THE Rochester Engineer

PUBLISHED BY
ROCHESTER ENGINEERING SOCIETY
www.roceng.org

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June 2020

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Location still at the Rochester Riverside Convention Center; Registration will re-open around August 1st.

RED Rochester Building 87 Chiller Replacement and Plant Upgrades

- Robert M. Gleason III, E.I.T.

As many Rochesterian's know, Eastman Business Park (EBP) is no stranger to cutting-edge and innovative technology. With the pursuit of sustainability driving so many conversations within the world of architecture and engineering, EBP is once again at the forefront of those conversations, becoming home to the world's largest magnetic bearing chiller.

3200 Ton Chiller installed at RED Rochester's Building 87

In partnership with RED-Rochester, LLC., C&S Companies was selected to provide engineering and design services for the first installation of its kind. The 3200 ton chiller, equipped with eight 300hp magnetic-bearing compressors was installed to replace an existing 3,500 ton back-pressure steam unit. The existing unit was nearly 50 years old and no longer operational.

Due to the nature of the project, and the amount of existing piping and conduit to be re-used, C&S's Building Information Modeling (BIM) services team was deployed to provide a three-dimensional scan of the existing facility. Using the Leica RTC360 LIDAR scanner, the team was able to capture the existing conditions of the building within 1/8" accuracy in only a few hours. After completing the scanning phase, a program called Edgewise was used to process the information gathered in the field. Edgewise uses groundbreaking algorithms to automatically identify and extract piping from cloud points and export them as Revit family objects.

The scan was also responsible for producing High-Dynamic Range (HDR) imagery that allows you to view and measure distances from a program called Jetstream. The advancement in this type of technology has been extremely useful for architects, engineers and designers. Instead of spending hours on site, you now have the entire facility captured in a digital panoramic format that can be viewed from anywhere.

Although the new chiller was the largest of its kind, it was only a small piece of the overall upgrades being implemented at Building 87. In addition to the chiller, the following equipment was installed:

- 400HP variable speed, vertical inline chilled water pump & step-down transformer (2.4kV-480V).
- Nine harmonic mitigating filters.
- Active front-end variable frequency drive (VFD) and step-down transformer (2.4kV-480V) for an existing 700HP chilled water pump.
- 200HP premium efficiency motor and accompanying VFD.
- Four new horizontal end-suction condensate return pumps with pump mounted VFD's.

Continuing with the theme of sustainability; 15 VFD's were added to the existing electrical distribution system as part of the plant improvements. With the VFD's, came the conversation of harmonic contribution. RED's Building 87 is composed of both a 2.4kV and 480V main-tie-main switchgear lineup; and the need for clean power is essential to operations at the plant.

Harmonics are nothing new in the world of electrical distribution systems. Engineers, designers and scientists

have been combatting harmonics for years, however, this battle has escalated in recent years due to the influx of non-linear loads, namely VFD's. Harmonics are generated through non-linear loads by drawing current and creating abrupt pulses that distribute themselves back into electrical systems. Facility electrical systems will remain very resilient to these harmonic currents until the harmonic contribution begins to approach 15%. Harmonic contribution can become a leading factor in the following occurrences:

- Nuisance tripping of circuit breakers.
- Harmonic resonance.
- Capacitor bank failures.
- Equipment overheating.
- Neutral overloading.
- Generator issues.
- Electro-magnetic interference to sensitive equipment.
- Motor winding burnout.

400HP Chilled Water Pump with Pump Mounted Variable Frequency Drive

As can be seen in the list above, harmonics are no laughing matter and cause significant issues for all types of facilities that rely heavily on the electrical grid. The results of the aforementioned items can cause additional cost implications including; maintenance and replacement of equipment, downtime/system interruptions and reduced system capacity.

The entity that is responsible for overseeing and providing standards for VFD's is the Institute of Electrical and Electronics Engineers (IEEE). The specific standard responsible for setting the guidelines around harmonic contribution is IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. Table 1 from IEEE 519-2014 is displayed below and can be used as a guideline for the total harmonic distortion (THD) limits in relation to voltage at certain points in the system.

TABLE 1 – VOLTAGE DISTORTION LIMITS

Bus voltage *V* at PCC*	Individual harmonic (%)	Total harmonic distortion THD (%)
$V \leq 1.0$ kV	5.0	8.0
1 kV < $V \leq$ 69 kV	3.0	5.0
69 kV < $V \leq$ 161 kV	1.5	2.5
161 kV < V	1.0	1.5[1]

[1]High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal whose effects will have attenuated at points in the network where future users may be connected.

A common misunderstanding for engineers and designers is the idea that these percentages must be maintained at the piece of equipment that is being installed. Many times engineers and designers will simply confirm with the VFD manufacturer that their particular piece of equipment is IEEE 519 compliant without looking at the system as a whole. As you can see from the table above, the bus voltage is referenced at the Point of Common Coupling (PCC). The PCC is described as, "The point on a public power supply system, electrically nearest to a particular load, at which other loads are, or could be, connected. The PCC is a point located upstream of the considered installation." More often than not, the PCC is located at the main switchgear near the utility tie-in.

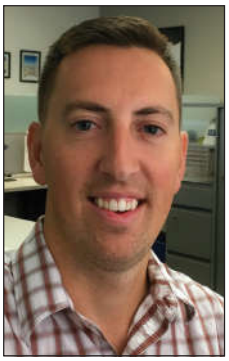
At Building 87, the PCC was located at the 2.4kV switchgear which resulted in aiming to maintain a THD percentage of less than 5%. In order to understand the harmonic contribution output of the new VFD's and their impact on the existing system, a harmonic analysis of the existing electrical system was performed. It is important to note that this analysis would not have been able to be performed without the information gathered in the field by RED's High Voltage Team. This information was vital in being able to analyze the existing harmonic levels, while seeing the affect the 15 VFD additions would have on the distribution system. As it turned out, the existing system contained very minimal THD; in the range of 1.5%-3.0%. This was not very surprising due to the small amount of non-linear loads that existed on the system prior to construction. The existing data was combined with the data received from the VFD manufacturers, and as expected the VFD additions had a significant impact on the THD levels at the facility. With no harmonic mitigation and 6-pulse VFD's, the THD rose well beyond the recommended IEEE 519 levels. As a result of this calculation, harmonic filters were introduced to the project. These harmonic filters are considered passive devices composed of inductive and capacitive elements designed to eliminate the build-up of harmonic currents and improve the reactive power of the electrical distribution system. Once the filters were incorporated into the analysis, the harmonic levels being calculated were well within the requirements of IEEE 519.

2.4kV-480V, 500kVA Cast-Coil Transformer

400HP Harmonic Filter

The B87 Chiller Replacement was the latest in a long list of exciting and innovative projects currently being designed and constructed at EBP. This project was an excellent example of the affects cutting-edge technology can have on our existing infrastructure. With this technology, it is important to understand the impact it may present and adjust accordingly. As an engineering community, we should be grateful for the opportunity to bring world class projects to life right in our own backyard! ❑

For more information regarding C&S Companies, please visit **www.cscos.com**. The C&S Rochester office is located at 150 State Street, Suite 120.



Author: ***Rob Gleason, E.I.T.***

Bio: Rob is a Project Engineer in C&S's education, healthcare and public facilities group focusing in high, medium and low voltage systems; including substation design, protective relaying and building/facilities engineering. He enjoys volunteering as an RES tutor at Dr. Walter Cooper School #10, and also serves as Vice President on the Illuminating Engineering Society (IES) board.

If you would like to request additional information on this article please email at **RGleason@cscos.com**.

References:

(1) Square-D Company, IEEE Standard 519