Idling Reduction Infrastructure Deployment
A Solution for Clean Communities

Task 1 Report – eTRU Infrastructure Deployment
State Energy Program Special Projects
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NOTICE

PREFACE

On April 2, 2004, the New York State Energy Research and Development Authority (NYSERDA) submitted a proposal to the U.S. DOE Clean Cities State Energy Program Special Projects Solicitation to advance the national deployment of shorepower Truck Stop Electrification facilities. Executed by NYSERDA on September 15, 2004, the Notice of Financial Assistance Award (Grant No. DE-FG41-04R101749, A000) obligated U.S. DOE funds to a diverse proposal team, which included Shorepower Technologies, LLC.

In spite of repeated efforts on behalf of the project team, the truck stop facility did not go forward and NYSERDA received formal approval from U.S. DOE (Amendment No. A002, executed on 01/23/07) to allow the Grant to be re-scoped and transferred to this project. From the original grant, approximately 20% had been expended to conduct an "Idle Reduction Technologies Preferences and Capabilities Survey" by the American Transportation Research Institute (ATRI) and to perform related outreach and technology transfer. The project work was completed in 2005, with the Survey Report being published and promoted at the American Trucking Association's Technology and Maintenance Council Annual Meeting in February 2006. The Survey Report is available from ATRI and is currently posted on their web site at:
http://www.atri-online.org/research/results/Idle%20Reduction%20Technology%20Fleet%20Preferences%20Survey.pdf

The remainder of the Grant was utilized to support the installation of the electric trailer refrigeration unit (eTRU) infrastructure and perform additional outreach and technology transfer. This report documents the Task 1: eTRU Infrastructure Deployment activities at Willow Run Foods in Kirkwood, NY and additional outreach and technology transfer activities are summarized below.

In July 2007, a technical paper on the eTRU project(s) entitled AeTRU Refrigerated Warehouse Technology Demonstrations@, was presented and published in the proceedings of the 2007 American Council for an Energy-Efficient Economy (ACEEE) Summer Study on Energy Efficiency in Industry, White Plains, NY.

In October 2007, a technical project overview entitled "Hybrid Electric TRU Demonstration Projects" was presented at the SAE Commercial Vehicle Engineering Conference and Exhibition in Rosemont, IL.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the sponsors of this effort and the respective project managers: New York State Energy Research and Development Authority (Joseph Tario) and U.S. Department of Energy (Michael Scarpino) for their guidance and support. The Willow Run Foods staff of James Donovan, John Mueller and Len Basso provided significant logistical assistance to enable the team to complete the installation of the on-site and trailer-side equipment. In addition, the authors also would like to acknowledge the leadership and guidance of Michael Panich of Shorepower Technologies, LLC. We also were very grateful for the technical expertise and input provided by Jeffrey Kim of Shorepower Technologies, LLC. Also, the support provided by James Harvilla of New York State Electric and Gas as well as Tracy Mattice of Carrier-Transicold was critical to the successful completion of this project.

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EXECUTIVE SUMMARY

Background

In the U.S., trailer refrigeration units (TRUs) powered by small diesel engines have traditionally provided the trailer cooling required for the transport of fresh and frozen foods. Small diesel engines are notoriously high emitters of nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide (CO) pollution. An approach to alleviate these onsite air pollutant and noise emissions is via the use of electric power. By utilizing this approach, the diesel engine can be switched off when the unit is plugged into electric (shore) power.

NYSERDA funded a Phase 1 assessment of electric TRUs (eTRUs), followed up by a Phase 2 demonstration of these eTRUs. During the Phase 2 eTRU demonstration activity, it became apparent that there are safety issues during regular warehouse operations that were not previously identified. Warehouse workers and yard jockeys could not communicate directly and would not be aware that a trailer is connected to electric power. If the warehouse worker completed their loading of the trailer and closed the warehouse door indicating that the trailer was ready to be moved, the yard jockey would not be able to determine the difference between an electric-capable TRU- and a conventional diesel TRU-equipped trailer. The outdoor light signal system would be green, which implies the trailer is ready to be moved when in fact this trailer is still connected to electric power at the dock. Thus the ability to safely connect to power at the warehouse itself became apparent during the demonstration of the eTRUs in commercial operations which could actually prevent the installation and utilization of these connections at the warehouse locations. The ability to safely connect to the warehouse was deemed necessary to fully demonstrate all needed technology improvements that will be required to ensure commercial success.

To address the fact that there was no method available to safely connect the electricity to the eTRU-equipped trailers to the refrigerated warehouse docks, Shorepower Technologies, LLC proposed and was awarded a Phase 3 contract to develop a safe approach to interlock the eTRU trailer to the warehouse when connected to electrical power.

Approach

Since it is critical that these electric connections be located near the places where the electric-power capable trailers are parked, electrical connection designs must be developed to ensure trailers powered by electricity are safely connected to the electricity and drive offs prevented. To do this, an approach was developed in Phase 3 to develop an interlock between the door operations via the trailer docking system and the eTRU-equipped trailer.

The scope of work for this was separated into seven (7) tasks; with the first four (4) task elements were completed and were required to conclude the design and installation of the electrical facility. The following four (4) tasks have been successfully completed.

Task 1: Procure eTRUs, trailers, and tractor APUs:

Task 2: Evaluate/design/integrate new dock safety system

Task 3: Integrate/test trailer wiring system onto nine (9) new eTRU-equipped trailers

Task 4: Deploy Facility Electrical and Data Connections

The final three (3) tasks are operational and project management activities that will continue through the completion of the demonstration. Specifically, the following tasks are included as part of the NYSERDA-sponsored activities will confirm operation and functionality of the electrical power and dock safety system during a six (6) month system demonstration.

Task 5: Optimize design and operations, as needed

Task 6: Collect and Analyze Data

Task 7: Reporting and Management

Pre-Installation Site Design Activities

To perform the demonstration, a partner that wanted to achieve lower costs via electric power utilization for TRU power needed to be located. Willow Run Foods, firmly aware of the initial eTRU demonstration project at Maines Paper & Foods, approached the team as an interested party for the Phase 3 activities. Willow Run Foods was presented with and accepted the opportunity to utilize the Vector eTRUs into their operations and to work with the project team to implement a dock safety plug-in system incorporated into their existing dock safety system. Since the distribution center currently had several docks outfitted with a current model, this met the criteria that was established by the project team to integrate the design with the most current dock safety systems. At this point, all parties agreed to participate in the project and a Site Agreement was signed in February 2007.

To ensure that adequate power to operate the eTRUs was available, the power capabilities at the distribution center were assessed. In addition, staff reviewed the specification of all dock doors, including the version of the dock safety system installed and the space available for additional hardware both inside and out. Staff also discussed IT requirements for data collection as well as operational strategies with Willow Run Foods (WRF) management staff to maximize the use of the electric power. It was determined that all requirements could be met with the facility and logistical operations and a final site design was developed. Four (4) dock locations equipped with the latest trailer warehouse docking system were selected to be part of the demonstration location. In addition, one non-docking location in a trailer staging area was also selected to assist WRF maximize eTRU electric power use.

Site Construction

A local contractor was chosen for the site construction after three bids were evaluated for best value at the lowest cost. Facility construction began in February 2008 and was completed in March 2008. Designed dock safety systems were installed into the existing trailer docking system. Upgraded control hardware and software as well as electrical switching systems were integrated to the existing controls to enable safe dock system operation. This system upgrade also enabled power flow control to the electric power connections mounted to the dock.

Electrical upgrades for five (5) 480 volt three phase power feeds were made to the warehouse electrical distribution system. Five (5) electrical connections were installed at the identified warehouse door locations. Four (4) dock locations – Dock 23, Dock 24, Dock 27 and Dock 28 – integrated the electrical connections with the upgraded dock safety systems. One (1) conventional eTRU connection was installed at a staging area between Docks 42 and 43 since a warehouse door is not installed at this location.. The equipment installed has been inspected and functioned normally. After construction was completed, these connections were immediately integrated into regular warehouse operations.

Trailer Retrofit

Nine (9) trailers have been retrofitted with the under-trailer wiring system. The retrofit was performed by PennDDA in Syracuse, NY. The retrofit began in April 2007 and was completed in June 2007. This system utilizes the re-designed trailer plug and socket system which provides additional safety by preventing road debris from coating or damaging the trailer connection.

Conclusions

The system design was effective and the electrical power modifications were deemed successful by the project partners and all work was completed prior to the end of the March 31, 2008 contract period for the installation of the equipment. This facility will continue to operate as a demonstration and data will be collected as part of the NYSERDA funded demonstration through September 30, 2008. Hardware design and facility installation conclusions are as follows:

- Design of the control system for the dock safety system was successful
- All power and operational safety systems perform as designed
- Integration of bumpers provided adequate protection for power modules
- All partners have expressed satisfaction with the final design and installation

Section 1:
INTRODUCTION

1.1 BACKGROUND

In the U.S., trailer refrigeration units (TRUs) powered by small diesel engines have traditionally provided the trailer cooling required for the transport of fresh and frozen foods. Small diesel engines are notoriously high emitters of nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide (CO) pollution. While these pollutants are now regulated, diesel-powered TRUs remain significant contributors to air quality issues in and around truck stops, distribution terminals and, to a lesser extent, grocery stores. In addition, operation of TRU diesel engines creates noise pollution. This can be a significant concern in populated areas, as these commodity deliveries often occur during the late evening and early morning hours. The on/off cycling of these diesel engines generates the emissions and noise most urban areas are attempting to reduce.

Electric TRU Development

To address the inefficiencies associated with regular diesel-driven TRUs, manufacturers have developed hybrid diesel-electric units and other alternative technologies. Many of the units that are capable of being powered by grid-supplied electricity are belt-driven mechanical models with additional electric motors that allow the diesel engine to be switched off when the unit is plugged into electric power (shore power). This is referred to as "standby" operation. Some new all-electric TRU models (eTRU) have fully electric components that can use shore power or be powered by small diesel generator-sets for over-the-road use; these are now commercially available in the United States. However, the shore power connection infrastructure for eTRUs and standby TRUs is unavailable at most warehouse and truck stop locations. To support the deployment of these connections, standards development is being led by the Electric Power Research Institute (EPRI) to ensure uniformity across the industry. Standby-capable reefer units (whether electric-driven mechanical units or eTRUs) generally require three-phase electricity input for large capacity trailer models due to high power requirements. Most deployed shore power infrastructure to date provides only single-phase power for engine block heaters and cab "hotel" loads. However, some refrigerated warehouses and distribution centers have electricity connections installed, usually for smaller refrigerated box trucks equipped with a mechanical-driven electric-standby connection. Photos of this type of connection are shown in **Figure 2-1** and **Figure 2-2**. Although progress continues to be made, the ability to plug-in to shore power electricity remains limited.

Figure 1-1: Refrigerated box truck capable of using electric connections

As more eTRUs and electric-standby TRUs become available in the market, there becomes an increasing risk for trailers to be inadvertently driven away from a facility while still plugged in to grid power. These high-voltage

Figure 1-2: Refrigerated box truck connected to electric power

connections could be a serious safety hazard if damaged by such an incident. Many warehouses and delivery locations have lock mechanisms which secure the trailers to the docking location during loading and unloading. By integrating the electrical connection's operation into these locking mechanism, it would significantly reduce the risk of these drive-offs occurring. The demonstration of this technology integration will illustrate anticipated and unanticipated safety benefits and shortcomings associated with this type of hardware interconnection.

1.2 PHASE 1 eTRU FEASIBILITY ASSESSMENT

Shorepower Technologies was tasked in September 2004 by NYSERDA to perform a feasibility analysis of eTRU technology. This assessment was completed in June 2005 and additional information can be found at http://www.nyserda.org/publications/ElectricPoweredTrailerRefrigeration.pdf. The results of the study indicated that eTRUs were ready to be commercially-deployed. Following the results of the feasibility assessment, a Phase 2 demonstration project was proposed and awarded by NYSERDA to Shorepower Technologies.

1.3 PHASE 2 eTRU DEMONSTRATION

As a follow-on effort, Shorepower was tasked by NYSERDA to perform a demonstration of eTRU technology at Maines Paper and Food Service in Conklin, NY. This demonstration was completed on January 31st, 2008. The results of the study indicated that eTRUs are a commercially viable replacement for conventional TRUs. The eTRUs outperformed their conventional counterparts in many areas including fuel efficiency. However, the electric capability of these eTRUs was not fully utilized for a number of reasons; one being that a safe connection to the warehouse could not be obtained. Following this Phase 2 demonstration, a Phase 3 eTRU safe warehouse connection design and demonstration project was proposed and awarded by NYSERDA to Shorepower Technologies.

1.4 PHASE 3 APPROACH

In September of 2005, the New York State Energy and Research Development Authority awarded a cost-shared contract to Shurepower, LLC, now doing business as Shorepower Technologies, to design, install, and conduct a field demonstration of electrified loading docks and parking spaces for refrigerated trailers. The design was specifically developed to meet the demands of Carrier Transicold's new Vector 1800MT, an electric-hybrid trailer refrigeration unit (eTRU).

Subsequent to this project, Shorepower Technologies was awarded a cost-shared contract by NYSERDA, with co-funding from the Department of Energy, to design, develop and field test an integrated dock electrical connection/safety system. The goals of this phase of the eTRU project is to prove and fully demonstrate the facility

and trailer hardware to enable a sustainable market for eTRU/facility connections, to develop and demonstrate a safety system that is needed to ensure the safe and efficient eTRU/facility connections, and to evaluate the under-trailer eTRU/shorepower wiring system that is required to connect to commercial eTRU/shorepower electric power systems.

Figure 1-3: Willow Run Foods dock door and dock safety system, exterior view

The primary objective was to design, install, and evaluate a system that would incorporate the operational demands of a distribution center's trailer loading and unloading procedures and integrate a dock safety system. The proposed location for this demonstration is Willow Run Foods, Inc., a refrigerated warehouse facility located near Binghamton, NY. This warehouse operation utilizes state-of-the-art warehouse-trailer docking systems produced by Rite-Hite Corporation (see **Figure 2-3**, **Figure 2-4**, and **Figure 2-5**). This system was designed to prevent a trailer form being released from the bumper capture system while it was still plugged into the electrical connection so that it could not be removed from the dock. Shorepower Technologies, New West Technologies, LLC, Willow Run Foods, and Rite Hite Corporation worked through various permutations of design implementation to ultimately develop a system that met all of the project partners' demands.

Figure 1-4: Trailer secured to warehouse dock with dock safety system

Figure 1-5: Dock control panel at Willow Run Foods

The scope of work for this Phase 3 was broken out into seven (7) distinct tasks; each deemed necessary to effectively demonstrate the components needed for a successful commercial deployment of eTRU. The first four (4) have been completed and were required to complete the design and installation of the electrical facility. The final three (3) tasks are operational activities and project management that will continue through the completion of the demonstration. Specifically, the following approach was utilized.

Design and Installation (completed)

Task 1: Procure eTRUs, trailers, and tractor APUs

Task 2: Evaluate/design/integrate new dock safety system

Task 3: Integrate/test trailer wiring system onto nine (9) new eTRU-equipped trailers

Task 4: Deploy Facility Electrical and Data Connections

System optimization, Data collection and analysis, and Project Management (ongoing activities)

Task 5: Optimize design and operations, as needed

Task 6: Collect and Analyze Data

Task 7: Reporting and Management

Section 2:
PRE-INSTALLATION SITE DESIGN ACTIVITIES

2.1 SITE SELECTION

As one of the leading independent foodservice distributors in the country, Willow Run Foods (**Figure 3-1**) has been committed to providing the highest level of quality, reliability and customer service. One of their methods is to incorporate leading edge technologies and equipment in their operations. Willow Run Foods was aware of the Phase 2 integration of new Carrier Transicold Vector MT 1800 electric-hybrid trailer refrigeration units at Maines Paper & Foods, which is located only a few miles from Willow Run's distribution center. This center is also located in the project partner New York State Electric and Gas (NYSEG) service area.

Willow Run Foods was presented with and accepted the opportunity to utilize the Vector eTRUs into their operations and to work with the project team to implement a dock safety plug-in system incorporated into their existing Rite Hite Corporation's DokLok dock safety system. The distribution center currently had several docks outfitted with the latest dock-trailer safety system which would facilitate design modifications. Both Willow Run Foods and Rite Hite Corporation saw the development of an electrical interlock to prevent trailers from leaving a dock bay while the eTRU remained connected as a desirable product enhancement.

Figure 2-1: Overhead view of Willow Run Foods

2.2 PRE-DESIGN ASSESSMENT

Several factors were considered in the pre-design decisions. Primary among them were the power capabilities at the distribution center and the trailer safety system installed at the bay doors. WRF indicated that they had two lock models installed at their doors with one model newer than the other. After discussions with Rite Hite Corporation and a site visit by their staff, it was confirmed that docks number 23 through 28 were equipped with the latest version of the control system and would be good candidates for modification.

The distribution center was serviced by the needed 480VAC, 3-phase power. Shorepower, New West Technologies, Willow Run Foods and an electrical contractor examined the existing electrical infrastructure and it was determined that the required amperage was available at their main service panel. As part of the preliminary design work, both the main panel and a secondary panel were investigated for the systems service feed connections. After discussions with WRF, it was decided that a new electrical breaker panel would be installed adjacent to an existing panel in the refrigerated warehouse adjacent to the bays that will be modified with the new dock safety system.

Access to Willow Run's computer and Internet connections was also a consideration. The office containing WRF's computer equipment and Internet connections was located between the proposed doors and the staging area location that was incorporated into the pre-design.

The relative proximity of the electrical service feed, breaker panels, and data center from the proposed dock areas to be modified offered a good opportunity to minimize project installation costs.

Staff discussed the warehouse operations with Willow Run Foods. It was learned that Vector trailers, as much as they will be used in normal procedures, can be somewhat optimized at the proposed dock locations. Willow Run management was interested in maximizing any cost savings that can be realized by operating the Vector units on electrical power. Through these discussion it was also decided that along with modifying four dock safety systems, the project would install an outlet module at a trailer staging area to assist WRF in further maximize cost savings.

2.3 FACILITY DESIGN

The overall site design was determined by project team and Willow Run Foods staff for maximum use of the connections. It was determined that five (5) connections would be installed. Four (4) of these connections would be located at docks where a dock system would be integrated into the operation of an eTRU connection. The fifth location would be a staging area with no dock or existing safety system.

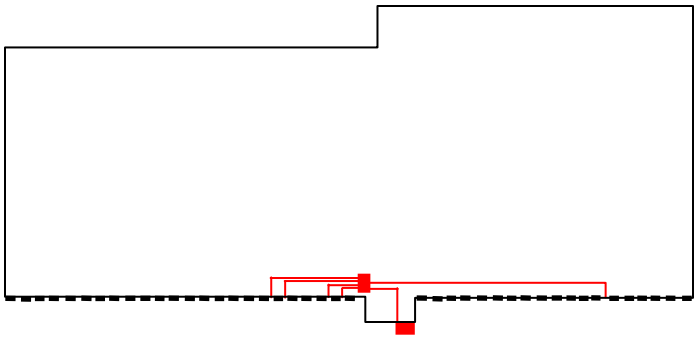

Figure 2-2: One-line diagram of Willow Run Foods

From conversations with the dock safety system manufacturer Rite Hite Corporation and Willow Run Foods, it was determined that the locations for these connections would be Docks 23, 24, 27, and 28 and the staging area would be between Docks 42 and 43. These dock locations were chosen based upon the model of the safety system currently installed as well as wall clearance from permanent exterior structures like roof drainage downspouts. The staging area was chosen because it was the most convenient location to install the hardware for trailer usage and costs. Approximate positions of the connections can be seen in the drawing in **Figure 3-2**.

2.3.1 DOCK SAFETY SYSTEM INTEGRATION WITH HIGH VOLTAGE ELECTRICAL CONNECTIONS

Two minor changes were made to previously designed power connection modules for use in the electrical facility equipment. First, the dual gang modules were modified to a single gang unit within the dual gang housing. Dual gang connection units would require the power cable to be passed underneath of a trailer docked to the right of the eTRU connection, making it difficult to use. This difficulty resulted in the redesign of the eTRU power module to a single gang connection unit installed in a dual gang module. (Dual gang enclosure was used to house the data collection and dock safety control hardware discussed later in this report.) Second, hardware was installed in the

dual gang enclosure to allow the dock safety system to determine if a trailer was connected to the electrical power module. This second change was designed to force the safety system to remain locked while a trailer is connected to shorepower to prevent a "drive-off" situation (trailer leaving the dock while still connected to shorepower). This change was not implemented on the equipment located at the staging area because there is no dock safety system at that location to prevent a drive-off.

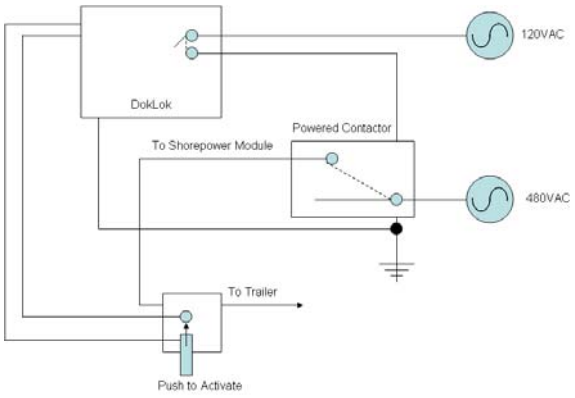

Figure 2-3: Upgraded dock system design

In order to support communication with the power connection module, the dock safety system also required an upgrade. The upgrade included several new components. The new hardware gave the system the ability to monitor the status of the eTRU connection for the trailer. A third (yellow) light was added to the exterior of the warehouse to alert the driver that the interior warehouseman has closed the warehouse door and the trailer was ready for departure; however, the trailer was still connected to shorepower and, consequently, the safety system had not released the trailer. When the power was terminated at the power module, the dock safety system would release the trailer. As part of this dock safety system upgrade, a relay that prevents electricity from flowing to the eTRU connection while the dock safety system is not engaged was added. This supplementary design modification was integrated to reduce the risk of electrical arcing during connection.

2.3.2 FACILITY DATA COLLECTION SYSTEM DESIGN

The data collection system design is very similar to the one used in Phase 2 of the project. As before, a unit which outputs pulses based on the amount of energy used by an eTRU connection is connected to a data logger which records the pulses. The data loggers interface with the existing Willow Run Foods IT infrastructure and report data across the internet where it is stored for real-time or historical viewing. This data collection system design takes advantage of the proximity of the warehouse mounted connections to the IT control hardware. This design change permitted the reduction of data collection devices. The design used all hard-wired line transmission to collect and report data which significantly improved the system's reliability in non-ideal operating environments.

Section 3:
TRAILER RETROFIT AND SITE CONSTRUCTION

3.1 UNDER-TRAILER CONNECTION INSTALLATION

The retrofit of the under trailer wiring system occurred after the Vector-equipped trailers had begun use in normal warehouse operations at Willow Run Foods. Nine (9) eTRU-equipped trailers were retrofit with the under trailer wiring system starting in April 2007 and finishing in June 2007. The modifications were performed at Penn Detroit Diesel Allison (PennDDA), a certified installer of Carrier-Transicold products. Pictures of the installed connections are included as **Figure 3-1** and **Figure 3-2**, and a detailed discussion of the design and installation of the under trailer wiring system can be found in Appendix B of the Phase 2 report, referenced previously in this report.

Figure 3-1: Side view of trailer plug assembly

Figure 3-2: Underside view of trailer plug assembly

3.2 ELECTRICAL FACILITY CONSTRUCTION

After the approval of the facility design by the host site, construction of the electrical facility began. Three bids were received for the electrical work per NYSERDA requirements and an electrical contractor was selected for the work. The selection of the electrical contractor was based upon multiple factors which included the lowest cost and the best value/accuracy in bid based on demonstrated familiarity with the installation parameters. A new 200Amp, 480VAC, 3 phase distribution panel with five (5) ML breakers was installed on a wall to the left of Dock 29. To provide power, a new 200Amp breaker was installed in the main service panel for the eTRU connections.

Figure 3-3: Installed trailer connection with new lighting fixture

Figure 3-3 through **Figure 3-6** show the installation of the facility wiring, the electrical facility connections, and bumpers to protect the electrical connections. **Figure 3-3** shows the installed eTRU module and the new 3-light system. **Figure 3-4** shows an electrical wiring junction box and the wall penetrations to the eTRU module. **Figure 3-5** shows

the protective bumper for the eTRU module. **Figure 3-6** shows the new 200Amp 480VAC breaker panel that was installed for the eTRU modules.

Figure 3-4: Electrical wiring for eTRU connection

Figure 3-5: Protective bumper for eTRU connection

3.3 INTEGRATION OF DOCK SAFETY SYSTEM DESIGN

The integration of the power connection module into the existing dock safety system to ensure that a trailer could not be pulled away while it was still connected to the warehouse-mounted power module was developed through discussions with the manufacturer of the dock system (Rite Hite Corporation), New West Technologies, Willow Run Foods, and Shorepower Technologies.

Figure 3-6: New eTRU breaker panel

The upgrade kit for the controls includes a 3-light outside light assembly and a URC Panel Assembly consisting of several components. The module was preprogrammed with the special program required by the subsystem. All existing system operations were accommodated. Before and after pictures of the upgraded panel assembly can be seen in **Figure 3-8** and **Figure 3-7**. The new 3-light system was shown previously in **Figure 3-3**. The new light assembly and the eTRU electrical connection required the installation of additional wiring.

3.4 SYSTEM TRAINING

On March 26, 2008, Shorepower Technologies, and Carrier-Transicold completed the training of the Willow Run Foods' facilities operations personnel. The training included two parts: a classroom presentation and a field demonstration of the system's operation. The presentation was held at the WRF corporate location in Kirkwood, NY and was attended by the Willow Run Foods management, facilities personnel, safety training coordinator, drivers, and service technicians. The presentation provided a background of the project, the project partners, Carrier Deltek eTRU technology, electrical safety warnings, system components,

detailed system connection/disconnection and operation instructions, as well as precautions to prevent/limit an unattended drive-away from a vehicle still connected to the power pedestal that could occur at the staging area. The presentation included a copy of the instruction sticker that was affixed to each pedestal and to the rear of the trailers, as well as a copy of the warning sticker that was attached at the trailer electrical connector.

Following the classroom presentation, the all attendees visited a modified dock bay for a hands-on demonstration of the eTRU connection/disconnection procedure, along with various eTRU operations. This equipment demonstration during the training session was performed under the direction of Shorepower Technologies and Carrier-Transicold. Questions from Willow Run Foods personnel were addressed during the demonstration to ensure all operators understood how to properly operate the system.

Figure 3-7: Dock system after upgrade

Figure 3-8: Dock system before upgrade

Section 4:
CONCLUSIONS

The system design was effective and the electrical power modifications were successful. All tractor, trailer, and facility were completely installed by the March 31, 2008 performance period. The equipment is now being used in as part of the NYSERDA funded demonstration through September 30, 2008. Conclusions specific to the hardware design and installation are as follows:

1. **Design of the control system for the dock safety system was successful.** The design of the dock safety system modification was successful and met all design requirements outlined for the eTRU/docking safety system.

2. **All power and operational safety systems perform as designed.** The integrated dock system and supporting hardware are performing as intended. No unexpected failures have occurred to date.

3. **Integration of bumpers provided adequate protection for power modules.** Safety systems for the power modules were installed to minimize the risk of collision with the power exterior modules. This approach was lower cost than bollards and did not affect the operation of the warehouse.

4. **All partners have expressed satisfaction with the final design and installation.** Willow Run Foods is satisfied with the operation of the dock units, as nothing has changed for warehouse side operations. Signal lights and power connections are the only visible change on the inside and outside of the warehouse. These modifications have had little effect on the overall logistical operations of facility wit the exception of identifying the electrified docks as a priority location for Vector trailers. All partners visited the site for a post installation inspection and approved the facility design and installation as final and complete.