Evaluating Packaged Pumping Systems

Are they for you?

By George Lingenfelder and Paul Shank, Precision Powered Products, Inc.

Change, we are told, is inevitable and continual. Business literature is filled with information on creating and managing change. Whatever the efficacy of those recommendations, competitive pressure in the petrochemical and refining construction industry is driving a move by many contractors and users to look beyond original equipment manufacturers to reduce both engineering and construction costs.

As manufacturers move toward greater emphasis on quality programs based on standardization to reduce costs and increase reliability, their ability to provide customized packages has diminished. Engineering contractors, competing in the most difficult market in a decade, are also striving to reduce man-hours in the design and construction phases of projects. Users are seeking greater coordination with suppliers and increased unit responsibility from vendors. No longer are they satisfied with a pump and motor mounted on a baseplate. Interconnecting piping, valving, controls and instrumentation provided by a single source are reducing front-end engineering and procurement and installation costs. A single source of responsibility for operations integrity of a multi-discipline design also reduces start- up and operational problems.

In our continuing fascination with spectacularly obfuscated terminology, a number of terms have been used to describe the organizations that design, engineer and fabricate packages. "Packagers," the somewhat archaic convention selected for this thesis, has been joined by such terms as "fabricators" and even the abstract, if not obtuse, "system integrators." The competition also has been joined by some seeking to corrupt the word "module" into something denoting those building modules, perhaps "modulators" or the eighteenth century French "moduleers." But the search for a satisfactory nomenclature begs the question of function. What exactly do packagers do and how do they do it?

First, let's dispatch the term "module" or "modularization." Modules can be packages or parts of packages, but packages cannot be modules. A module is a component or sub-system of a package, although it may well be mounted independently of any other equipment, system or package. It also may be an independent component mounted separately for convenience in transportation or installation. To regress into physics, the definition can be supported by the module's inability to do work. A module does not do work; it does not directly add energy or reduce entropy to the prime fluid. Modules typically are characterized by a relatively high degree of fabrication and low design and engineering content. Typical examples of modules include LACT (Lease Automatic Custody Transfer) units; skid mounted piping manifolds and the like. Less stringently, and for API aficionados, a module also can be defined as a system with a dedicated API standard. This would allow inclusion of lube oil and pressure relieving systems.

A package, then, is a system that performs work; that is, it adds (or intentionally removes) energy or reduces entropy. For our purposes, it also includes components from multiple areas such as piping, instrumentation, control and electrical, as well as structural and mechanical elements. Packaging also implies the coordination and responsibility for integrating all these components into a unified whole, including design, engineering, construction, and assembly and testing.

A great deal of territory is covered by the term packager, and that presents one of the largest obstacles to the use of packagers by many engineering contractors and users-selection of a qualified company.

Advantages of Packaging

Because quality and reliability can be controlled (at least in theory), commercial considerations are perhaps the primary driving force in selecting packaged systems over individual components. This requires, however, a realistic evaluation by the purchaser based on several basic factors, including the following.

Field Erection Costs

This factor has long mitigated extensive use of packaged systems in the oil and gas industry. Shop labor costs, with the availability of simple but necessary equipment, are almost always less expensive than field labor.

Installation Time

This can be a critical factor when the destination is inside an operating process unit in a refinery or chemical plant. It is quite likely that the unit will need to be shut down to enable piping and utility interconnections.

System Run Testing: Functional and Performance

If there is a problem, it is always faster and cheaper to fix it in the shop than in the field.

Remote Site

The availability and cost of raw materials, skilled labor, construction equipment and tools can be deciding factors in choosing packaged systems over components.

Field Hook-Up

This involves not only the skilled labor factor, but also provides the user with greater options for selecting an installation contractor, since packaged equipment is inherently less complex to install and commission. Keep in mind that most packages will have received a complete functional test (if not performance test) at the packager's shop prior to shipment.

Detail Design

Because most of the detail design work will be done by the packager, at a considerably lower rate than an engineering consultant can charge, substantial savings can be obtained at this level. This assumes, of course, that the packager is capable and competent, an issue discussed later.

Scheduling Delays

These usually fall under several broad categories:

1. Weather-Packaged equipment is generally built in shops where inclement weather is rarely a concern.
2. Design and fabrication-These usually occur earlier in the process with packaged equipment than with field-installed individual components. They are easier and less expensive to correct or resolve in a shop environment than in the field.
3. Construction-Packaged equipment is generally a self-contained system; delays with other equipment or site construction will rarely affect the manufacture of packaged equipment. Packaged process equipment enables simultaneous construction on multiple fronts.

Packaged equipment is not limited to lower energy or standardized equipment. It is increasingly common for packagers to take delivery of highly specified equipment purchased directly by the user or engineering contractor for installation in a package. This enables both the specifying engineer and user to maintain .control of purchasing, inspection and testing of major components, and still utilize the services of packagers. This flexibility by most packagers is useful for high-energy pumps, compressors and even heat exchangers.

Limitations in Packaging

The most obvious limitations in packaging are weight and size. Transportation limits are also a primary consideration. Most states limit width to 14 feet without an escort. Even above 14 feet, cost may be prohibitive and some roads may not be suitable. Rail is sometimes an option, as is water transportation, but rail is nearly as limited as over the road or common carrier, and most packagers don't have easy access to water transportation.

Internationally, limits tend to be more restrictive than in the United States, so care must be taken by both purchaser and packager to be sure the loads don't exceed weight and size limits. In fact, overall dimensions and the ability to manufacture extremely compact systems are an important reason for looking to packagers rather than field erection.

Since the ability to provide functional and performance testing for packages is an important factor in choosing packaging over individual components, connected power also must be taken into consideration. Steam is obviously out, and using compressed air in lieu of steam is generally not a realistic option due to the greatly reduced energy content of air over steam. High voltage (generally over 460 volts) or high power consumption packages also can prove difficult to test. While generators can be rented, the cost might not be justified.

Obviously, it is not necessary to fully operate a package prior to shipment. Instrumentation and control sub-systems usually can be tested to ensure proper operation even if the major components or prime movers cannot be energized. If only components were purchased, the system would have to be built in the field prior to operation, so an inability to perform shop testing prior to shipment is not an absolute requirement. Regardless of the packager's ability to test, the manufacturers of the individual components would still do performance testing

Selection of a Packager

Selecting the proper packager is undoubtedly the single most difficult step in purchasing packaged or modular equipment, and it is potentially the most perilous. While stories abound of failures by packagers, as with other suppliers, there are usually two equally culpable parties to each disaster - buyer and seller.

EVALUATING PACKAGED PUMPING SYSTEMS

Unlike purchasing a conventional pump on a baseplate with a motor, procurement of a package is more analogous to hiring an engineering contractor. The packager usually receives a bid package including a P&ID (Process and Instrumentation Diagram) and a broad cross-section of project specifications that may or may not relate to the package in question. Occasionally, a rudimentary process flow sheet or possibly a process design data sheet also is provided. From this information, the packager develops a mechanical design and selects equipment. Unlike equipment manufacturers, packagers are not limited by existing designs or the expense of developing a new product. Packagers rarely have the pleasure of building two packages with sufficient similarity to avoid the design and engineering phase of a project. And like most engineering based organizations, they are anxious for a challenge and the opportunity to expand their expertise. Falling effortlessly into this potentially dangerous maelstrom is the purchaser looking for a bargain.

The packager should have experience with packages of similar process design and complexity to the buyer's. This includes not only the generic process, but also such frequently overlooked (or underestimated) factors as experience packaging equipment for the specific destination, be it desert or arctic climes. Experience with steam traced packages does not automatically translate into a clear understanding of the ramifications of electrical heat tracing for a Class 1, Group C & D, Division II area. But using this as an example, let's consider some of the factors a purchaser should understand about this single item as a way of looking at the evaluation process of the entire package.

1. Has the packager ever performed this type of work before? In a similar environment?
2. If not, how relevant is his experience with similar packages?
3. Will the packager perform this particular part of the contract himself or will he use a subcontractor?
4. What is the size and experience level of the subcontractor?
5. If after-market assistance is required, who is the responsible party?

Obviously, an overly strict requirement for exact duplication of previous work will needlessly limit your options, so it becomes important for the purchaser to understand the experience level of the packagers. Depending on circumstances, a relevant "similar" project could be a totally unrelated process package for a customer requiring highly specified or unusual materials of construction.

For packages under $2,000,000, most companies will use sub-contractors for specialty work such as thermal tracing and insulation. In fact, companies in this size range that do not utilize subcontractors should probably raise more questions than those that do. Because of the number of industry standards and government regulations that come into play in a multi-discipline package, most packagers in this size range simply cannot maintain qualified personnel to meet the eventualities of all packages. All reputable packagers should be willing to identify their major subcontractors and provide information about their experience and qualifications.

Finally, it should be clear to everyone that the packager is the responsible party for all after-market service. Unit responsibility is a major reason for purchasing packages.

What a Packager Needs

The packager must have an understanding of the process he is to build. He also must understand the scope of the project, both for the package in question and to a lesser degree the overall project. This not only helps in the design of the package, but also makes possible early detection of problems that might affect the overall operation of the system.

Some of the most important data that must be included are the basic scope and a clear explanation or description of what the package is supposed to do. While this may sound absurd, it is surprising how often critical information is simply assumed to be self-evident; and it certainly is to those that have brought the project from the initial concept to detailed engineering. It is less obvious to those coming in at later stages. A complete listing of all utilities available, especially air and instrument power, is required, as are area classification and equipment surface temperature limits.

As much process information as possible is always helpful. It may not be necessary, but the packager will have a much easier time in the design phase of the project excluding extraneous data than searching in vain for information that is not available. Buyers should include not just the process design for the unit under consideration, but also for adjoining units. What are the operating parameters and ranges? What are the relief valve settings on contiguous units that are either upstream or downstream? What systems upsets can occur and how are they dealt with? What sizing criteria have been used to design the unit? If appropriate, are process simulations available? If not, whose responsibility are they? If done by the purchaser, will they be available so as not to impact the packager's design and engineering schedule? If they are to be provided by the packager, are they subcontracted, and if so, at what level? Will it be a production or design hold point or should they simply be submitted for information?

Background information from both parties must be collated early in the project and should be detailed completely in the request for quotation. Unfortunately, it seldom is, and these points back to the fact that the purchaser is fully aware of how packages will be supported, but it is not at all clear to the packager. Will the unit be grouted? Welded to a superstructure or deck? If mounted on something other than a conventional concrete foundation, what type of support is available and what are the load bearing characteristics of the structure?

Vibration limits also must be realistically discussed with the packager. How much vibration can be transmitted through the foundation and piping to other units? How much can the unit under consideration accept? A contiguous package may be well within industry standards and still transfer an unacceptable level of vibration to another package.

In a similar vein, piping stresses must be mutually acceptable. The simple fact is that pipe loads will be present in any packaged equipment. Realistic limits, based on the design of the equipment and system, must be developed, and purchaser and packager must determine how best to meet these limits. This is less a. design issue than a commercial issue. Either party can design its side of the system to eliminate excessive pipe loads. The question is who can do so in the most cost-effective manner.

Specifications: How Much is Too Much?

I once received a quotation claiming to “be in full compliance with all applicable specifications.” On further discussion with the vendor, I was pleased to find that our concept of applicable specifications was in almost complete agreement.

However, our legalistic and litigious society has forced us to sharpen our linguistic swords and consider assignation of liability to be just another line item on the tabulation spreadsheet. Specifications won’t resolve this problem. Open and forthright discussions will.

In any discussion of specifications, we must first be sure that enough, but not too many, specifications have been included or invoked by reference. Inclusion of unnecessary specifications creates needless misunderstandings and generates unnecessary costs throughout the project. While difficult to quantify, simply consider the time it takes to read unnecessary specifications and multiply that time by the number of people that must read and apply or adhere to them: bidders, evaluators, designers, engineers on both sides, and on to the inspectors, manufacturing managers and quality control personnel of every company involved.

Creating the most unnecessary problems are those specifications invoked by reference. Requests for quotation usually include a page that references industry and proprietary standards deemed important to mention but not important enough to include in the package. The list frequently includes ten to twenty (or more) standards that someone thought might apply. They probably do, in some oblique way. Unfortunately, many of them also will have monstrous conflicts with the project specifications and will include requirements that may or may not be applicable to the package under discussion. To prevent misunderstandings and avoid needless expense, industry standards should be invoked only when there is a clear-cut need. Inclusion of a vaguely related industry standard to be sure all bases are covered demonstrates a lack of expertise and professionalism. Industry standards are best applied when their object is clearly specified.

Controls and Instrumentation

Controls and instrumentation, typically relegated to the back burner, are important areas for packagers and specifying engineers. Because most packagers tend toward strength on the structural and mechanical side, instrumentation and control schemes are not as intuitively obvious as increasing impeller diameter to gain differential pressure. This is frequently coupled with the fact that the specifying engineer is typically aligned with the mechanical or piping discipline, all of which can make for a difficult situation. Unfortunately, this is often not addressed until after an award is made, making changes and modifications much more difficult.

The most important facet to controls and instrumentation is to clearly and concisely present the packagers with a list of recommended vendors. This is not the time to demonstrate a lack of preference. If the plant is standardizing (or if the user has a decided preference), everyone will be well served by making that fact known. Not only does it save the packagers and their sub-vendors a lot of work, it also saves the specifying engineer the tedious and unrewarding task of sorting out and eliminating unwanted components and substituting preferred ones. There are wide variations in cost for many items in this category. With increases in automation, these products represent a larger portion of package costs than ever.

As is true with process design, it is imperative that the packagers understand the underlying philosophy of the instrument and control scheme. These commodities usually are important in the protection of something, be it equipment, vessels, piping, personnel, the environment or the process itself.

The object is usually not on the package in question, so it becomes even more difficult for the packager to be sure the proper level of protection is being furnished. This is particularly true with the widespread application of transmitters and the increasing frequency of PLC-bascd systems, where the cost of the instrumentation and control scheme can exceed the cost for the primary equipment. Critical information that must be passed on to the packager includes the degree of remote monitoring, interface characteristics and tie-in points. Again, a working understanding of the control philosophy greatly assists the packager in ensuring that the system works.

Conclusion

While the days of simply purchasing a couple of pumps and motors on baseplates are not behind us, the industry has changed. The more common request now is for a pair of pumps and motors on a structural base with interconnecting piping and control valves, as well as single point connections for power, and instrument and control signals. Single point responsibility for system design, assembly and testing provides engineering contractors and users with a number of advantages. Cost savings at every level, from design through construction and operation, are making packagers advantageous to both engineering contractors and equipment users.