zones with higher or lower pressure or flow requirements.

Still the vast difference between pump systems made controlling the built-on-site units difficult. "Superintendents wanted more control over their pump systems, but because the proper equipment wasn't selected initially, controls were costly and cumbersome. We had to match the characteristics of certain pumps to the needs of the irrigation system," explains Harbour, "and provide the major control components ourselves so that the superintendent could have what he wanted. In short, we had to select and provide all the pumping equipment, not just the controls." Eventually the special needs of golf courses and other sports areas led to the selection of various components found on "prefabricated" pump systems today.

Prefabricated doesn't mean a manufacturer builds one type of pump station at his plant and ships it to all customers. Each system is designed for the particular customer to match the needs of his particular irrigation system. The system is then built to these specifications under controlled conditions at the company's plant and shipped to the site for installation. It is estimated that 75 percent of all pump stations built today are prefabricated.

The irrigation designer or pump system specialist selects a pump or combination of pumps as determined by the needs of the particular irrigation system—needs based on the irrigation programming and the sprinklers and other equipment being utilized.

Prefabricated pump station being lowered on to pad at golf course. Photo courtesy: Carroll Childers.

The workhorse of turf irrigation is the centrifugal pump. There are two versions—the horizontal centrifugal pump and the vertical turbine. The horizontal centrifugal pump can be located above or below the water level and draws water from its source into the system. If located above water level, suction lift is provided by the impeller with blades which spins around the axis of a shaft in a confined cavity. Once the suction line has been primed, water entering the pump at the center or eye of the spinning impeller is accelerated and thrown to the outer edge of the blades. This creates an increase in pressure. The water then escapes at higher pressure through a discharge nozzle located on the outer edge of the cavity.

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Calculating Pump Efficiency

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The centrifugal is a very versatile pump. By varying the diameter and pitch (tilt) of the impeller and the speed at which it turns, a pump can be made to provide a wide range of pressures and flow rates.

However, a plain centrifugal pump does not have the capability to lift water a great distance and cannot handle air in its suction line. Anyone with an old centrifugal well pump knows it has to be primed before it will start working. Should it lose prime during operation, repair costs can be extreme. To overcome this characteristic, centrifugal pumps are quite often installed below water level.

> *On a golf course or park, a booster pump may be used to provide enough pressure for heads in elevated areas.*

Vertical turbine pumps were first developed for deep-well service. They are normally suspended down into the water source and use multiple impeller and bowl sets called stages to develop the required pressure. As with the horizontal centrifugal pumps, water is propelled by an impeller from the center to the outside of a cavity. But the cavity or bowl of the vertical turbine is shaped to direct the flow of water upward to the next stage so it can create additional pressure. The efficiency of these units is better than most other pumps and they can produce higher pressures.

One thing to remember, says Harbour, is that these pumps often operate at different speeds. In order to develop the pressure needed, horizontal centrifugal pumps may operate at 3,600 revolutions per minute (rpm) whereas vertical turbines generally operate at 1,800 rpm. Lower operating speed can result in lower maintenance/repair costs and longer life.

A third type of pump being utilized in a growing number of pumphouses is a diaphragm pump. It operates on a back-and-forth or up-and-down stroke. One stroke fills a cavity on one side of the diaphragm with a liquid fertilizer or chemical. The next stroke forces the liquid into the irrigation line. This process is called fertigation or chemigation. The diaphragm pump injects a small, precise amount of liquid into the irrigation water for distribution on the turf.

Having the injector pumps in the pump house or near fertilizer storage tanks can present some problems with corrosion of the metal on the irrigation pump station. For this reason, AquaTurf of Jacksonville, FL, galvanizes the exposed components of their stations and protects control panels in stainless steel cabinets. "You have to protect the pump station from any hostile condition that might eventually affect its operation," explains Kent Curley, president of AquaTurf. "Once we have assembled all the components for a pump station, we take it apart and dip all the exposed metal before final assembly at the site."

Centrifugal pumps can also be used as "booster pumps." If water is supplied by a municipal water system, a booster pump may be used to increase the pressure of the municipal system to match the requirements of the sprinkler heads. On a golf course or park, a booster pump may be used to provide enough pressure for heads located in elevated areas. "It takes an additional 25 psi to raise water up to a zone 60 feet higher than the rest of the course," explains Harbour. "A booster pump located at the base of the elevated area can eliminate the need for a larger pump at the pump station."

Rather than fighting gravity, a pump system should utilize it to maximum advantage. An elevated lake can serve a pumping sys-

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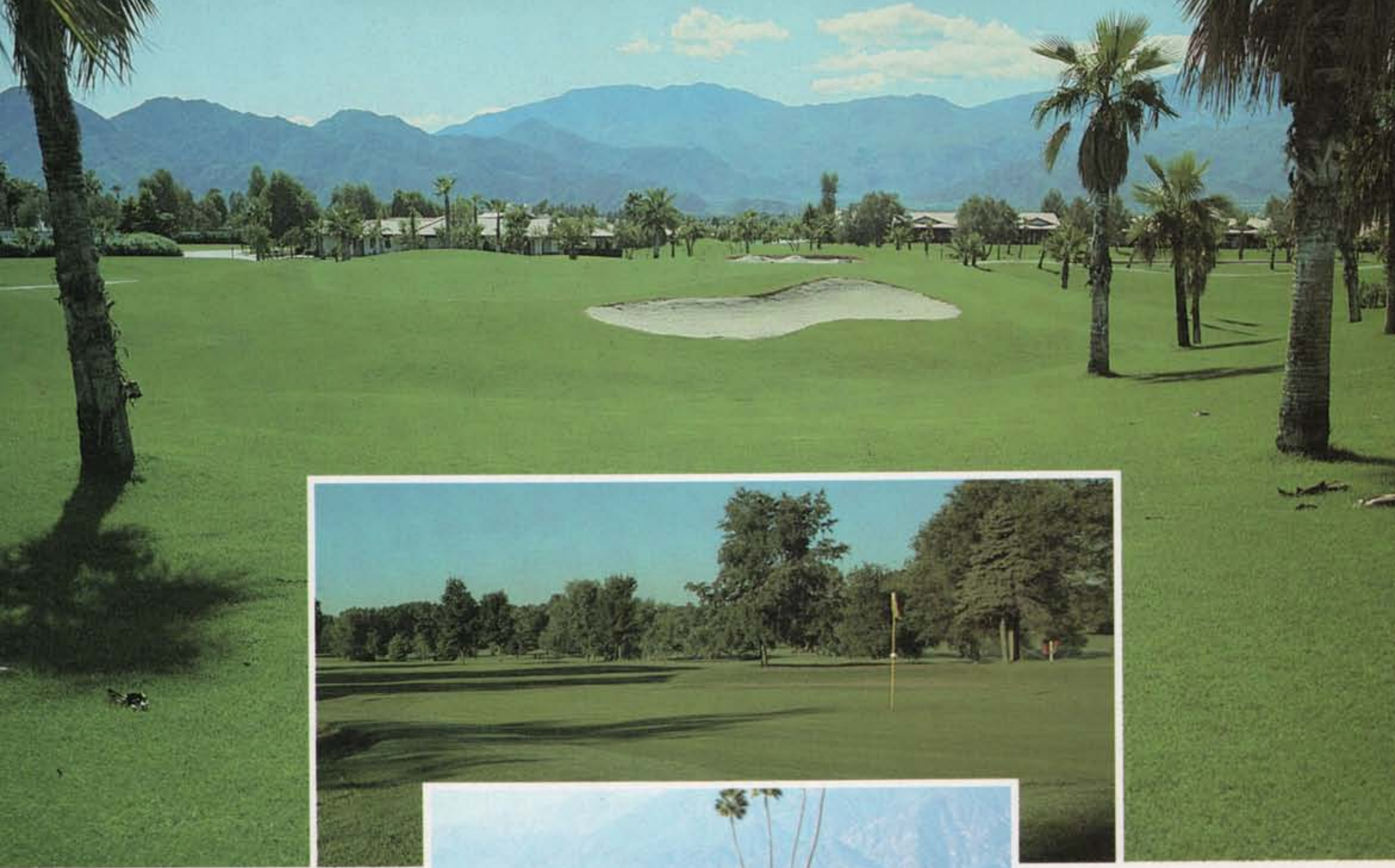

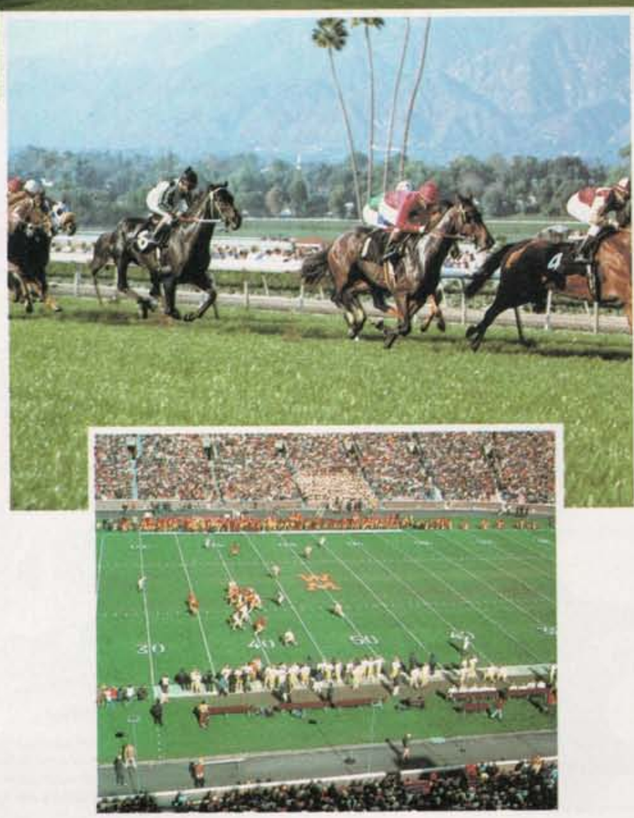

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Calculating Pump Efficiency

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tem just as municipal water towers do. For each foot of elevation a water source is located above a pump, nearly one-half pound of pressure per square inch is gained. The less pressure needed from the pump the more energy is saved. In some instances, it may be more efficient to pump water up to a holding reservoir than to develop all the necessary pressure with the pump system for a few hours of peak demand.

The cost of water today is based primarily on the cost of energy. As energy costs have risen, so has the cost of irrigation. Anything that reduces the amount of energy consumed by the pump system, increases the cost efficiency of irrigation.

Pump manufacturers work with sports turf managers to provide the greatest energy efficiency for the pump station while meeting all the various irrigation needs of the site. Today, an irrigation system at a golf course, park or stadium may include a wide range of flow and pressure requirements. Advanced controllers can link together the water needs of turf, plant beds and water features. They also provide the flexibility to adjust water application according to weather, soil types, sun or shade, slope, traffic levels and types of turfgrasses.

There is also a trend toward lower pressure sprinkler heads, says Larry Keesen, an irrigation consultant in Denver, CO. "Heads that used to require 100 or more psi are being replaced with new heads that only need 60 to 80 psi." As a result, pressure from the pump station needs to be reduced.

Variable frequency pumps change speed to provide a range of pressure requirements. Photo courtesy: Western Pumping Systems.

All manufacturers agree that energy is wasted when the pressure from a pump has to be reduced by a valve. The ideal situation is to select pumps that closely match the pressure requirements of the various portions of the system so they require minimal pressure reduction. The sports turf manager has a great influence on the efficiency of the pumps as well. By scheduling the zones with the same pressure re-

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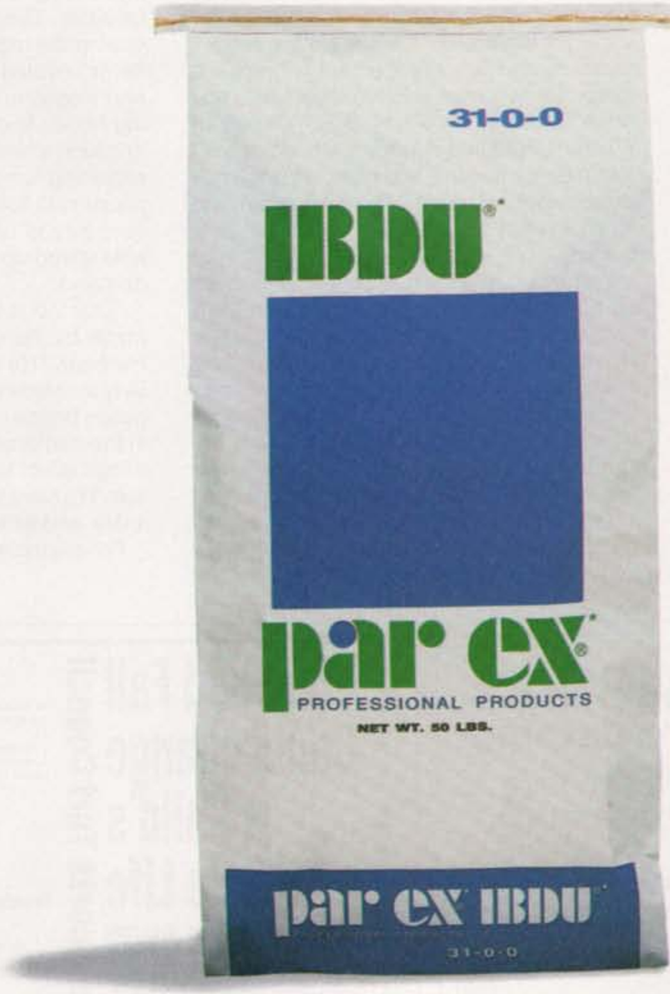

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Calculating Pump Efficiency

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quirements to run consecutively, the pumps do not have to expend energy to meet changing pressure needs.

There are two schools of thought on pump efficiency. The first is that certain pump/motor combinations are most efficient at certain speeds, flows and pressures. "Maximum efficiency is achieved by running a pump at its most efficient output," says Harbour. "The pump motors use the most energy when they are starting or speeding up." Running them at their most efficient level for as long as possible reduces energy waste.

Electric motors are matched to the rpm and flow characteristics of each pump to create the highest energy efficiency. This is one reason to incorporate more than one pump in a pump system. The "jockey pump" is the result of this type of energy saving. The small jockey pump can keep the irrigation system pressurized and allow for syringing or single-station operation without turning on a higher pressure, higher horsepower pump.

"The main purpose of everything we do in building our prefabricated stations is to maintain a constant downstream pressure, regardless of how the flow requirements may vary," explains Rick Allenstein, marketing manager for Carroll Childers.

The second school of thought is it is more efficient to eliminate the waste caused by pressure reducing valves and to change the speed of the motor to maintain the proper pressure and flow requirements. There are some energy losses with "variable-frequency drive" pumps," explains Bob Whalen of Western Pumping Systems, Chandler, AZ, "but they are minimal and pumping efficiency is markedly improved." By using one pump for a range of outputs, fewer pumps are required.

> *A major source of energy savings has been running pumps at off-peak hours.*

There is also a second school of thought on pump pressure and flow. "Rather than using pressure to indirectly gauge flow," says Norm Bartlett with Data Industrial Corp., "we encourage superintendents to use devices that measure flow directly." Bartlett says that a small drop in pressure may cause a second or third stage pump to kick on, when the flow rate is still adequate. By controlling the pumps by flow instead of pressure, pumps may not have to cycle on or off as frequently, saving energy. Data Industrial's flow measuring system can be linked with Motorola's MIR-5000 irrigation computer system. "Other manufacturers are considering flow rate control," Bartlett adds.

A major source of energy savings to sports complexes has been running pump systems at off-peak hours. Electricity rates can fall 20 to 35 percent in some areas from late evening to early morning. By scheduling irrigation during this period, thousands of dollars can be saved. Cramming all irrigation into this period may be impractical for large facilities. But, at the very least, zones requiring the highest pressure and output can be scheduled then. Sports turf managers and irrigation manufacturers are developing heads and controllers which speed up irrigation where possible. Repeat cycles are replacing long cycles to match water application to soil infiltration rates. Lower pressure heads and higher output heads can also speed up irrigation and lower pressure demand.

"Our job is to keep up with the changes made by the sports turf manager," states Harbour. "He changes programming regularly in response to the turf's changing irrigation needs and may make major changes in the equipment every few years. All these things affect the efficiency of the pump station. We have to provide them with both flexibility and efficiency."

For example, valve-in-head sprinklers per-

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Calculating Pump Efficiency
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mit a sports turf manager to run one head at a time if he so desires. Short, mid-day syringe cycles are used frequently by golf course superintendents and sports field managers during the summer. Both require low pump output at times when the rest of the system is off. To power up a large pump for these cycles would be wasteful when a small jockey pump could do the job.

With the advent of lower pressure heads, pumps that were once needed to generate 90 psi now operate at just 60 psi. "Pumps that did not fit the high pressure systems before can now be used effectively in pump stations and save the sports facility money," Harbour says. With so many types of pumps and other pumping system components, it is no wonder that Bob Cloud, an irrigation consultant in Los Angeles, CA, warns that picking the right equipment can become confusing. "There are as many pumps as there are sprinkler heads. If not properly selected and used, they can cause more problems than they solve."

Cloud believes that pumping systems are too complex a subject for a busy sports turf manager to understand in full—there just isn't time to master all the combinations and calculations. Yet they are highly efficient when properly used.

"I think the most helpful thing I can do when advising someone is to get him to respect all the different potentials of pumps," he says. When the sports turf manager appreciates the complexity of the subject, then hopefully he will rely on somebody who is a specialist on pumps. A growing number of sports turf managers are looking to manufacturers of prefabricated pump stations. "They can take various elements and requirements and efficiently provide a unit that will best serve the needs of that particular site, requiring less-skilled people to install, and resulting in a far more reliable unit."

Today's pumps enable new irrigation systems to perform better.

Prefabricated systems allow irrigation contractors to do their thing, which is piping, fittings, wiring, sprinklers and controllers, says Bob Smith, of Triangle Manufacturing and Pump Co., Durham, NC. Smith believes most installers are not pump people. That is his company's line and he'll do whatever it takes to satisfy the customer's needs. That is why his equipment has no model names, no series names and no trademarks.

The pump system industry has a very bright future, according to PSI's Gram. "There are more and more competitors entering the marketplace on a regular basis. The demand to irrigate parks and recreation areas of all types, as well as industrial areas, is increasing. New products are entering the market. The research and development now being pursued will continue to create highly efficient systems for the future."

"A designer can design an irrigation system to work properly at certain pressures and manufacturers can develop products to work within certain pressures, but neither will be acceptable if proper water pressures are not available," explains Sam Tobey, president of Salco Products Inc., a manufacturer of drip irrigation components. "Sports turf managers can adjust pressures downward for desired water requirements—but if supply-side pressures are continuously changing, these adjustments have no meaning."

A pump is the beating heart of an irrigation system. Today it pumps with a newer, more efficient beat, positioning itself at the leading edge of irrigation technology, thanks to recent improvements in pumping systems. Most importantly, today's pumps enable the newer and more sophisticated irrigation systems to perform better. That, of course, it what it's all about.

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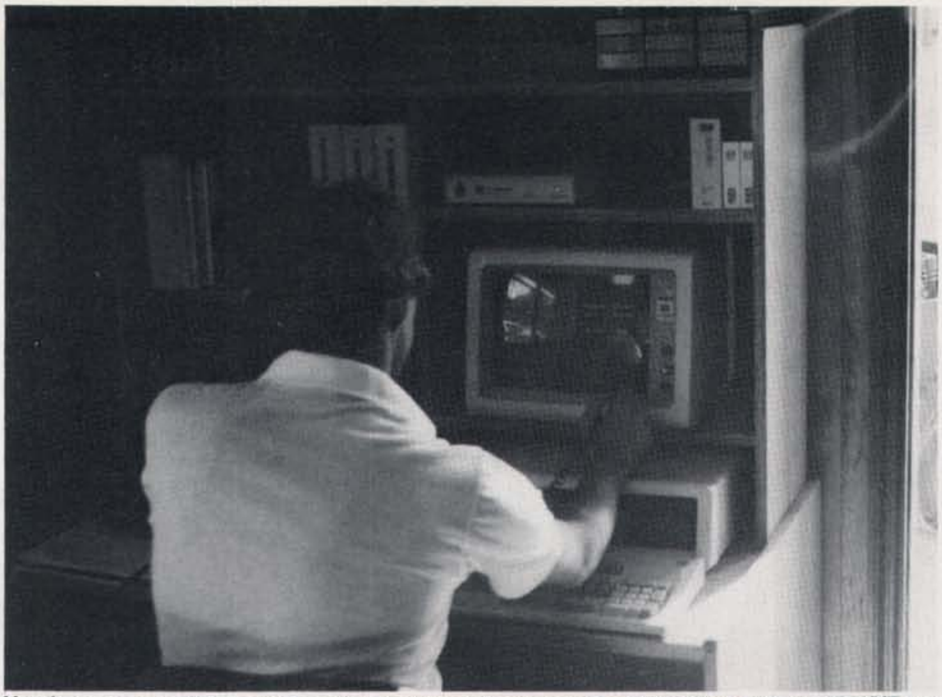
McAnlis used a new method he calls "time slot design" to design a system that uses 90 percent of the capacity of the pump station at all times.



Henderson uses a light pen to make program adjustments from his office with the IBM/XT personal computer that is the central control for the Network 8000.

Regaining Control
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a Rain Bird dealer in Boynton Beach, FL, had impressed Maloney and Henderson with its explanation of the Maxi.

After all the options were laid out on the table, McAnlis was given the job of putting together the best combination of products to fit Atlantis Golf Club. He used a new method he calls "time-slot-design" to design a system that utilizes more than 90 percent of the capacity of the pump station at all times. Rather than grouping heads in stations, he took advantage of the valve-in-head sprinklers and the capability of a central computer so that 33 to 34 heads in scattered locations would operate at all times during the schedule. By using a computer he was able to select the right combination of heads in a few hours rather than two or three days using zones and a calculator.

"We were able to knock more than four hours off the time it took to irrigate the course," boasts McAnlis. As a result, the pumps work more efficiently for a shorter length of time. Furthermore, Atlantis could take advantage of a 25 percent savings in electrical rates by operating during off-peak hours. During the day, a small jockey pump would keep the system pressurized and allow for repeat cycles and syringing.

McAnlis wanted to give Henderson the ability to make adjustments in the program from both the field and a central computer. That meant the satellites had to have much of the same programming capability as the central. That way Henderson could make changes in either location based upon conditions at each head. After adjustments were made for shade, soil, slope and wind, the schedule could be shortened or lengthened according to a calculation called evapotranspiration which determines how much water needs to be replaced each day.

McAnlis thought that if any change was made at a satellite, he wanted the change to be noted by the central computer as well. Finally, if the central computer went down, he wanted the satellites to continue to carry out the schedule as "stand-alones." He saw an advantage in downloading the commands for each satellite at once rather than having the central send the commands to the satellites as the schedule dictated. That way, if the central went down, the satellites could carry on the program without being notified by the central.

As his want list grew, McAnlis found himself leaning toward the Toro computer and satellites. "It was exciting working with what would be the first Network 8000 to be installed in southern Florida," he recalls.

Utilizing a combination of a computerized central controller and satellites with extensive stand-alone capability, the Network 8000 brings new efficiency to irrigation management. The system uses an IBM/XT personal computer, including keyboard, color monitor, matrix printer and light pen, as its operating hub. The non-dedicated central computer can be used simultaneously for business tasks and irrigation program operation. One function does not tie up the computer from other functions.

The central computer can operate up to 800 satellites with 32 stations each. By entering design, weather, geographical and agronomic information into the central, operating times for all stations are automatically computed based on the evapotranspiration rate, modified by any applicable rainfall. These calculations can be reviewed by the irrigation manager before they are downloaded to the satellites.

All relevant programming can be downloaded to the satellites at one time. From then on, the satellites can operate as standalones without further instructions from the central. Programs can be adjusted manu-

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Irrigation programs are downloaded once each day to the satellites. The temperature monitor attached to these satellites feeds data to the central computer to determine daily ET.