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Checking, testing, and updating installations improves overall electrical parameters.

Jersey City-based New Jersey International & Bulk Mail Center (NJI-BMC), one of the largest United States Postal Service facilities, was concerned about effectively maintaining its aging grounding system for 26kV, 5kV, and 600V primary, medium, and low voltage power distribution systems. The safety and security of employees and equipment in the 1.7-million-sq-ft facility were primary goals.

We have been collecting harmonics and power factor data for the past three years, using Power Measurement Ltd. (PML), Saanichton, BC, meters at the 5kV bus. Data showed that voltage total harmonic distortion (THD) varied from 35 to 1 percent. The current THDs displayed a drastic variation from 727 to 3 percent. The power factor varied from 53 to 93 percent. These figures concerned us.

Background of the facility
NJI-BMC, the largest among 21 bulk mail centers, is located on 142 acres of marshland; its three main buildings—bulk, foreign, and administration—occupy approximately 1.7 million sq ft. The bulk and foreign buildings contain about 1100 conveyors, parcel sorting, and sack sorting machines that, if placed end-to-end, would stretch up to 25 miles.

These conveyors and machines sort and distribute sack and parcel mail on a 24/7 basis. Mail then is distributed to various postal facilities and international shipping docks via 2000 trailers. These trailers are dispatched on a daily basis from 296 truck bays.

How the electrical system is grounded
The high and medium voltage system comprised of 26kV primary high voltage and 5kV medium voltage switchgear is grounded to an underground grounding grid located in the fenced-in outdoor switchyard. The low voltage distribution, 480/277V load centers, power lighting, and receptacle panels, etc., are ultimately grounded to the building's steel columns. The existing building steel columns are grounded to 46 newly installed ground rods located throughout the outdoor building perimeter. A new main ground-loop cable that runs inside the building perimeter was installed to connect these columns.

The high voltage 26kV system includes main and ground disconnect switches, bus work, two oil circuit breakers, two 10 MVA transformers, surge suppressors, bushings, and connecting bus work. The medium voltage system contains eight 5kV breakers, meters, relays, controls, batteries, chargers, cables, and connecting bus work. This equipment is housed in the outdoor switchgear cubicle. The low voltage distribution system comprises eight load centers (LC). Six contain double-ended 1000 kVA, 4160-480/277V transformers, 12 main breakers, and six tie breakers. Two LC are rated at 1500 kVA, 4160-480/277V transformers, four main breakers, and two tie breakers. The eight LC contain 126 subfeeder breakers that distribute power to various power, lighting, and receptacle panels. These load centers are located in the penthouses of the bulk, foreign, and administration buildings.

Examining the system

In 1997-98, the facility was considering replacing the aging (1972-73) high, medium, and low voltage equipment because of several operational and maintenance problems with the breakers. We also were concerned about the overall grounding scheme of the facility. To find out the existing status of the grounding system, we procured architect/engineer (A/E) services to check and confirm the overall validity of the facility-grounding scheme. The A/E reports indicated:

- 46 percent of the building's steel columns lacked adequate grounding and bonding.
- Inspections in July 1999 showed that the 26kV and 5kV grounding system was acceptable.
- Several of the building steel columns' grounding and bonding connections were missing.
- Some of the steel columns' grounding cables were disconnected, lost, or had disappeared.

The primary reasons for this situation were ground settling over the past two to three decades that dislodged the ground cables' connections, and failure of the facility to keep adequate records/data and to maintain the grounding system.

Correcting the situation

Option 1 was to use a traditional grounding scheme of laying the ground cable outside the building perimeter, approximately 6000 ft. This work would require digging trenches, laying the ground cable, and restoring the site to its original status. Digging trenches around our significantly long building perimeter would hamper our routine mail processing operations.

Scheduling and coordinating active bay outages in a safe and secure manner would need additional resources and manpower. Furthermore, prior to authorizing digging around the 30-year-old buildings, we needed to validate that contractors would not inadvertently damage any underground utility lines (water, sewage, electrical, fuel, drains, etc.).

In the past 30 years, the plant had gone through various changes and improvements including the underground utility lines. The as-built drawings retrieved from the library did not represent actual underground topography and piping layout. Checking and validating the underground utility lines layout would also add to the final cost estimate. Any inadvertent breakage in the water, sewage, fuel, or electrical lines would jeopardize safety and security of employees and equipment, and the environmental impacts of breaking these lines could be costly. Subsequently, any one of these incidents could result in shutting down the plant.

Plant shutdown is costly. One USPS contractor, not associated with this project, in the summer of 1999 was billed, and subsequently reimbursed NJI-BMC, $75,000 per hour for an unintentional shutdown. Considering these critical issues, we concluded that this option would be significantly costly, disrupt the plant operation, and might jeopardize safety and security of employees and equipment.

In spite of these grounding problems, the majority of the electrical equipment was working satisfactorily. Somehow, neither operations or maintenance noticed any obvious electrical problems with the plant electrical equipment. The facility kept on processing mail as usual.

Option 2: cable installation inside

When we found out that the overall grounding of the 26kV and 5kV equipment was in acceptable condition, we decided to revitalize the building steel columns' grounding system. The unique option that we selected for our site was not to use the traditional outdoor building perimeter grounding scheme, but instead install the ground cable inside the building.

Selecting this option saved us digging the trenches, scheduling and coordinating outages of working bays in a safe and secure manner, and restoring the ground. This concept was the key contributor to the faster, less costly, less risky installation of the grounding cables at the NJI-BMC.

Revitalizing the grounding system

In the spring of 2001, we revitalized the grounding system by installing 20-ft-deep ground rods at 46 locations. A bare, 4/0 copper cable was installed that bounded the perimeter steel columns inside the building. This copper cable was located approximately 20-30 ft high to provide adequate access for mail tow truck trafficking and mail processing operations.

As mentioned earlier, we were very much concerned about the safety of employees and equipment, and any adverse impact on mail processing operations. Since this option of laying ground cables inside the building had not been tried on such a large scale, we were slightly apprehensive. To this end, we procured the services of a specialized electrical engineering firm that verified the installation and supervised the overall work and this project.

Unforeseen problems
Of course, we encountered several unforeseen problems in revitalizing the old system. The underground utility as-built drawings were questionable and we were apprehensive when driving 20-ft-deep ground rods without clarifying and validating exact ground rod locations. The contractor faced unique problems in finding adequate manpower (electricians) resources because of the market conditions. We had to delay the overall schedule by several months.

Acorn connections that connect the ground rods to the grounding cable were found to be unacceptable because of the limited contact-surface area. The set screw that grabs the ground cable and rod did not provide adequate connections. CAD-welding these connections was the correct remedy and best solution for this problem. In spite of all issues, the contractor, electrical firm, and NJI-BMC personnel were very resourceful and proactive in resolving major hurdles. The project schedule was extended because of various scheduling issues with the manufacturer, the supplier, the shippers, and our operations department.

Estimating shutdown costs
Since our facility operates 24/7, any shutdowns, regardless of whether intentional or unintentional, impact our revenue. Minimizing the number of shutdowns was extremely critical. Initially, we estimated several major shutdowns for revitalizing the grounding system. However, we successfully completed the project without any shutdowns.

It is difficult to estimate the actual cost of each shutdown because of several factors that directly or indirectly impact total business costs. Some of these factors are: the manpower resource allocation at the time of power interruption, equipment availability, loss of business, type of mail to be processed on that day, customer service impacts, etc. The absence of shutdowns for this project minimized the overall impact on mail processing operations and improved total budgeting allocation for this facility.

Recommendations
Based on our limited experience, we recommend considering the following key items:

- Strongly suggest completing proactive PMs of the existing grounding system.
- Measure and record power quality parameters: harmonics, power factor, etc.
- Install new ground cables inside the building perimeter to save capital cost and resources.

- Perform extensive testing of existing equipment and grounding system.
- Assess need for an on-site standby-by power source if shutdown is inevitable.
- Emphasize CAD welding when necessary.
- Prepare detailed planning and step-by-step procedures to minimize operational impact.
- Review safety and environmental issues with an on-site expert prior to initializing the project.

After revitalizing the grounding system, addressing the power panels, and retrofitting low voltage circuit breakers, our present electrical readings have improved significantly. The voltage THDs vary from 2 to 3 percent, the current THD varies from 11 to 15 percent, and the power factor fluctuates from 74 to 99 percent. At present, we do not know, or have any records, of equipment malfunctioning directly related to power quality issues.

In general, our equipment operated satisfactorily in spite of drastic variations in THDs. We believe that our limited exposure or know-how of power quality issues might have unknowingly impaired some equipment operation or life expectancy. Nevertheless, our site offers opportunities for diagnosing, testing, and validating power quality products and their impact on the existing electrical distribution system.

Checking, testing, and revitalizing this aging grounding system did improve overall electrical parameters. At this stage, we do not know or do not have the expertise to assess and validate if these improvements, in fact, had any impact on our daily mail processing operations. **MT**

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