Written by Joseph C. Pearson and Dilip A. Pandya United States Postal Service New Jersey International & Bulk Mail Center
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Upgrades at a critical USPS facility delivered a number of benefits, including enhanced comfort, improved heating, lower energy usage, and reduced operating expenses. Way to go, Uncle Sam!

Until recently, ongoing heating issues related to air-curtains had been a big concern at the New Jersey International & Bulk Mail center (NJI&BMC) in Jersey City, NJ. When the outdoor temperature became abnormally chilly (in the low teens), the inside temperature would be in the high 70s. Retrofitting the air-curtain motors with VFDs, though, has made a big difference for this facility.

Dealing with the problem

The Maintenance staff at the NJI&BMC had determined that the site's existing single-speed (1200 rpm) air-curtains were unable to distribute adequate heat for the employees working there. In fact, most of the air-curtains had been turned off because of unacceptable heat distribution and higher-velocity airflow that stirred up dust in surrounding areas. As a result, it was particularly uncomfortable to work around these areas during the cold winter season. Concerned about the problem, Maintenance management searched for a viable, cost-effective solution.

In December 2006 and in January 2007, the NJI&BMC maintenance crew successfully retrofitted and field tested three variable frequency drives (VFDs) on Bays 23, 25 and 26 of the facility (as shown in the accompanying photo.) The units were tested individually and simultaneously to determine if there were any adverse effects on the facility's electrical distribution system and to assess the overall impact of retrofitting 50 more of the site's single-speed aircurtain motors with VFDs. These tests showed that the VFDs were, indeed, very effective-*improving surrounding temperatures (from 65 F to a toasty 77 F), especially when*

outdoor temperatures were 23 F or below.

The ampere draw for three VFDs (7.5HP each), on average, was 4.81 amps. The total harmonic distortion (THD) varied from 20% to 70%, and the power factor improvement was approximately 34%. Based on the facility's more recent electrical rates and 3600-hour operating cycle, NJI&BMC has found that it can slash approximately $689 per VFD per year in electrical costs. As a result, plans have been made to retrofit 50 out of 72 units at the site, and keep the remaining 22 units to mitigate THD. Collected site data confirmed that turning on existing non-retrofitted units, in conjunction with three upgraded VFD units, in fact reduced overall THDs from 70 to 20%. Thus, by retrofitting 50 out of the remaining 72 single-speed air-curtain motor units, the facility anticipates being able to lower its annual electric bills by approximately $34K.

Project decisions

NJI&BMC is one of the largest of 21 USPS bulk mail centers in the country. The operation encompasses three main buildings totaling approximately 1.8 million sq ft. The facility's high voltage 26 kV electrical 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, 4160- 480/277V 1000-1500 kVA transformers, with main, tie and subfeeder breakers. These subfeeder breakers provide power to various power, lighting, receptacle panels, motor control centers (MCCs), etc. One of the 480 V, 3-phase, 60 Hz breakers in the load center "B4" provides power to the tested air-curtain motors.

Investigating inadequate heat distribution…

When the Maintenance tech staff began investigating costeffective options to rectify heating problems and improve total operating expenses, it noticed that the majority of the air-curtain motors were turned off and damper-vanes directing hot air at the entrance of the bay doors were closed. Operating staff noted that these units blew cold air, at high speed, and that the high air velocity was not only noisy, it also stirred up dust.

We conducted an infrared thermography survey to learn if the heat-exchanger piping and valves were operating correctly. Initial findings showed that the solenoid valves were closed and the damper-vanes were forced-closed. Even though we opened the damper-vanes and reactivated the solenoid valves, overall heat distribution was questionable and not effective. The 1200 rpm speed of the air-curtain motors initially created high-velocity air that practically forced cold air toward ground level. At 10 feet below the unit, it felt as though the unit were blowing cold air instead of warm. Because this raised concerns as to the overall comfort level and safety of employees, we chose to follow up with a root-cause analysis. Our limited expertise and

experience, though, resulted in it taking a rather long time to pinpoint the fact that the high single-speed of the motor was one of the main causes of questionable heat distribution.

Choosing to retrofit as a cost-effective option…

We considered several alternatives for enhancing heat distribution near Bays 21 to 28. One of the costliest was to replace all existing air-curtains with new overhead door heaters. A second option was to extend and upgrade existing HVAC ductwork and support structure. A third alternative was to experiment with multi-speed motor controllers or field test off-the-shelf VFDs.

Considering NJI&BMC's rigorous 24/7 operating schedule, the availability of manpower resources needed to complete the upgrade project work instead of our usual PM, and the ease of the field installation, we ultimately elected to retrofit only three units with VFDs-but to do so with in-house personnel. We realized that by upgrading the units ourselves, we not only would be enhancing the working environment, we would be improving our inhouse employees' skill sets. That decision, however, was not made lightly.

Most of the air-curtains had been turned off because of unacceptable heat distribution and higher-velocity air-flow that stirred up dust in surrounding areas.

When we began looking for the least costly option, the first step was to assess our on-site manpower resources and skill sets. The Maintenance staff assessed the work scope and initially determined that NJI&BMC's in-house crew should not tackle the complex tasks of retrofitting VFDs and reconfiguring field wirings. Because the existing motor starters and disconnects were mounted approximately 14 feet above the floor and not easy to reach, we thought that it was too cumbersome for our crew to carry out the project. Our initial thinking was that we might cause damage by mishandling existing components. Furthermore, we thought that utilizing our Maintenance crew instead of outside contractors would force us to reallocate manpower that was assigned to complete regular maintenance work. In general, our Maintenance resources are aligned and dictated by our mail-processing department. Any changes impacting processing of mail could adversely jeopardize our revenue. Because our facility processes mail on an around-the-clock basis, it was difficult to commit the availability of a Maintenance force that was specifically dispensed and reserved for maintaining critical mailprocessing equipment.

Our limited experience clearly caused us to be skeptical over our in-house ability to safely remove, reinstall and subsequently field test and validate the equipment components related to this project in their various operational modes. At least it did at first. In retrospect, however, our decision to allow the Maintenance crew to venture into retrofitting VFDs turned out to be very rewarding.

Timely help from vendors…

Two local vendors were very helpful in field-testing and retrofitting our VFDs. The technical staffs of both vendors provided excellent assistance in selecting the appropriate VFDs, reconfiguring the installation layout and mitigating high THDs, as well as support on connecting the power quality meter and capturing harmonic and various other electrical parameters, including energy usage data.

Retrofitting

NJI&BMC's first air-curtain motor VFD unit was acquired in summer of 2006, without any enclosure or additional harmonic mitigation devices. In-house staff chose to add the choke, wiring, terminal block, fuse holder, etc., and installed the entire unit in a NEMA enclosure at Bay #23. Later, when we conducted an IR survey, we found that we needed additional vent holes to dissipate heat accumulation within the enclosure.

We learned our lessons quickly and procured our next VFD unit with an enclosure and built-in DC choke. Our in-house manpower usage to wire the internal components was not cost-effective, however. Our crew installed this new unit on Bay # 26. We then reviewed our surrounding environment and decided to field-test one more unit without the enclosure or choke on Bay # 25. The vendor loaned this unit, contingent on successful field testing and acceptance. During the installations of all three units, we encountered no major problems-*nor were NJI&BMC's critical 24/7 mail-processing operations impacted in any way.*

Field testing

Five field tests conducted in the last quarter of 2006 showed that the THD, in general, varied from 85% to 102%, when we measured THD individually, at the unit, and the VFD was running at 30 HZ. The current probes were clamped on to three incoming cables at the unit disconnect switch that is mounted on the unit, next to the VFD. When the VFD's speed was increased to 40HZ, however, the THD dropped down, varying from 85 to 91%.

We then lowered the VFD speed from 40 to 35HZ, then to 25 HZ, and measured the THD at the power panel, located approximately 85 feet from the VFD units. The current THDs, in general, varied from 25 to 70% when we turned on the VFDs sequentially. To our surprise, though, when we turned on the non-VFD units, the THD dropped to 10% and the voltage THDs varied from 1.45 to 1.9%.

In general, the power factor improved by approximately 34%, whereas energy usage significantly improved-by 60%. Accordingly, based on NJI&BMC's recent electric tariff of 10.5 cents per kWh coupled with a 3600-hour seasonal operating cycle, we expect the ROI from this VFD retrofitting project to take less than one heating season.

Conclusions

Lessons learned…

- For NJI&BMC, retrofitting VFDs to existing air-curtains was a viable, easily-done energy-saving way to enhance employee comfort levels.
- Based on recent electrical tariffs and a 3600-hour operating cycle, NJI&BMC can reasonably expect to slash our utility bills by approximately $34K per year.
- Power quality and future THD impact on the existing electrical distribution system should be addressed through preparation of meticulous field-testing procedures and actual field testing.

- NJI&BMC's own test data confirms that switching on existing non-VFD units, in conjunction with retrofitted VFD units, significantly lowers the THDs. As a result, additional THD mitigation devices may not be required.

Recommendations…

- Seriously evaluate the skill sets of in-house technical staffs and Maintenance crews when considering a retrofit project of this magnitude. Developing the level of in-house craft expertise required to carry out this type of project may be somewhat difficult.
- Remember that reconfiguring, laying out and wiring individual components on site is not a cost-effective option.
- Repeat and validate field-testing procedures, specifically highlighting safety measures, when working with 480V power sources.

- Monitor and collect field-test data and repeat it at least twice to eliminate any abnormalities. Document extensively (i.e. take and maintain digital photos, event logs and craft testimony).
- Candidly discuss field-test data with in-house craft personnel and vendors.
- Acknowledge and recognize the contributions of everyone involved, including both in-house staff and vendors.

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Joseph C. Pearson has been the manager of Maintenance at the United States Postal Service's New Jersey International & Bulk Mail Center for the past 16 years. The facility's maintenance department consists of approximately 500 managers, engineers and craft employees.

Dilip A. Pandya, an electrical engineer at NJI&BMC for the past seven years, manages electrical requirements for the plant. He also is responsible for investigating and implementing innovative cost-effective technologies at the facility. Telephone: (201) 714-6727; e-mail: dilip.a.pandya@usps.gov