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New installation provides information not readily available previously that identifies and rectifies potential problems directly related to VFD components.

In installation of 97 variable frequency drives (VFDs) at the New Jersey International & Bulk Mail Center (NJI-BMC), Jersey City, NJ, in 1994-95 had reduced energy usage for the USPS. But a recent revitalization of the drives, which slashed the yearly utility bill by approximately $300,000, and installation of a drive link communication scheme for the HVAC controls further enhanced overall maintenance resources.

The new data network provides communication with all drives, and relays this information to a centrally located data link network PC workstation where craft employees can view various online parameters for all drives. But it was not an easy process to put this network in place.

Electrical distribution system

NJI-BMC, the largest among 21 bulk mail centers, includes three main buildings that occupy about 1.7 million sq ft. The high voltage 26 kV system equipment is located in a fenced-in high voltage outdoor switchyard. The medium voltage 5 kV system is housed in an outdoor switchgear cubicle. The low voltage distribution system is comprised of eight double-ended, 1000-1500 kVA transformers 4160-480/277 V, with main, tie, and subfeeder breakers. These subfeeder breakers provide power to various motor control centers (MCC).

These MCCs furnish 480 V, 3 phase, 60 Hz power to the VFDs. Ninety-seven UNICO Inc. 1100 HVAC Series drives and auxiliary equipment were installed in 1994-95 to conserve energy and reduce monthly electric bills. At that time, we assumed that installing the drive link network communication, which was estimated at $30,000, was not cost effective. Furthermore, we had not developed the skill sets needed to operate and maintain the overall drive link network or VFD components.

Field data shows problems

In the summer of 1998, during one of our periodic site inspections, we found that the air handling units (AHU) control systems were not functioning as designed. Our field data showed that some of the motors had failed and burned out, and some of the motors would not function in the VFD mode. One of the reports indicated that 80 percent of AHUs had minor to major problems and were switched to the “bypass” mode.

At that time we realized that we needed a centralized data gathering system that would retrieve, collect, and monitor data for all 97 VFDs. Usually, our technician, with a handheld pad and pen, would go to a VFD panel, insert the key, open the door, and start retrieving various parameters using the VFD touch keypad. The technician would scroll through the display screen and note the data on the pad. Repeating this simple procedure for 97 VFDs that are located throughout a 137,000 sq ft area was tedious, questionable, and labor intensive.

Moreover, we did not know how to manage all the VFD data effectively to ascertain if the HVAC was functioning in the optimum modes. We were not confident that we were capturing any financial benefits from the VFD technologies. Without a comprehensive data network system, it was difficult to gauge and validate VFD operation. It was an extremely laborious and tedious task monitoring all drives on a periodic basis.

Complications of a new data gathering network

In general, most of the data system service contractors would replace existing components and install a new independent data system. Customarily, this is a common solution and an easy option.

This option includes hiring an architect/engineering design firm to prepare design and engineering, and install and validate the system operation. Installing an independent new communication data link and modules could require removal of certain original components in the VFD cell configuration and surrounding structure. This option would require a power outage because the installing contractor must shut the power off prior to entering the power/controls compartment of the VFD cell.

Estimated costs for this option, as expected, were high, and a return on investment (ROI) criterion was less favorable than other options. A rough estimate for the new communication data link for 97 VFDs was conservatively assessed at approximately $60,000.

This hardware and software link, designed to communicate with all drives, would gather data, generate specific data files, and prepare operating trends, defaults files, reports, etc. It then would communicate this information to a PC centrally located in the plant. At the PC, a craft employee could view various online parameters individually for all drives. Based on the existing VFD's keypad display, we selected eight parameters including rpm, Hz, A, ac and dc, V, kW, torque, fault history, etc., to be displayed on the PC monitor.

Looking for lower cost options

During 2000 and 2002, the U.S. Postal Service was under serious budgeting constraints, and virtually no funding was allotted for any new projects. The NJI-BMC maintenance staff had to look for a nonexistent no-cost option.

When we began looking for the no-cost option, the first step was to assess our on-site resources. The maintenance craft personnel and technical staff reassessed the work scope and determined that our in-house electronic technicians could complete the fieldwork.

However, there were some inherent difficulties in this method. One of the major problems, when using our crew as compared to acquiring outside contractors, was how to reallocate the regular assigned work, which is dictated and approved by the mail-processing department. Any changes impacting mail processing could adversely jeopardize our revenue.

Primarily, we needed to procure all material, install the main hub, install all wiring to and from the VFDs, and test the hardware and software. However, we were somewhat skeptical and concerned because of our limited experience in installing such a sizeable network.

There was also the issue of questionable availability of manpower for a long period of time. We had limited resources and could not reallocate our on-site maintenance labor for other project work. Our facility operates on a 24/7 basis, and it was somewhat difficult to commit the availability of a maintenance force that was specifically dispensed and reserved for maintaining the mail processing equipment.

We presented this concept to our facility's management, USPS headquarters, procurement, and purchasing departments. They highly favored the concept of motivating our maintenance crew, who would be completing the major work. Additionally, NJI-BMC management was pleased we would be developing and acquiring in-house communication network skill sets, using our on-site resources. Of course, the overall cost reduction was the critical component for favoring this option.

Contact with the VFD supplier

Although we could manage the on-site labor for completing the installation and field validation of the data link network, we needed the hardware and software package from the VFD supplier at no cost. Initially, when we discussed our proposal with the supplier, they were interested in validating the network, but had no instant response for the no-cost option. In return, we offered our unique test site for gathering and sharing the actual database for the 97 VFDs. Furthermore, we assumed that in the future, this database and communication link could be used to appraise cost effectiveness and optimization of manpower resources.

We mutually agreed that the online network data could be used to pinpoint miscellaneous faults that are not directly related to the VFD components and its operation.

Historically, most of the failures in operating the AHUs that are equipped with VFDs were presumed to be the failures of VFD technologies. In general, a maintenance worker would switch the unit to a bypass mode whenever the AHU malfunctioned or had any problems. The worker may not investigate or may lack the skill sets to find out if any component in the VFD (rectifier, converter, controls, etc.) malfunctioned, or any of the AHU's components (filters, dampers, belts, bearings, coils, etc.) malfunctioned. At the VFD panel, it would display a default message whenever the VFD shut down. The proposed data link might resolve some of the problems in pinpointing a faulty component.

Following further discussions, the supplier agreed to provide the data link software and any technical support at no cost. We agreed to complete all on-site work including material procurement and installing data link hubs, wiring, PC, modems, etc. This consideration would minimize overall cost, was less risky as compared to other options, and was comparatively easy to accomplish.

Evaluating safety concerns and shutdown impacts

Since the concept of linking 97 VFDs had not been tried elsewhere, we did not know how to evaluate any risk factors that might hamper our mail processing operations. Management was apprehensive regarding the testing of any equipment or systems that were not tested before.

At the NJI-BMC, we are very much influenced by the safety and comfort level of employees. What if the air handling control system malfunctioned because of the newly installed network? A common mode failure could propagate fault to other drives, and might adversely impact the operation of other drives.

Since our facility operates around the clock, any shutdowns that impact our air-handling HVAC system could cause an adverse environment for employees and equipment. In general, minimizing the number of shutdowns in the air handling system, regardless of whether intentional or unintentional, is critical for our overall mail processing operations. Initially, we estimated one or two shutdowns. However, we were successful in completing the revitalization project without any shutdowns.

Project delays encountered

We encountered several unforeseen problems in completing the project as scheduled. The as-built drawings that were retrieved from the library were questionable because our 30-year-old plant had gone through several modifications and building expansions and drawings did not match the actual layout. Another major problem that the supplier faced was retaining its information technology experts. The supplier had to reallocate the manpower, or needed to hire new IT experts.

We had to delay the overall schedule by several months. One critical reason was ongoing manpower reorganization and reallocations. Just as the supplier faced difficult problems in retaining skilled data link communications experts, we could not allocate our maintenance resources as committed.

In spite of all the hurdles, the supplier's engineering staff was proactive, resolving major problems with the hardware and software. The supplier developed the software specifically for our application.

The chip sets that were installed in the 87 VFDs that were manufactured prior to 1995 were not built for a linking data network. We had to replace all the original chips and reprogram them to communicate with the installed data link software.

Project is ongoing

The project team continues to find substantial changes and modifications that would enhance overall ease and user-friendliness of the network. Recently, in conjunction with the supplier, we found out the following:

- The existing script file should be modified to formulate and create a database that would:

1. Enhance the fault file to be retrievable on a daily basis. Study and analyze the default file logic.
2. Create a database that includes a watch file for each of the VFDs. Record all faults.
3. Create a “norm-parameters file” for a group of alike/similar VFDs (5, 10, 15, 25, 40, 125 hp) and display those VFDs and parameters that exceed/lag the specified values.
4. Set up a file that shows a log of underperforming AHU or VFD components. Display the file periodically.

- A new block should be added for the operator to type in remarks or notes on the setup screen for later reference.
- A display should be added to view all faulted VFDs.
- A display should be added to view all VFDs that are approaching tolerance limits or operating beyond the specified parameters.
- A display should be added to reset and, if required, to modify tolerance limits.
- A display should be added to archive or retrieve VFDs that were on the watch list.

Newfound information solves problems

So far, our experience with testing the installed data link system is encouraging and useful. The system has provided detailed information that was not readily available prior to the data link installation. We found this information to be useful in identifying and rectifying potential problems that were not directly related to the VFD components.

Initially, we did not know how to interpret and use the information provided on the screen. We observed that the values of some parameters were questionable, and appeared to be abnormal as compared to similar VFDs.

We found out that these parameters indirectly pointed to problems with blocked filters, broken belts, flapping belts, inadvertent damper operation, or dampers not operating at all. Based on this data, we replaced filters and belts, adjusted sheaves, cleaned coils, etc. Subsequently, we noticed the improvement in AHU operations. Reviewing the faults history indicated problems with local power supplies, mismatched micro chips, bad boards, capacitor burned out, etc.

Recently, after we replaced the motor on one of the 125 hp drives, it would not operate properly in the VFD mode. The drive repeatedly displayed high dc V faults, and shut down. Immediately, we blamed the VFD for causing the repeated shutdowns. However, checking various parameters, specifically, the rpm for the supply side motor/fan and the return side motor/fan, we found that the rpm settings were incorrect because of the mismatch of the recently installed new sheaves sizes. Fan speed for the supply side was 37 percent less than

the settings. This inadvertent setting resulted in forcing the supply side motor to become a generator, eventually raising the dc V and shutting down the drive.

We noticed that the majority of the VFD shutdowns were caused by faults in motors, fans, belts, sheaves, bearings, filters, dirty coils, dampers, etc.

Recent developments

In late February 2003, we crossed one of our milestones in communicating with the VFDs as we began retrieving 16 VFD parameters from the data link.

Our preliminary data analysis indicted that 80-90 percent of our 30-year-old AHUs are functioning in the very favorable or acceptable range. We are on a learning curve and frankly do not know, yet, how to interpret all this complex data.

We knew that the data would be extremely useful in pinpointing those AHUs that were not operating in an acceptable range, as compared to other AHUs in the same group. Based on the data collected, we identified several AHUs that displayed high torque, amperes, speed, etc. Subsequently, our maintenance crew cleaned coils, greased bearings, replaced filters, repositioned dampers, and implemented other corrective measures that resulted in improving the AHUs' performance.

The data showed that only eight VFDs were occasionally shut down, generally waiting for parts or manpower allocations, or temporarily locked-out for periodic maintenance. Because of the design redundancies in AHUs, shutting down of a few did not have any major impact on overall mail processing operations.

We were extremely pleased to notice two outstanding parameters: total rated motor hp at 1455 and energy usage of 322 kW. We were saving energy, and drastically reducing kW demands by monitoring and optimizing the VFD operations. **MT**

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