplier.

EQUIPMENT NOISE DATA SHEET

REVISIONS	0	1	2	3	4
NUMBER	0	1	2	3	4
DATE					
ORIGINATOR					
REVIEWED					
APPROVED					

pseinds

JOB NO.		PAGE 1 OF 1
CLIENT	**Chemical Company**	
LOCATION	**Anywhere**	
UNIT	**Utilities**	
ITEM NO.	**P-1A/B**	
SERVICE	**Boiler Feedwater**	
REQUISITION NO.	**XYZ-P-1A/B-01**	

DESIGN, MANUFACTURE, INSPECTION AND TESTING SHALL CONFORM TO THE SPECIFICATION: ______

INFORMATION TO BE COMPLETED : ○ BY PURCHASER ☐ BY MANUFACTURER

GENERAL

☐ Manufacturer: ○ Description of Equipment:

Location of Equipment: ○ Indoors ○ Outdoors ○ Under Roof ○ Partial Sides ○ Other:

Elevation of Equipment: ○ Grade ○ Mezzanine ○ Other:

EQUIPMENT DESCRIPTION

The Noise Data Provided Shall be a Composite of the Following Equipment: (Indicate all that Apply)

	Item No.	Type of Equipment (Pump, Motor, Valve, etc)	Description of Equipment (BkW, Flow Rate, etc.)	Mfr. Model No.
○ Driven Equipment				
○ Gear				
○ Driver				
○ Other:				
○ Other:				

SOUND PRESSURE LEVELS

	Sound Pressure Level (SPL) Decibels (dB) at 1 meter									
Octave Band Center Frequency (Hz) ►	A-Weighted	31.5	63	125	250	500	1000	2000	4000	8000
○ Maximum Allowable										
☐ Std. Equip.: **Driver**	**85 dbA**									
☐ Std. Equip.: **Driven Equipment**	**85 dbA**									
☐ Std. Equip.:										
☐ Std. Equip.:										
☐ Std. Equip.: **Lube System**	**NA**									
Noise Abated Equipment (Note 1)										
☐										
☐										
☐										

Sound Pressure Level Remarks:

Has the Noise Data Presented been Corrected to Predict the Expected Max. Noise Level at the Installation Site? ☐ Yes

☐ No► Estimate the Correction to Predict the Expected Max. Noise Level at the Installation Site: Add/Subtract dB

Source of Data: ☐ Test Stand ☐ Field ☐ Shop Floor ☐ Computation ☐ No Data Available

Computational Basis: ☐ Test Data ☐ Field Data ☐ Shop Data ☐ Theory ☐ By Subvendor ☐ By Consultant

Data Condition: ☐ Semi-Reverberant ☐ Reverberant ☐ Indoors ☐ Outdoors ☐ Free Field

☐ Loaded ☐ Unloaded ☐ Averaged ☐ Maximum

☐ Includes Safety Factor of dB

Additional Remarks:

Note1: Vendor to complete if needed to fulfill max. sound level requirement

Description of Noise Abatement *:

Notes:

FIGURE 7 Typical noise data sheet

Bidding Time The time required to prepare a bid will depend on the complexity of the equipment, the relative cost of buy-out items (such as exotic castings and turbine drivers), and the level of business activity in the market. It also depends on the number of pump services included in the requisition. The more sub-vendors the main equipment supplier must depend on, the longer the time needed for the vendor to provide an accurate quote.

As a guideline, the following timing may be used to set the bid due date.

Bid Preparation Time

Application	Weeks Required
Pre-engineered and conventional pumps—6 in (152 mm) discharge and smaller	2–3
Pumps with 8 in to 48 in (203 to 1219 mm) discharge	3–4
Larger pumps or multiple pump requisitions	4–6

Often a vendor may have several bids due at approximately the same time. For this and other reasons, vendors may ask that the bid due date be extended. Extensions can be granted if the project schedule allows for this extra time.

It is in the interest of the purchaser to be flexible on bidding time limits to avoid losing a potentially favorable bid. If a bid is extended, all bidders should be notified of the extension so the additional time can be used to improve all quotes.

In many cases, it may not be acceptable to extend a bid due date. If a project schedule is tight, timing may not allow for an extension. In the case of many public sector bids, bid openings are advertised long in advance and may not be extended for this reason.

Pre-Bid Meeting If the required equipment is for a complex or difficult service, or if project timing is such that the purchasing cycle must be minimized, a pre-bid meeting may be of benefit. This meeting should be held after the vendors have read the inquiry but before quote preparation has begun. During this meeting, the full range of requirements are reviewed and emphasized when necessary. Areas of compromise may be suggested. At this time, the vendor is free to ask questions and determine if alternatives to the specified equipment might be advantageous. If specification errors or oversights are noted during these meetings, all bidders must be quickly informed.

The chances of obtaining quotes that are usable without major upgrading are much more likely after a pre-bid meeting. This meeting might prevent a full re-bidding process that might be necessary if vendors misinterpret requirements or are not able to offer equipment in accordance with the inquiry.

Evaluation of Bids After the bid requisition has been prepared and sent to the approved pump vendors for quotation, it is time to start preparing bid review documents. Both commercial and technical evaluations will be necessary and can be accomplished on the same or separate documents.

Review Strategies Review strategies differ between projects and clients. Often, technical reviewers are not made aware of the quoted costs and are concerned only with technical specification compliance and scope of supply. In this case, the commercial evaluation is done by others. The final comparison of costs can be made after the various vendors quotes are conditioned to meet all technical requirements. If the cost is withheld from the technical reviewer, an important piece of evaluating information is missing, which increases the chance of missing key requirements. Based on a quick comparison of cost, it is easy for the document reviewer to establish the quoted general scope for each vendor. If large cost differences are noted between vendors, the reviewer must carefully determine what major differences in quoted scope likely exist.

The number of quotes that will be fully evaluated will depend partly on the number received. The goal is to ensure that the least expensive, technically acceptable bidder can be determined while also minimizing evaluation hours.

Short Listing of Quotes When bids are first received, a quick commercial and technical tabulation is often prepared that lists the main scope of supply, extent of specification compliance, major deviations, and the associated total cost. This is done to get a general idea of the completeness of the quotes as well as to provide information to determine which of the quotes will be fully evaluated.

Technical Bid Evaluation Quotations must be evaluated against the specified requirements. Avoid a temptation to conditions bids so they are apples to apples. Comparing apples to oranges is acceptable providing that specified requirements are met. Professional ethics prohibit giving a vendor's better idea to competitors. A vendor should be encouraged to use ingenuity when preparing a quotation. One vendor's ingenuity should never be shopped around to the others.

After the decision is made on which bids to fully evaluate, the formal review and conditioning process can begin. A technical bid tabulation form is necessary to ensure that the equipment is provided in compliance with the requisition. This tabulation will list the important points of each vendor quote in table form. Each quote is then compared line by line.

Items that are usually contained in a technical bid tab include

- Equipment model number and size
- Compliance with process duty requirements (flow, head, *NPSHR*, and so on)
- Mechanical design limitations (pressure and temperature)
- Mechanical and hydraulic operating parameters (such as brake horsepower, head rise to shutoff, capacity rise to run out, percentage of best efficiency point)
- Mechanical design features (such as materials of construction, seal type, seal flush type, bearing and lubrication type)

When the technical bid evaluation form is being completed, the reviewer must highlight all items that do not meet requisition requirements or that are not clearly defined in the vendor's quote. In addition, features of the vendor's quotation should be highlighted to clearly indicate advantages, disadvantages, ambiguities, and non-compliances. A typical API-610 pump technical bid evaluation is shown in Figures 8a to 8c.

Technical Quote Clarification Questions When the initial review is complete, a list of clarification questions needs to be prepared and sent to each vendor being evaluated. Questions should be direct and concise to ensure that responses answer the questions asked. The vendors must be encouraged to provide cost adders, if necessary, to meet requisition requirements. It is usually appropriate to allow the vendors one week to reply.

When answers to the clarification questions are received, the bid tabulation must be updated to include any revisions in the vendors quotation. Care must be exercised in tracking revisions to the original quotation. If additional clarification is needed, there are various ways to go about it, depending on the situation. Some suggestions are detailed in the following sections.

Telephone Inquiry This method should be discouraged in all but the simplest cases. If used, notes of the telephone conversation must be recorded and filed for later reference. The applicable portion of the vendor quotation should be marked to reflect any changes, with proper reference made to where and why the changes were made. The vendor should confirm all answers in writing, even to verbal questions. Good documentation is necessary to clarify any future misunderstandings either before or after a purchase order is placed.

E-mailed and Faxed Questions and Answers It is preferable that questions be asked and answered by e-mail or fax. This will provide a positive information trail and can be as timely as a telephone conversation. Each vendor will require approximately one week to reply to this second round of questions.

Vendor Clarification Meeting Many factors will be used to determine if a vendor clarification meeting is necessary. Is the potential value of the order high enough to justify

Fluid:	Boiler Feedwater	Sp. Gr:	0.94
Flow Norm/Rated:	1500 / 1800 GPM		
Suct Press Max/Rated:	- / 5 PSIG		
Disch Press:	1144 PSIG		
Diff Pressure:	1139 PSI		
Diff Head:	2800 FT	NPSHA	50 ft.
Temp - Norm/Max:	250 / - deg C	Vapor Press:	24.8 psia
Driver Type:	Motors	Visc:	0.7 cP

Typical
Centrifugal Pump Bid Tabulation

Job No.	XYX		Page 1 of 3
Client	Chemical Company		
Location	Anywhere, World		
Item No.	P-1A/B		
Service	Boiler Feedwater Pump		
Requisition No.	XYZ-1A/B-01		
Originator	Joe Engineer	Date	
Approver	J. Senior Eng.	Rev No.	

	Units	Specification	Pump Company A	Pump Company B	Pump Company C
Pump Size and Model:			A-6 X 8 X11	B-6 X 8 X 11	C-6 X 8 X 11
Number of Stages:			Six	Six	Six
PERFORMANCE:					
Proposal Curve No:		By Vendor	6 X 11 - A	6 X 11 - B	6 X 11 - C
RPM/Rotation:		By Vendor / CW	3560 / yes	3570 / yes	3560 / YES
Suction Specific Speed:		less than 11000	10880	7314	10900
Head - Rated/Maximum (C):	ft	By Vendor	2800 / 3406	2800 / 3180	2800 / 3420
% BEP @ Rated Flow & Rated Imp:	%	By Vendor	100	95	100
% Max Head @ Rated Flow & Max Imp:	%	By Vendor	99 (1)	90	94
% Head rise to Shut-off:	%	20	21	14 (acceptable)	22
Minimum Flow:	gpm	By Vendor	643	950	600
Efficiency, Rated:	%	By Vendor	81	79.4	80
BHP, Rated/Maximum (EOC):	hp	By Vendor	1478 / 1531	1507 / 1700	1495 / 1533
NPSHR (@ C.L. of impeller):	ft	By Vendor	32.5	32.3	38
CONSTRUCTION:					
CASE - Horizontal/Vertical:		Horizontal	yes	yes	yes
Mount/Split/Type (A):		CL / A / D V	yes / yes / yes	yes / yes / yes	yes / yes / Yes
MAWP @ Rated Temp:	psig	By Vendor	1500	2000	2000
MAWP, % of Max Disch Press:	%		93	65	70
Hydro test Pressure:	psig	By Vendor	2250	3240	3000
Max. Discharge Pressure (B):	psig	By Vendor	1390	1300	1400
IMPELLER:					
Diameter, Rated/Max/Min:	inch	By Vendor	11.69 / 11.81 / 9.62	10.83 / 11.25 / 10	11.5 / 11.88 / 9.5
Rated Impeller Diameter, % of max.:	%	By Vendor	99 (1)	96	97
Suction - Single/Double:		By Vendor	single	double	single
Mount - Between Bearings/Overhung:		Between Bearings	yes	yes	yes
SHAFT:					
Diameter @ Sleeve:	inch		3.0	2.88	3.25
C.L. to C.L. of Bearings:	inch		68.69	ADVISE	69.8
L / D Ratio:			4000	ADVISE	3048
NOZZLES:					
PUMP:					
Suction Size/Rating/Facing/Loc:		900# / RF / Side	8" / yes / yes / yes	8" / yes / yes / yes	8" / yes / yes / yes
Discharge Size/Rating/Facing/Loc:		900# / RF / Side	6" / yes / yes / yes	6" / yes / yes / yes	6" / yes / yes / yes
Vent/Drain:		Sch 160, SW,Flanged	yes / yes / yes	yes / yes / yes	yes / yes / yes
BEARINGS:					
PUMP:					
Type - Radial/Thrust:		Sleeve / Tilt Pad	yes / yes	yes / yes	yes / yes
ELECTRIC MOTOR:					
Type - Radial:		Sleeve	yes	yes	yes
LUBRICATION SYSTEM:		API 610 Force Feed	yes	yes	yes
Mounting:		Separate Baseplate	yes	yes	yes
Lube Pumps:		Rotary Type	yes	yes	yes
Material:		Carbon Steel	yes	yes	yes
Filters:		Dual, 10 micron	yes	yes	yes
Material:		Steel	yes	yes	yes
Cooler:		Single, TEMA C	yes	yes	yes
Material:		Steel	yes	yes	yes
Reservoir Retention:		5 minutes	yes	yes	yes
Material:		Stainless steel	yes	yes	yes

FIGURE 8A Typical API 610 technical bid evaluation, page 1 of 3

oiler Feedwater		Sp. Gr:	0.94
n/Rated:	1500 / 1800 GPM		
s Max/Rated:	- / 5 PSIG		
ss:	1144 PSIG		
ure:	1139 PSI		
	2800 FT	NPSHA	50 ft.
orm/Max:	250 / - deg C	Vapor Press:	24.8 psia
pe:	Motors	Visc:	0.7 cP

Typical

Centrifugal Pump Bid Tabulation

Job No.	XYX		Page 2 of 3
Client	Chemical Company		
Location	Anywhere, World		
Item No.	P-1A/B		
Service	Boiler Feedwater Pump		
Requistion No.	XYZ-1A/B-01		
Originator	Joe Engineer	Date	
Approver	J. Senior Eng.	Rev No.	

	Units	Specification	Pump Company A	Pump Company B	Pump Company C
ping:		Butt welded	yes	yes	yes w/CS slip on flanges
Material:		SS downstream of filters	all stainless steel	all stainless steel	yes
PLING:					
anufacturer/Model/Type:		DEF / Flexo / Disc	DEF / Flexo / Disc	DEF / Flexo / Disc	NA
ts/Rated BHP @ Rated RPM:	BHP	By Vendor	462 / 2282	ADVISE	512 / 3100
upling Guard		Non Sparking - Aluminum	yes	yes	yes
ernate		CDE / Flexi / Disc	NA	NA	CDE / Flexi / Disc
HANICAL SEAL:					
anufacturer/Model:		Noleak Seal Co. / Bestseal1	Seal Co. / Bestseal1	Seal Co. / Bestseal1	Seal Co. / Bestseal1
I Seal Code:		BSTXN	BSTFN	BSTFM	BSTFN
anufacturer's Seal Code:		SSOS	SSOS	SSOS	SSOS
x Nameplate for Seal:		Required	yes	yes	yes
LIARY PIPING:					
I Seal Piping Plan:		Plan 23 with TI	yes	yes	yes
al Piping Construction:		Stainless Steel Tubing	yes	yes	yes
oler Shell Material:		Carbon steel	yes	yes	yes
I Cooling Water Plan:		API, Plan C	Not required	Not required	Not required
oling Piping Construction. :		Galv steel, if supplied	NA	NA	NA
ALS:					
P:					
sing:		Carbon steel	12% Chrome	12% Chrome	12% Chrome
peller:		12% chrome	yes	yes	yes
se/Impeller Wear Rings:		12% chrome	yes	yes	ni-resist
aft:		12% chrome	yes	yes	yes
eeve:		316 SS w/ chr oxide coating	ADVISE	ADVISE	ADVISE
aring Housing:		By Vendor	CS & CI	Carbon steel	Carbon steel
TRIC MOTOR:					
ame:		C.I or Fab Steel	Fabricated steel	Fabricated steel	Fabricated steel
nction Box :		C.I or Fab Steel	Fabricated steel	Fabricated steel	Fabricated steel
pper Bar Rotor:		Required	yes	yes	yes
et Air Filters:		Stainless steel	yes	yes	yes
Manufacturer:		By Vendor	Sparky Motor Co.	Sparky Motor Co.	Motors Are Us
/Speed/SF:	HP	By Vendor / 1800 / 1.15	1750 / yes / yes	1750 / yes / yes	1750 / yes / yes
sure:		WP II	yes	yes	yes
erature Rise:		80 over 40 by Resistance	yes	yes	yes
tion:		Class F - VPI	yes	yes	yes
MENTATION:					
PS:					
D's - Radial & Thrust Bearings:		Not required	NA	NA	NA
ration Equipment:		Not required	NA	NA	NA
TRIC MOTORS:					
D's - Radial Bearings:		Not required	NA	NA	NA
tor RTD's :		Not required	NA	NA	NA
ace Heater, Sep Conduit Box:		Required	yes	ADVISE Voltage	Advise voltage
rrent Transformers:		Required	yes	yes	yes
ferential Pressure Switch :		Required	yes	yes	yes
rge Capacitors:		Required	yes	yes	yes

FIGURE 8B Typical API 610 technical bid evaluation, page 2 of 3

ler Feedwater		Sp. Gr:	0.94
/Rated:	1500 / 1800 GPM		
Max/Rated:	- / 5 PSIG		
s:	1144 PSIG		
re:	1139 PSI		
	2800 FT	NPSHA	50 ft.
m/Max:	250 / - deg C	Vapor Press:	24.8 psia
r:	Motors	Visc:	0.7 cP

Typical

Centrifugal Pump Bid Tabulation

Job No.	XYX	Page 3 of 3	
Client	Chemical Company		
Location	Anywhere, World		
Item No.	P-1A/B		
Service	Boiler Feedwater Pump		
Requisition No.	XYZ-1A/B-01		
Originator	Joe Engineer	Date	
Approver	J. Senior Eng.	Rev No.	

	Units	Specification	Pump Company A	Pump Company B	Pump Company C
ntening Arresters:		Required	yes	yes	yes
ration Equipment:		Not required	NA	NA	NA
ANEOUS:					
ic Balance Rotor:		Req'd after each stage	yes	yes	yes
g:		Manufacturer standard	yes	yes	yes
late:		Prepare for epoxy grout	yes	yes	yes
Parts (including spare rotor):		Required	yes	yes	yes
:					
S:					
formance - Wit/Non-wit:		Witnessed	yes	yes	yes
SH - Wit/Non-wit:		Witnessed, if required	Not required	Not required	Not required
ro test - Wit/Non-wit:		Witnessed	yes	yes	yes
se Level Required:		Reference only	NO	yes	NO
Test Report:		Casing and impellers	yes	yes	yes
liographic Test:		Not applicable	—	—	—
Part or LPT		Yes, Casing	yes	yes	To be announced
asonic Test:		Not applicable	—	—	—
dness Test:		Not applicable	—	—	—
RIC MOTORS:					
tine Test - Wit/Non-wit: NEMA MG-1		Non witness	yes	yes	yes
nplete Test - Wit/Non-wit: NEMA MG-1		Non witness	yes	yes	yes
nersion Test		Non witness	yes	yes	yes
se Level Check		Sound Survey	yes	yes	yes
or balance report:		Required	yes	yes	yes
& DIMENSIONS:					
HTS:		By Vendor			
np:	pounds	By Vendor	5380	4720	10,000
ctric Motor:	pounds	By Vendor	6450	6700	6700
eplate:	pounds	By Vendor	4185	3555	included
e System	pounds	By Vendor	2500	2500	2500
Space	feet	By Vendor	78 X 210	advise	60 X 150
l Acceptability :			yes	yes	yes

unt: CL - Centerline, F - Foot, BR - Bracket; Split: R - Radial, A - Axial; Type: D - Diffuser, SV - Single Volute, DV - Double Volute
x. discharge pressure based on rated impeller max. head (C), max. SG, max. suct pressure.
x head is used to calculate (B) above. (B) plus max suct pressure shall not exceed MAWP of case @ rated temp.
SHR & NPSHA are referenced to impeller centerline (suct nozzle centerline for vertical in-line pumps).
OC = End of Curve
r has alternate impeller pattern to meet API 5% future head requirement.

FIGURE 8C Typical API 610 technical bid evaluation, page 3 of 3 the vendor's (or purchaser's) expenses associated with the meeting? Is the equipment sufficiently complex to warrant a face to face meeting to ensure full understanding between the vendor and purchaser? Is timing so critical that this method needs to be used to accelerate the clarification process?

As with any vendor communications, it is important to precisely minute all discussions during the meeting. The vendor and purchaser must both agree on the content and action items that have been noted. Agreements with commercial impact should be confirmed in writing by the vendor. Action items should be assigned to a specific individual with an agreed-upon closure date for each item.

Commercial Evaluation During Technical Evaluation Prior to completion of the technical evaluation, certain commercial items can be reviewed and negotiated with the vendors being evaluated. Terms and conditions of payment, guarantee/warranty, and proposed delivery schedule can usually be discussed in parallel with the technical conditioning of the bids.

Technical Purchase Recommendation When all issues of bid requisition non-compliance have been satisfactorily addressed, the engineer must recommend which vendor or vendors may be considered for purchase of the required pump. Usually, part of this recommendation is the completed and signed technical bid tabulation. The final bid tabulation may show that all (or none) of the vendors are in complete compliance with all requisition requirements. The bid tab should clearly show where all noncompliance occurs. On the tabulation, a statement of technical compliance or non-compliance for each quote that has been reviewed must be provided. Notes that clarify any ambiguous line item on the tabulation are highly recommended so reviewers will have as few questions as possible on the bid tabulation content.

The bid tab should be attached to a recommendation memo or letter that states the recommendations and provides adequate justification. If a vendor is not in full compliance with the bid requisition, this should be noted, along with other reasons that support the recommendation. All revisions made since the original submission of the quotations that are necessary for purchase must be addressed. This might take the form of a scope of supply listing for each recommended vendor that clearly defines what must be purchased to meet the requisition requirements.

If a vendor is clearly favored over others for technical reasons, this must be clearly stated. Because the purchase order is usually given to the lowest cost technically acceptable bidder, this type of preference must be compelling.

For vendors that have been listed as technically acceptable, recommended for purchase, a list that addresses vendor's exceptions to requisition requirements should be attached. These exceptions should be justified in the technical purchase recommendation.

Commercial Purchase Recommendation After the technical recommendation for purchase is complete, the commercial purchase recommendation may be completed. In addition to including the technical bid analysis, this recommendation should cover the following items (if applicable):

1. Listing of original vendor bid scope of supply and the associated cost(s)
2. Listing of revisions to the vendor's original quotes needed for requisition compliance with the associated cost(s)
3. Required spare parts cost
4. Shipping costs
5. Miscellaneous costs associated with documentation, inspection, and so on
6. Utility consumption cost evaluation
7. Agreed delivery schedule
8. Exceptions taken to commercial terms and conditions
9. Economic adjustments for different terms of payment

At this point, the purchase recommendation can be made, usually based on the lowest cost technically acceptable bidder.

Final Purchase Decision and Purchase Order Issue Now that the commercial purchase recommendation is complete, it is forwarded to the parties responsible for making the purchasing decision. After the selection is made, the engineer must decide if additional discussions with the vendor are needed prior to issue of the purchase order. For complex, costly equipment, and large orders, this extra discussion often takes place in a pre-award meeting.

During this meeting, the final agreed-upon equipment, technical, and commercial requirements are confirmed. A final review of the vendors technical exceptions to the requisition can also be completed at this point. As with previous meetings, recording all discussions and agreements is very important. Both parties should read and sign the meeting notes.

After final discussions are complete, the last step in purchasing the pump is the issue of the purchase order.

Because the paper trail for the purchasing cycle can be very complex, it is strongly suggested that the purchase order be a stand-alone document. It may or may not be sufficient to only reference previously transmitted narrative specifications. Many options are likely to have been discussed and agreed to during the process. All these agreements, even if properly documented during the process, should be incorporated into the purchase order. This includes revising data sheets as necessary and also incorporating agreed vendor exceptions to the inquiry. Don't make determining the requirements a treasure hunt for anyone involved later in the execution of the order.

Often it takes several days (or weeks) to incorporate all agreements to the various documents that are contained in the requisition. In order to permit the vendor to proceed in advance of the formal purchase order issue, a letter can be written by the purchaser that confirms the order and requests the vendor to begin work immediately.

Summation of Pump Purchase Cycle API-610 was used as the base document to specify the pump included for the hypothetical purchase in this chapter. It is considered a complex pumping service. Because of this, a large amount of documentation is necessary to describe the purchase requirements.

The other end of the spectrum might be the purchase of a standard drum pump directly from a supplier's catalog. In this case, a single page purchase order listing the model number and any available options would be adequate to ensure the correct selection for this simple service.

SELECTING AND PURCHASING PUMPS IN THE INFORMATION AGE

Many firms are applying emerging information technologies during the process of selection and purchasing pumps to improve their competitiveness. Computer-based applications are often used to aid in generating pump proposals or to check part inventory status. Design departments use CAD/CAM systems to shorten the design cycle and run simulations using structural finite element methods. However, the use of computer technology alone does not guarantee a measurable economic benefit.

Organizational and process changes are usually necessary to achieve the benefits of computer automation. These process improvements often extend beyond a single firm with the formation of formal and informal alliances between pump users, owners, engineering contractors, architect-engineers, pump suppliers, and other equipment suppliers. These trends place a greater emphasis on the purchaser-supplier interface during the pump selection process. From the purchaser's perspective, the optimal choice of pumping equipment has significant cost implications over the service life of the equipment. From the manufacturer's perspective, configuring the preferred offering of pumping equipment is crucial in securing a competitive advantage during the purchase evaluation.

The information age is redefining virtually all aspects of conducting business including the way pumping systems are designed, evaluated, procured, manufactured, and maintained through their entire lifecycle. In this section, the process of selecting and purchasing pumps will be revisited in the context of the way critical information is communicated between pump purchaser and supplier. Then, four of the emerging information technologies that are contributing to improved quality and cycle time in the overall process will be described.

Information Flow Between Purchaser and Supplier Following the decision that pumping equipment is required, an Inquiry/Proposal process is undertaken involving the six major steps outlined in this chapter: (1) engineering the pumping system, (2) selecting the pump and driver type, (3) pump specification and data sheet preparation, (4) inquiry and quotation (proposal), (5) evaluate of bids and negotiation, and (6) purchase the selected pump and driver. The entire process is information intensive, consisting of both technical and commercial information. The first three steps of the process (steps 1–3) are technical in nature, involving the exchange of system design, pump specifications, and performance and construction details of the pump. The last three steps of the process (steps 4–6) transition toward the commercial elements of the purchasing decision such as equipment costs, life cycle cost evaluations, terms and conditions, and delivery lead-times. This flow of technical and commercial information is ascribed by the Inquiry—Quotation information exchange depicted in Figure 9.

This Inquiry—Quotation information exchange is not limited to only one purchaser-supplier interaction. With each new procurement opportunity, this information exchange effects every trading partner participating in the entire supply chain. Consider the simplified example (in Figure 10) of an Operating Company that gives three Engineering/Design contractors the opportunity to bid on an expansion of a chemical process plant. If each of these contractors issues three inquiries to pump manufacturers, nine inquiries are issued. Now, if each manufacturer issues three inquiries to their sub-suppliers, a total of 27 inquiries are pending for this single plant expansion. In the end, only one contractor, one equipment-supplier, and one sub-supplier actually receive orders to supply equipment for the project. Thus, only 3 inquiries out of 27 representing 11% of the total application and quotation effort represent "useful" work. These engineering costs are recovered only when equipment is actually purchased. The cost of the other 89% of effort by those participants in the Inquiry/Proposal process who did not receive a customer order are "wasted"

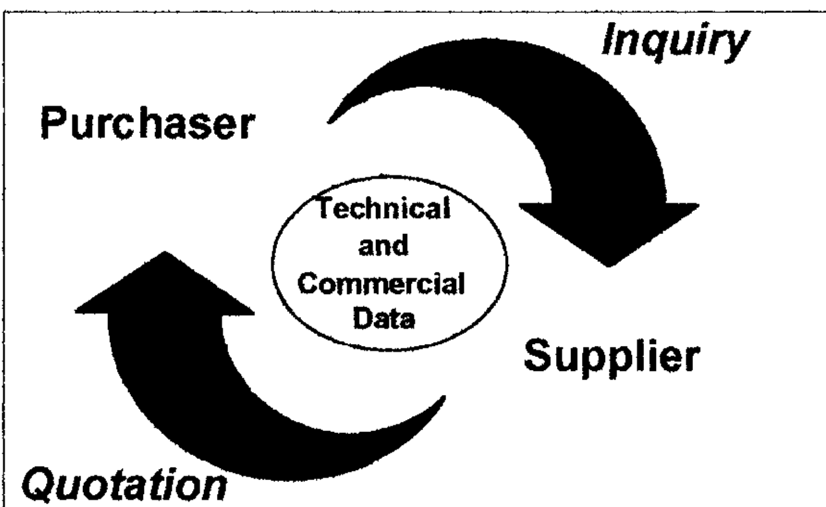

FIGURE 9 Purchaser supplier information exchange

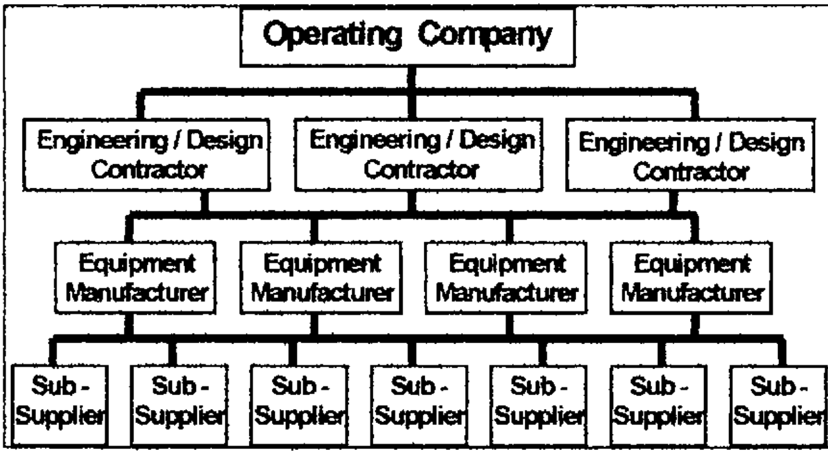

FIGURE 10 Multi-firm information flow

and absorbed as a sales and engineering overhead. This example actually understates the total number of inquiries issued indicating that the "wasted" effort is probably much greater than calculated.

To reduce costs, purchasers are seeking ways to reduce the engineering resources required to process this information without compromising the quality of the competitive evaluation. Similarly, suppliers are developing methods for responding to inquiries (or requests-for-quotation [RFQ]) with less resources and effort while striving to still provide high quality quotations to their customers. Simplifying the inquiry-quotation process is an attractive proposition for both purchaser and manufacturer.

Strategies for Improving the Selection and Purchasing Process Both purchaser and manufacturer in the Inquiry/Quotation Process are striving to enhance their competitiveness by reducing costs through process and information technology-oriented productivity improvements. *Intracompany* productivity gains have been the focus of many internal reengineering programs within a given firm. By their nature, these gains are limited to changes made within a single company and cannot effect improvements between multiple companies. However, the "ripple effect" on the total cost across multiple firms, described earlier, is a significant cost and represents a relatively unexplored opportunity for *Intercompany* productivity gains. Some of these cooperative strategies engaged by both purchaser and supplier include the following:

- Form alliances to streamline the Inquiry/Quotation process and flow of information across multiple firms
- Reduce the number of participants in the process by defining a preferred set of customers and suppliers
- Move the pump selection task earlier in the pumping system design process by providing purchasers' access to computerized selection programs allowing the purchaser to optimize their process design
- Structure the flow of information between companies to reduce ambiguity and enhance common work processes

Existing and emerging information technologies offer a technology platform necessary to implement many of these strategies. The next section describes four of the information technologies that are particularly important in improving intercompany activities in the selection and purchasing process for pumping equipment.

Applications of Emerging Information Technologies Information Technologies are used throughout the design, manufacture, and maintenance of pumping equipment and systems. With respect to the specific activity of selecting and purchasing pumps, there are four important information technologies that are playing a more meaningful role, including (1) Pump System and Selection Programs, (2) Pump Configuration and Pricing Systems, (3) Electronic Data Exchange, and (4) the Internet.

Pump System and Selection Programs Designing the piping network and sizing the components for a pumping system are performed very early in the overall pump selection and purchasing process. The piping system design involves numerous components that introduce friction losses in the system. These must be calculated in order to estimate the behavior of the system resistance curve needed to properly size the pumps needed in the system. Changes in process conditions (pressure, temperature, fluid properties, tank elevation, and so on) or multiple/variable branch systems introduce additional operating conditions in the system design that must be predicted. This design process, when done manually, is tedious and time-consuming. However, handling design iterations and performing system optimization studies have become more practical with the use of computerized design and analysis programs.

Use of design and analysis programs became more prevalent in the mid-1980s with the advent of personal computers as powerful engineering workstations on the desktops of pumping equipment designers. These computers, with their easier to use software interfaces, encouraged the development of more robust and capable software applications that were more economical to deploy. Consequently, a substantial amount of effort went into the development of engineering programs dedicated to the sizing of piping systems, pumps, and other components.

Numerous Piping System Design/Analysis computer applications are now available to aid in the design or analysis of piping systems and their components. Most of these programs are based on simultaneous path solutions. The more complete programs easily model piping networks and are capable of calculating friction losses through pipes and fittings. They also contain large libraries of standard pumped liquids and their fluid properties such as density, viscosity, and vapor pressure as a function of temperature. These programs are more time-efficient and give more predictable results than former manual methods.

Some of these piping design/analysis programs also contain integrated pump selection programs. Performance curves from various pump manufacturers are digitally programmed and accessed by the program to establish preliminary pump performance and design specifications. These programs can be reasonably sophisticated, using specialized mathematical algorithms to predict pump performance under varying operating conditions of speed, temperature, *NPSHA*, pressure, viscosity, and so on. Some are even capable of adjusting performance based on alternative mechanical seal design, wearing ring design and clearance, bearing design, materials of construction, or other mechanical design features. There are over 30 different pump selection programs used in the industry today (Cotter, 1996). With few exceptions, these pump selection programs were specially developed by each pump manufacturer using proprietary selection and searching methods. These programs are available under a licensing agreement directly from the pump manufacturer and are usually the same programs used by their internal applications engineers. Some third-party programs are available incorporating product lines from multiple pump manufacturers. Versions of both manufacturers and third-party programs are readily available for download from the Internet.

Pump system and selection programs have improved the ability to evaluate large numbers of alternative design alternatives in a short period of time. Accurate performance calculations, even with variable pump speeds, fluid properties (viscosity, temperature, pressure), and mechanical configurations are readily predicted. Design and calculation errors have diminished and the overall quality of the process has greatly improved.

Pump Configuration and Pricing The primary tool that pump manufacturers traditionally use during the Inquiry/Quotation process is commonly known as the *Pricebook*. The Pricebook is a manual that contains extensive pump performance curves, materials of construction, engineering data including dimensions and cross-sectional drawings, a plethora of guidelines on proper application of pumping equipment, and pricing information. Essentially, the Pricebook is an engineering design, specification, and pricing manual used by a trained pump applications engineer to convert a customer's inquiry into a customized quotation. These quotations include datasheets, performance curve, general arrangement drawings, and a price quotation including terms and conditions. In many cases, alternative selections, comments to the customer's specification, or other supplementary information are provided. The diverse array of information, expertise, and resources needed to generate a customized proposal has prompted the need to systematize the selection and configuration process using computer-aided tools.

Some manufacturers have responded by developing computerized product configurators. Product configurators aid the applications engineer in developing a pump quotation according to a prescribed product configuration model. These configurators are based on *design rules* and *configuration rules* that limit configuration choices. Examples of design rules are maximum casing pressure, maximum pump torque for a given shaft design, or the allowable temperature range for a given material. Using these design rules, a configurator could automatically upgrade a flange rating on a casing based on casing pressure or restrict the use of a gasket material as a function of temperature. Similarly, configuration rules ensure that a complete and permissible pump scope-of-supply is generated. For example, the mechanical seal type dictates the list of allowable seal flush piping options or the choice of pump and motor automatically defines coupling size required. These rules are coded into a knowledge base and serve to enforce product standardization and reduce configuration errors.

The pump selection program and the product configurator are the hub of the computer-aided tools used by the pump supplier to produce customized quotations. Supplementary programs are used to develop additional information such as pump performance curves, datasheets, general arrangement/outline drawings, and price make-ups. These programs have reduced the quotation cycle time while improving the quality and accuracy of the technical and commercial information required by the purchaser.

Electronic Data Exchange The communication of inquiry and quotation information is still predominately managed through paper-based methods in spite of the increasing use of computer-aided inquiry and quotation systems. The exchange of pump technical data has been traditionally handled using the pump datasheet. Both purchaser and manufacturer have developed their own datasheet formats. Consequently, each datasheet exchange requires a laborious translation and interpretation of information from one datasheet format to another.

With the implementation of computerized selection programs and bid-tab programs, this manual translation represents a lost opportunity to streamline the data communication process. In response, some firms have developed proprietary data exchange formats to leverage their own proprietary systems. Unfortunately, that approach has only shifted the burden to their trading partners who must develop special data translators to accommodate this wide variety of datasheet formats. It has been shown that the total number of translators needed for M data exchange formats follows the relationship, $M \cdot (M - 1)$. Therefore, 3 unique data formats require 6 translators, whereas 10 unique formats require 90 translators.

To halt this trend, a neutral data exchange specification was developed under the auspices of the American Petroleum Institute's Standard 610, *Centrifugal Pumps for Petroleum, Heavy Duty Chemical, and Gas Industry Services* (8th edition, August, 1995). This is used to exchange structured pump technical information reliably and efficiently between trading partners requiring each firm to develop only two translators (that is, input and output) to exchange pump data. The same neutral data exchange format has been adopted by *Process Industry Practices* (PIP). A number of purchasers and manufacturers are now using the data exchange file during the Inquiry/Quotation phase.

The Internet The use of the Internet has grown dramatically since the advent of the World Wide Web (WWW) in the mid-1990s. The rate of change on the Internet is witnessed in terms of days rather than years. Information or Web sites that exist on the Internet today may be eliminated or replaced by tomorrow. As a consequence, any references about the use of the Internet for the selection and purchasing of pumping equipment will most likely be obsolete at the time the reader sees it. Nonetheless, it is prudent to anticipate the effect the Internet will have on this process in the pump industry.

Routine communications between purchaser and supplier are increasingly performed over the Internet using electronic mail (e-mail). E-mail is replacing both the paper mailings as well as the use of the fax because of its rapid delivery and ease with which messages are routed to multiple addressees. Other electronic documents such as spreadsheets, proposals, and drawings are readily communicated as file attachments in e-mail messages. Similarly, most purchasers and suppliers are developing, or re-developing a presence on the Internet with their own Web sites. These sites started as relatively simple sites displaying information about the company, its products, and company contact information. These sites improve the access of general information between trading partners, often replacing the need for mailing of brochures or other marketing information. More sophisticated sites are capable of conducting electronic commerce (e-commerce), described next.

The Internet is rapidly becoming the medium by which business-to-business (B-to-B) or electronic commerce will be conducted between trading partners in the future. The pump selection and purchasing processes described in this chapter will be substantially performed across the Internet in the future. Purchasers and suppliers will team up by either contacting each other through their own Web sites or by meeting through special "portals" or exchanges specifically established on the Internet for pumping equipment. These exchanges provide a natural place to host bulletin boards or discuss technical issues about pumping equipment. The pump system and selection processes described earlier will be Web-enabled, allowing users to perform these activities directly on the Internet. Similarly, the process of electronic data exchange will be performed across the Internet using structured data exchange methods that eliminate the manual re-entry of technical information between different systems. Standards created by either international standard bodies or a de facto standard created by a commercial entity will provide the necessary framework for this data exchange.

Finally, the actual business transactions involving inquiry, quotation, purchase order, and invoice will expand over the Internet. This process will evolve starting with commodity-type pumps and eventually will involve more sophisticated types of pumping equipment. Interactions during the order fulfillment cycle will be available such as order status information. Drawings, certifications, test data, and other technical information will be available as secure business transactions. The use of voice and video are also capable of replacing face-to-face meetings or equipment inspections that often involve detailed coordination and expensive travel.

SUMMARY

The basic activities involved in the selection and purchasing of pumps as described at the beginning of this chapter are substantially the same now as in the past, and will be in the future. However, the processes and technologies employed in performing these activities are changing rapidly because of the Information age. The motivations surrounding these changes are driven by the desire for shorter cycle times, higher quality, and lower costs in the selection and purchasing process. These objectives are driven by the availability of new and emerging information technologies that offer a seamless and structured flow of information between the purchaser's and the supplier's sales, applications, engineering, and manufacturing functions. The availability of computer systems guarantees only that the infrastructure is in place to achieve the anticipated benefits. However, common work practices in both an intercompany and intracompany environment must be adopted and adapted to these new technologies. These process changes, not the availability of new information technologies, will govern the speed at which the pump industry changes in the future.

The emergence and use of new information technologies such as pumping system and selection systems, product configurators, electronic data exchange, and the Internet were described. These technologies are in use today, but will be “re-invented” on the Internet in the future in ways that cannot be fully anticipated. However, the rapid changes brought on by the Information age must be recognized for what they are—a support process in the selection and purchase of pumping equipment. The information age will support, but not replace, the basic requirement to design, select, configure, and manufacture high quality and reliable pumps that support a substantial part of our modern life and industry today.