APPLICATIONS

Please note that these applications have been obtained by phone and fax, from ESCs around the world. Since only limited details are available on these installations, the following disclaimer is included. Please contact ACT for further technical information if applicable.

Disclaimer note: It is understood that the choice of components is not to be relied upon as final, and is provided only for informational purposes. The application of any ACT PCC equipment to any electrical system is unique and, therefore, should be performed by trained installers, adhering to all appropriate electrical codes. Nothing contained herein shall be used for or construed as creating any liability or engineering responsibility from Advanced Control Technologies, Inc.

Type of Installation: OFFICE BUILDING

Control Application: Controlling packaged terminal air conditioners located in four different non-connected buildings.

Comments: The control of approximately 225 packaged terminal air conditioners located in four different non-connected buildings was achieved with PCC. Primary control is through a TU102 (computer programmable universal controller). Communication between the buildings on campus was achieved with Signal Carrying Conductors (SCC) via spare phone lines. Time of day temperature compensated duty cycling was the main objective.

Type of Installation: OFFICE BUILDING

Control Application: Wiring 2-speed exhaust fans in an office to be controlled by PCC components

Comments: The installation included wiring 2-speed exhaust fans in an office to be controlled by PCC components. The goal was accomplished by using a double pole relay with both normally opened and normally closed contacts, in addition to 2 RS101 (feed thru relay switch) modules. This equipment was mounted above the hung ceiling adjacent to each fan. A TB100/TK031 (transmitter base/keypad) was installed on the walls, as required, with labeling to indicate high and low speeds. The client was instructed to turn each speed OFF before turning the other speed on. This would insure uniform and proper operation of the equipment installed. Although this installation did not require PCC components, it was the only feasible way to meet the needs of the client.

Type of Installation: OFFICE BUILDING

Control Application: Control of packaged AC units

Comments: The control of 200 packaged AC units over 30 floors of a high rise building was achieved with PCC. Primary control was from a TU102 upgraded with a POD (phone override device). A Signal Carrying Conductor (SCC) riser is used to connect a controller located on 10th floor to a total of 14 CA000s (coupling amplifier), 2 per service switch, located in basement.

Type of Installation: OFFICE BUILDING

Control Application: Conference Room Lights

Comment: In an older executive office building in Toronto the conference rooms had been wired with a single wall switch to control all the banks of florescent lighting. The customer wanted to control individual banks for energy savings and presentation. A big difficulty that made them think twice before starting rewiring was the asbestos present above the ceiling. The wiring in every room was modified in the following way: existing wall switch replaced with TB100/TK060 (four-controller switch), installation of RF100 (fixture relay) on each bank of fluorescent lighting to be controlled.

Type of Installation: **OFFICE BUILDING**

Control Application: Cooling

Comments: An office did not have air conditioning but was built above a huge basement that was always cool. A kind of air duct was installed between the basement and the office. A low cost, low voltage thermostat was installed in the office wired directly to an adjacent TB134 (6 channel interface transmitter) and an RR120 (duplex receptacle) was installed in the basement. An extension cord was plugged into the RR120 to control a fan that blew the air in the air duct.

Type of Installation: **OFFICE BUILDING**

Control Application: Baseboard Heating & Lighting Control

Comments: A two-story office building has 38 line voltage wall thermostats and 68-line voltage wall switches with 120/208-power supply. The object was to setback the baseboard heaters at night and bring them ON in the morning and to turn lights OFF in the office after hours. ESC used thermostat controllers and RS101s for lighting control. The front end was a TU102 with coupling provided by a CR234 (coupler repeater).

Type of Installation: **OFFICE BUILDING**

Control Application: Exterior Lights

Customer: A 625 foot main building, with eleven 300 foot wings, has a street light at the end of each wing and four street lights at the ticket booths at the street. These lights are controlled by a TB100, TK040, RF100, three CR134 (coupler repeater), and two CP000 (passive coupler) because of the three electric services in the building. Currently there are also four exhaust fans throughout the complex that are controlled with a TB100, TK060, and four RS101. The added controls save energy as well as the time it took to walk through these large buildings to turn all these items on.

Type of Installation: **OFFICE BUILDING**

Control Application: Coffee Machines

Comments: Office buildings have several loads being controlled by RS101's. The operator is also controlling coffee machines with RR120's using TB100s for plug load overrides. The building is controlled with a TU102, programming the logic statements to flash the lights in suites when a timed shut down is to occur giving the user five minutes to turn ON the override giving them two hours before shut down starts again. Lights are controlled by RS101s. Building power is 480 3-phase, each floor be fed by its own transformer. A CP020 (passive coupler) was used to pass the signal from floor to floor using low voltage wiring.

Type of Installation: **OFFICE BUILDING**

Control Application: HVAC

Comments: The application was installed in a 10-story office complex south of downtown Cleveland, Ohio. A contractor had developed and installed a custom designed Energy Management Building Automation System in this complex approximately 7 years ago. The EMS/BAS system controls the sequence of operation of the chiller, chilled water system, boilers, zone control and supply/return air distribution, throughout the facility.

Management change resulted in the new management group wanting to be able to manually turn "ON" and "OFF" various critical loads, in addition to being able to perform simply "Time of Day" scheduling, that could be adjusted on a daily basis. RS101s provided the manual control desired for 10 loads. The TP110 (wall mount programmable controller) provided the flexibility of schedule modification on a daily basis, and easily programmable for holiday schedules. The ten interfacing relays were din rail mounted inside the enclosures for interfacing with the EMS/BAS. Phase coupling was not required since

all additional control was accomplished within the self-contained enclosure. This Powerline Carrier modification to the existing Energy Management Building Automation System was expanded to provide additional building control of scheduled loads such as water coolers, lighting, with scheduling performed from the TB100.

Type of Installation: UTILITY HEADQUARTERS

Control Application: Lighting

Comments: The ESC is currently working with the local electric company to control/conserve energy consumption by controlling the lighting in their high rise headquarters. Using PCC principles, the ESC is attempting to use dimmers and light sensors to control the massive lobby lighting during daylight hours. As the building is mostly glass, on bright Richmond days, lighting in the lobby is mostly wasted. By automatically dimming the lights using photoelectric sensors with ACT transmitters and receivers the ESC is helping the power company to save on their own power consumption. This would allow the power company to help practice what they preach, and set an example for the rest of Richmond to follow.

Type of Installation: OIL COMPANY BOARDROOM

Control Application: Remote lowering/raising of a projector screen and on/off control of a projector

Comments: A boardroom was being upgraded with a new video projector and screen. The client wanted to be able to turn ON the power to the projector and be able to raise and lower the screen from a remote location. Various ideas were suggested using switches and relays to allow the screen to go up or down. However, interlocks would be required to prevent the screen from possibly trying to go up and down at the same time. An RB304 (SPDT relay receiver) was the ideal solution. An existing wall switch near the screen was rewired to act as a local control for the RB304. TB100 base transmitter with a TK030 2 button keypad was used to control the power to the projector through an RR120.

Type of Installation: PARKING LOT AREAS

Control Application: The use of PCC to be installed by a utility on their side of the distribution system offering their customers an energy saving control of lights

Comments: PSE&G decided to use PCC so that they could establish a control system that would be economically available to their customers without the need for the utility to purchase and install the equipment on the customer's side of the electrical distribution system. The tariff laws are very specific concerning the utility's involvement with the "meter" side of their customers. PSE&G requested a PCC system that would allow PSE&G a legal way to set up control of their customer's lighting without installing the equipment on the customer's side of the lighting system.

The basic design of the lighting system was discussed which included the utility's and customer's side of the electrical distribution system. A test location was picked at one of PSE&G's Division Headquarters. Note: The final test date for the management team occurred around Christmas so outdoor Christmas lights were also hooked up to the parking lot lighting controlled by PCC. A TD100 (manual controller) and a set of TB100/TK000 were connected to an AX000 (coupling transformer) at an office on the second floor of a large office building. At the 277 volt panel, approximately 200 feet away, a CR334 (coupler repeater) was installed. The signal was generated on the first floor as near to the outside of the building as possible. Then a CP020 was installed on the "A" phase of the 277 volt system and SCC was run to outside parking lights approximately 400 feet away. On the secondary side, another CP020 was installed and connected to an electrical box that had an RS101 controlling a lighting contactor that controlled the 120 volt outdoor parking and Christmas lights.

When the test was performed the management personnel were able to turn the lights ON and OFF using the TD100 or TB100/TK000 transmitters. The test was a huge success and approval was given to install the system at a new shopping center, which will control over 300 HID lights. There will be three separate zones with three separate transformers. PSE&G will install the CR334's, CP020's, RS101's. The customer will install the AX000, TB100/TK000 and the TP110.

Type of Installation: SECURITY SYSTEM

Control Application: Aid emergency personnel in locating premises.

Comments: Most of today's security systems sound an audible device (i.e., siren or bell) to scare away the would-be intruder. Since this noise must be silenced within five to fifteen minutes per local code and UL, it is somewhat difficult for emergency response personnel to locate the premises. If the premises audible devices were sounding, they could not be heard over their own sirens. On residential and commercial accounts with security systems, several outside lights are flashed for a twofold purpose:

1. To help responding authorities locate the premises faster
2. So the would-be intruder now has an audible and visual deterrent against him.

Using a TB134 connected to the security system's auxiliary relay programmed to pulse and time-out in 60 minutes; upon activation, lights connected to receivers will flash. Flashing lights will time-out by security system or when system is deactivated.

Type of Installation: FIRE ALARMS

Control Application: Aid emergency personnel in locating premises

Comments: On any account protected by a fire alarm, use PCC to light the way for occupants inside and help emergency personnel locate the premises faster, as described below. Fire alarms panels have programmed auxiliary relays. Use one relay programmed to close upon alarm activation, connected to an ACT TB134 that will transmit ON signals to receivers to turn ON selected lights to help occupants see their way out of the building. Use another relay on the fire alarm panel programmed to pulsate, and also connect it to the TB134 to flash exterior lights to assist fire-fighting personnel in locating the premises.

Type of Installation: HOTEL

Control Application: Energy Saving System

Comments: The project consists of two systems that will reduce both kWh and kW consumption by turning equipment ON and off. The technology utilized a PCC system that uses the buildings existing AC wiring to transmit and receive digitally encoded signals in order to operate relays. This eliminates costly labor/material to install low voltage wiring throughout the hotel.

The room control system consists of a transmitter at the front desk that interfaces with the existing Property Management System. This allows for sending on/off commands as rooms are put in occupied/unoccupied mode. Receiver relays are located in enclosures mounted in each of the six electric rooms. The relays turn the power ON or OFF to each rooms heating/cooling units. Coupling devices were installed in order to transmit signals on each leg of the 277/480 VAC system. The demand lighting system consists of a controller located in the main electrical room. This is interfaced with a metering system and a dry contact transmitter. The metering system includes 3 current transformers for the 277/480 VAC power and is wired into a meter receiver that monitors the kWH/kW consumption at all times. This metering system also is wired into a controller in order to turn ON common area equipment based on kW set point. The controller provides a dry contact output that drives a PCC transmitter. Receiver relays are installed at each RTU and corridor make up air units. The metering system indicates exactly what date and time the highest demand occurred.

Type of Installation: HOTEL

Control Application: HVAC

Comments: Customer desired to decrease energy usage by regulating the operation of individual HVAC units in rented rooms. Problem was that customers turn units on, and set temperatures to extremes, to cool or heat rooms. After a customer checks out of a room it is often found that the HVAC has not been turned OFF and the room continues to be conditioned. Housekeepers sometimes will

adjust the temperature, or turn the units off, but it does not happen often enough. The customers wanted to have remote control over the operation of individual HVAC units from the front desk. The hotel's power is provided via a single transformer providing 120/208 3-phase power through 1 main panel and 3 sub-panels, one sub-panel on each floor of the building. After an initial check of the power quality it was noted that the power looked clean and noise free. Signal strength tests were conducted after a CR134 was installed on the main panel. It was noted that no other panel signal conditioners or couplers were needed, as all rooms had sufficient signal strength for reliable operation. The owner wanted to do a small-scale test prior to a full commitment to the technology (10 rooms). The HVAC rooms were 208 VAC units, and required that power not be denied to the unit. Therefore, the owner opted to control the power to each unit thermostat rather than removing power from the HVAC unit. To accomplish the thermostat control RB104's (SPDT relay receiver) were used as an isolated contact regulating the 24 VDC control power to the thermostat. The transmitter for the front desk is a TD140 (64-channel load controller).

Type of Installation: **FARM**
Control Application: Automatic Waste Disposal for Hogs
Comments: This application is unique in that the TU102 is used to "flush the commode" for hogs. The customer has a large hog raising installation that requires that the waste products be flushed from the pen area on a regular basis. This was complicated by the fact that the customer has to be able to document how often this happens, as there are restrictions on the amount of effluent that can be discharged, as it must be properly treated in accordance with water quality standards.

The customer must document how often the pens are flushed. Local control or on-site personnel could not have achieved this. The installation consists of eight large pens or barns and the TU102 is installed in the management/control area of each site. A total of twenty-one sites are controlled. The program is modified via modem and there are no on-site manual controls or overrides. The various water valves are controlled by RF100 modules and the water level is monitored via TB134's. The flushing action is initiated on a time schedule basis after the flush tanks are filled to a predetermined level.

Type of Installation: **FARM**

Control Application: Temperature, Fans, and Pumps

Comments: The Del-Air System 2 is designed to control all the ventilation equipment within two rooms (or two zones of one room) for all seasons. At least four (4) control stages per zone are required (3 phase controllable ventilation stages and one (1) heating/cooling stage). The System 2 incorporates control of timed events (e.g. lights/spray cooling, feed system, etc.). A total of (10) "status outputs" for timed events is provided. Any "status outputs" must be capable of controlling timed devices (lights, feed system) or on/off temperature dependent devices (fans) or a combination of both (spray cooling).

Each zone can have up to two (2) temperature sensors. A separate sensor for ambient temperature is required. The System 2 comes with several factory default programs based on the kind of animals in the zone. These programs are easy to modify (override) by the user but can always be reverted back should the user make a mistake. Each program allows for "step-day" programming of temperatures and minimum ventilation. The System 2 allows "night set back" of the set points. The System 2 is capable of logging its activity and storing data that can be retrieved by interfacing with a computer. Some of this data is retrievable from the controller display. Up to 128 individual System 2 controllers can be net worked together to a central desktop PC. The central PC can assume all data logging and process functions, except backup. All controllers are programmable from the PC, and share current information with the PC ON request. Software for the PC will be of a graphic nature for user convenience.

Basic Theory of Operation:

1. Ambient temperature and zone temperature are read and logged continuously by the System
2. If the zone temperature is different from the set point temperature(s), then the appropriate HVAC stage is activated based on a stable P.I.D. algorithm.

3. If there is a change in the HVAC control (i.e. if a stage of fans is activated or deactivated as a result of step 2), then a log entry is made.
4. If the difference between the “actual room temperature” and the desired temperature is large (as defined by the set points) and is not reasonable when compared to the ambient temperature, then an alarm is triggered and a log entry made. The alarm will stay ON or continuously reappear until a user acknowledges the alarm.
5. If a step day program is being run, then automatic adjustments of set point and minimum ventilation is made throughout the step-day period.
6. If timed events are being used then, when they are activated, a log entry is made.
7. Status inputs like open doors are logged.
8. Every 24 hours, the following information is logged:
    a. Minimum zone temperature
    b. Maximum zone temperature
    c. Minimum ambient temperature
    d. Maximum ambient temperature

Detailed Operations

1. Temperature sensors are temperature - current conversion type thermistors hard-wired to the System 2 controller. If two sensors are used in one room, the average temperature is used in the control calculations but the individual temperatures are recorded in the log. This will be for information purposes only. Since temperature readings could be taken several times a second for controlling purposes, it might be suggested that the temperature readings for logs be averaged over 1 minute rather than having each reading logged.
2. The zone temperature is compared to the controller set-point temperature. A proportional-integral-derivative (P.I.D.) algorithm will then operate the available heating & cooling equipment appropriately to maintain a “zero error” temperature in that zone.
3. Usually, the first stage fan(s) will always be ON at a variable speed known as the “minimum ventilation rate.” Often, the “minimum ventilation” is provided by a heat exchanger(s), especially in winter. Heat exchangers are considered as a ventilation “stage” but for the System 2 they are considered an on/off temperature dependent “status output”. If additional ventilation is required, the first stage fan(s) are gradually increased up to maximum using phase control. A log entry is made when there is a change in the stage of ventilation. If a second stage fan(s) is used and is required, the phase controller will step it up from 0% to 100% while the first stage fan(s) stay at maximum. If a third stage fan(s) is used and required, a similar scheme is used.
4. If all fans are operating at 100%, and the temperature in the room is still not approaching the set-point temperature, an alarm may be necessary. This alarm is dependent on the ambient temperature. In other words, if the zone temperature is out of range from the set-point temperature then a warning is displayed but will not require acknowledgment. If the zone temperature is out of range (by 10 C or more) from both the zone set point and the ambient temperature then a full alarm is activated and will require an acknowledgment.

Type of Installation: **FARM**

Control Application: Irrigation Pumps

Comments: A cost effective method of remote control of Irrigation Pumps was needed so as to enable the user to control an operation dependent on weather conditions, while providing protection from frequent power outages. While this could be accomplished with digital radio receivers, this would require that the control be at a central control point to execute commands and, as changes are often required from the user’s vehicle, it was decided to utilize a telephone DTMF transmitter which could be controlled from the user’s mobile phone and the notice of power failure could be sent to the same phone. The

RB304 units were used to provide an OFF situation after a power outage. Control was required over the 480 system as well as on a 120 subsystem. Control was acquired by breaking the control voltage at the pump control panel at the Hand-Off-Auto switch. This use of PCC prevented having to run control wires over an approximately 10 square mile area or the use of radio receivers at a cost of over $11,000.

Type of Installation: SCHOOL

Control Application: Controlling HVAC units

Estimated Payback: $1000.00 per year

Comments: PCC has been successfully implemented in approximately 300 schools in North Carolina and South Carolina. The popularity of the products in these schools comes primarily from its ease of use, from both an installation and programming standpoint. Throughout the years the school systems have found that their own maintenance departments can install all of the products (the receiver relays, the coupling, and the programmable transmitters) and perform the programming quite easily. If problems arise, they are aware that there are only three major components in the system: the transmitter, the coupling, and the receivers. So they know very quickly to look in one of those three places for the problem. In most cases, they solve their own problems and call only for replacement parts.

Many schools are not air conditioned, particularly in the rural areas of North and South Carolina. So they are continually renovating these old school systems (especially elementary schools) by installing air conditioning, but they want some method of controlling the increased costs. Hard wiring these systems is not a good alternative. It is very labor intensive, conduit and wire is expensive, and even though it's relatively simple, it can confuse maintenance personnel. PCC offers three very strong benefits to school systems, particularly in the retrofit area. These benefits are:

1. The low cost of the product.
2. The ease of installation.
3. The ease of use and low maintenance cost.

A nice footnote to these projects is quick return on investments. When air conditioning is installed in the schools with a low up front cost makes the payback very quick. In some school systems, the difference between their projected energy cost increases and the energy savings created by PCC pay for the cost of renovation. Maintenance by the school personnel keeps costs low.

Type of Installation: SCHOOL

Control Application: Lighting and Heating Units

Comments: 9 buildings on one site with 10 transformers and 3 different kinds of distribution systems: single phase, 3 phase, high leg delta. The design constraints required that from the administration building the system would be able to provide a network system that is highly expandable to initially control exterior lighting, next to control interior classroom lighting, and last to control heating units. The state energy office provided partial funding on this project.

The major problem was coupling all the secondaries and providing the various phase shifts necessary for the receivers to respond properly. This is a small job, but it is in the process of being written up in the energy extension newsletter, which goes out to all of the school districts in the state. Coupling was established from the administration building to a gym. The installer used existing extra pair of phone wires buried to a CA000 amplifier in the gym which controlled HID Receivers and a special programmable relay which then provided a 24 volt one second pulse to initiate override to the gym's 30 kW heaters. A constant 120 volt output powered the relay, which has a microprocessor that was programmed to pulse 24 volts AC for one second.

Type of Installation: SCHOOL

Control Application: Controlling HVAC Units and Lighting

Comments: Each building in the college had an automation system product as a front end linked together throughout the seven buildings for communication back to an IBM PC. Off of each one of these slave panels are TB134 six channel transmitters. In some cases they use these for eight channels of output, sometimes maybe three or four depending on a modular approach so that they would have four or eight or twelve or sixteen outputs in each building. The TB134s tie into the 120V. A signal is sent back over to the 120/208V panel since every building was isolated separately. Since there were seven different service entrances, a TB134 was getting a signal off a building automation slave panel, sending a signal on to the 120V going back to the panel with a CR134 off of 3 phase and neutral in each panel in that entire building, to get lighting control and HVAC control. Fan coils were cycled based on time of day or temperature from the energy management system's program. The BAS used the PCC signal to get the signal out to the modules without having to wire the building and all of the ON/OFF status and temperatures were monitored back at a central computer.

Type of Installation: SCHOOL

Control Application: Light Board

Comments: The professional PARCAN stage lights and a long row of globe lights at the foot of the stage already existed. Since lightning destroyed the controller board and a new board would cost in excess of $10,000, an alternate solution was needed. A 40 sixty-watt globe lights were connected to an RD123 (2400W dimmer). The 8 three hundred watt PARCAN stage lights were connected to RD131's (dimmer switch). At stage-side three TB100's were installed with two TK050's and one TK040, allowing the customer bright/dim solution control and all on/off. A triple gang box was added above the existing receptacle. The summer camp preferred control from the rear of the auditorium, and this was accomplished simply by plugging in a TD100 to an existing receptacle.

Type of Installation: SCHOOL

Control Application: Lighting Control System

Comments: The NWS State Government carried out an energy audit of the costs of providing lighting in primary & secondary schools. This was followed by installing a lighting control system in four schools as a test case over a six-month period. At the end of the test period it was found that a so called "well managed school" (one that was conscious of switching OFF lights when not needed) had savings of up to 20% on their lighting and a poorly (which was the majority) managed school had savings up to 40% after the Lighting Control Systems was installed. The other problem the Government had was to provide a reliable cost effective lighting control system that would return cost savings over a reasonable pay back period in relation to capital expenditure. They considered a reasonable period to be two years. As there is a great number of existing schools it was not cost effective to install a hard wired system as the cost would be prohibitive so they were looking at a Powerline Carrier System for the job. They had previously been using an English company's Neutral Earth Powerline Carrier System but this had reliability problems due to noise on the power supply caused by computers, fire alarm panel, charging circuits and emergency lighting fittings.

A more reliable PCC system was designed by having a special eight channel timer built which would put out up to ten pulses of contact closures from an "ON" or "OFF" selection. These contact pulses and the time interval of the pulses can be selected by the operator. A timer was made so that having set "OFF" at 9:00 AM with five separate "OFF" pulses at 2 second intervals, the school could then have a refresh set of pulses from the timer from five minutes to four hour intervals. This meant that if the school were operating in a very intermittent noisy environment it could refresh signals every five minutes or less if required, however in an environment with little or no noise the refresh could be selected every two or three hours depending on the overall program for the lighting control. The timer was designed with separate "ON" and "OFF" contact so that the school could use a TB334 (6 channel interface transmitter) to interface with four of the channels of the timer.

The Government preferred system was to have a lighting control system that could send “OFF” commands only to classrooms. They wanted a system where the classroom lights were switched “ON” by the local class room light switches, however switched “OFF” at the end of the class room period by the controller. This could have been easily done by using RR301 receivers in every class room, however the cost was too high when only four or six lights were being controlled in a class room due to the fact that a neutral conductor had to be installed to each light switch position. Also, the Government was not happy to have RS301 (feed thru relay switch) receivers located at the switch position as from their experience the students would have removed the paddle and altered the codes.

A reset unit was designed that consisted of a relay and some electronics so that the relay would not pick up after the circuit was de-energized by the pulse timer with the light switch in the “ON” position. This enabled the reset unit to be installed in the switch wire circuit feeding the first light being controlled by the local switch. Also at this position an active and neutral were ready available. The reset unit enabled the classroom lights to be controlled “ON” and “OFF” by the local switch in the classroom and to be controlled by the Pulse Timer. The Pulse Timer was installed in the Administration building for the school and a CR334 was installed at the main switchboard. A RF310 (fixture relay) receiver was installed at each distribution board that had lighting circuits connected to it. The Receiver operated a contactor and the circuits were fed through the normally closed contacts of the contactor. In each classroom a reset unit was installed for each switching circuit to control the lighting. This enabled the classroom lighting to be switched “ON” and “OFF” by the local classroom light switch and be controlled by the Pulse Timer.

System Operation

The pulse Timer is set to send out PCC signal at the end of each classroom period and this signal operates one of the Receivers to switch “ON” a bell and after five seconds a “OFF” signal is sent to switch “OFF” the bell. Two minutes after the bell has stopped ringing the Pulse Timer then sends out separate PCC signal to switch “ON” the Receivers located in each distribution board. This then energizes the contactors that de-energize all the reset units thus switching “OFF” the classroom lighting. Two seconds later the Pulse Timer sends out an “OFF” signal to switch “OFF” the Receivers in each distribution board. The reset units have now all been energized, however the lights will not come back “ON” in each classroom until the local classroom light has been switched “OFF” and then “ON” again to energize the reset unit.

The Pulse Timer Controller provides a very reliable cost effective system to control lighting costs in schools as the utilization of the PCC Transmitter and Receivers eliminates the expensive costs of cabling and labor required to install a hard wired system. From tests carried out in NWS schools, considerable savings can be achieved in annual lighting cost when this system is installed. Bearing in mind that lighting costs represent approximately 60% of the total power bill in Primary and Secondary schools.

Type of Installation: SCHOOL

Control Application: HVAC

Comments: Queenchy High School consists of eight freestanding buildings that have a combined floor area of approximately 8,000 square meters. The buildings are of timber construction of approximately thirty years old and located at Launceston in northern Tasmania where climate conditions and temperatures are extreme in winter and early spring. In the late autumn, winter and early spring overnight temperatures drop to -5 degrees C and continue up to spring. This however changes in early spring and the minimum overnight could be zero degrees C and 15 degrees C by midday where heating of classrooms is not then required in the later part of the day. It was decided that full independent control of all sixty classrooms, ten staff rooms and the administration block should be controlled on a time and need basis as dictated by the teaching timetable. Due to the construction and the age of the school it was decided that PCC was the only economical way to provide a central control system on a time needs basis.

Type of Installation: SCHOOL

Control Application: Water Source Heat Pumps

Comments: A cost effective method of controlling individual water source heat pumps throughout a multi building complex and to provide for after hours override, freeze protection, and Time of Day (TOD) functions was required by a high school. The complex is served by a 240 Delta service from the Grid. The previous control method consisted of TOD on the cooling tower/boiler and circulating pumps, which caused the individual units to then cycle OFF on high head pressure. They additionally desired that a time override be available for after hours functions in the Boy's Gym, Girl's Gym, office area and the auditorium. The boiler/pump/cooling towers are all located remote from the classroom and athletic buildings.

Each of the override locations consist of a TB134 interface transmitter connected to 120 vac and triggered by a NO push button, which sends a momentary ON command to a RI204 (4 relay output receiver) which provides a digital input to a Paragon EC128 Control Panel. The EC128, on receipt of this input, provides a preset timed override which first starts the circulating pump, and then the boiler or cooling tower as required based on ambient temperature input to the EC128. When the water is within the preset temperature range, the EC128 closes the appropriate output, which is interfaced to a TD100 and this turns ON the individual heat pump which has its control voltage broken by a RI204. Each override unit uses a different address, as does each heat pump, which is subject to override. The classrooms, lunchroom, work areas, etc. are grouped by location and scheduled into five different groups. The other EC128 output is used for outdoor lighting based on an analog input from a photo cell and programmed levels. This installation was accomplished at approximately half the cost of trenching and hard wiring the complex. Additionally, all installation of control modules at the individual classroom heat pumps required less than 20 minutes each and was accomplished after school or during the class lunch break and without interruption to the classes.

Type of Installation: UNIVERSITY STADIUM

Control Application: Lighting Control

Comments: This domed football stadium installed new halogen HID fixtures and requested custom lighting control to enable them to control the five zones of lighting from the facilities 120 volt convenience outlets. 480 volt delta transformers powered the lighting fixtures and each side of the building was fed with separate 15KV services. There was a low voltage twisted pair available between each side of the building.

Lighting control cabinets using multiple poles mechanically latched contactors were used to control the fixture zones. The contactors were controlled with RB304 relays with each relay controlling several contactors. An AC100 (choke) was installed at each fixture and separate circuits were used to power fixtures and RB304 relays in order to provide as noise free a circuit as possible. CR334s were used on each side of the building to receive signals from a manual controller and place the signal on the low voltage conductor. CA000s and CP400s (passive coupler) were then used to place the signal on the 480-volt system on each side. This coupling scheme allowed control of both sides of the facility from either side of the building.

In addition to normal lighting there was also a requirement to control the emergency quartz lighting. A mechanically latched 100 amp contactor controlled this lighting. The control coil of this contactor was controlled by another RB304 wired reverse of normal applications and powered by the building's normal 480 power. When the normal source lost power the electrically held RB304 would drop out. The normally closed contacts were wired to the ON coil of the contactor. When the generator provided emergency power, the contactor was energized and emergency lights came on. When normal power was restored the RB304 was manually sent an ON command and the OFF coil of the emergency contactor was energized through the RB304s normally open contact and the contactor opened turning OFF the emergency lights. Manual control of the emergency contactor was achieved through the use of a TB334 contact interface and a manual switch again using reverse logic, an OFF signal turned the contactor ON and an ON signal turned the contactor OFF. The manual switch was labeled in reverse to avoid user confusion.

Type of Installation: LIBRARY

Control Application: Lighting Control

Comments: A TP110 and a TI100 (64 channel dry contact interface) are connected back to a building automation system, which is typically running the HVAC equipment, very sophisticated or interface to pneumatics. The TI100 interfaces to that piece of automation equipment to turn ON and OFF the lights. The TP110 is used strictly for override capabilities at another location in the building. Using RS301s (feed thru switch relay) on a 277/480V service with a CR334 coupler repeater and (2) CP000's to bridge the phases, and a CP010 (passive coupler) coming off of phase A and neutral going around a step down transformer to 120V going into an CA000 amplifier coming off of phase A and neutral going around a step down transformer to 120V going into an CA000 amplifier on 120/208V for some particular outside lighting. Thus, a 480V service and 120V service are coupled together with transmitters at two locations, one off of the automation system and one at a TP110 at the front desk so they have their own control. These circuits come directly off of a 20 amp breaker into this panel through a RS301 or RS101 and out to those given circuits, so they are all in three rooms on three separate floors. Also, there were frequency drives placed on the job that caused problems in the beginning and the frequency drive people came in and put in filtering and it filtered out all of the problems.

Type of Installation: MUSEUM

Control Application: Lighting

Comments: A Powerline Carrier Control (PCC) system has recently been installed and commissioned at a Museum. It is open to the public between the hours of 10:00 AM and 5:00 PM daily. ESC carried out the installation of the powerline carrier control components. The powerline carrier control equipment has been used to control the vast array of lighting located within the sprawling and largely windowless building. The installation is an essential part of the museum's ENERGY MANAGEMENT PROGRAM. Power is fed into the Museum from four separate supply transformers via four separate main distribution boards and metering positions. Forty-one sub-boards are fed from these four main distribution boards. Thirty-eight of these sub-boards have the entire lighting load connected to them controlled by the PCC system. Lighting loads connected to the sub-boards vary between 6 and 54 kilowatts each. The load is then subdivided into categories. Each category of lighting is supplied from a three phase contactor which switches supply ON or OFF to the bus ways feeding them. Most common categories of lighting controlled are public area lighting; display lighting; security lighting; cleaning lighting. Each category of lighting can be selected for either manual or automatic operation. This control selection is effected by a simple three position, auto-off-manual switch located on the front facia panel of the sub-boards. The entire lighting control system was installed and connected to a "Simplex" hard wired system for automatic control for some years before it was decided to convert to PCC control. Control of the lighting system, automatically, from the Simplex model time clock controller had not proved effective. It was Simplex that decided to convert the system to a PCC based system.

Prior to installing any PCC equipment, ESC carried out the normal "noise" tests on the mains frequency carrier wave. Many variable frequency drive units controlling air conditioning fan motors as well as other control devices that effect the carrier wave service the museum. In some areas, the powerline was particularly "dirty." It was decided not to use the powerline to carry the command signals in this application. Command signals would be distributed throughout the building using Coupling Conductors. This is a method of transferring command signals in their original state over a two wire, twisted pair, shielded cable. The signals are not superimposed on the mains until they arrive at a sub-board. This decision solved the problems of "dirty" mains carrier waves and multiple supplies. Fortunately, the former Simplex system had used a two pair wire network to distribute its commands.

Each sub-board was fitted with four receivers, one for each of the coils of the contactors that controlled the various lighting categories connected to the board. A filter unit was also installed at each sub-board, which filtered the 50 Hz mains frequency supplying the PCC components. This eliminated the noise problem. To achieve two-way communication, a four-channel transmitter unit was fitted across

the auxiliary contacts of the receiver-controlled contactors. A computer could now, via an interface unit, tell the receivers to turn the selected contactors ON or OFF. The operation of the contractor was transmitted back to the sending computer. Both the receiver and transmitters located at the sub-boards were set to the same channel code. For each switching command sent an exact same command had to be returned or 'echoed' from the board - NO ECHO MEANT AN ABNORMAL CONDITION NEEDED CHECKING. The system controls, in all, some 150 contactors located in sub-boards spread over four separate supplies in a large public building. It is a computer driven system switching very visible area lighting, in a building that has little natural light, in real time. It is doubtful if a system employing dedicated data coupling techniques could have performed the same operation as cost effectively as this PCC system.

Type of Installation: **CHURCH**

Control Application: Birthday Lights

Comments: This installation is in a synagogue. There is a large panel with bronze nameplates for the deceased members of the congregation. Next to each name is a pair of small lights that the customer illuminates on the date of the individual's birth. As the number of names increased, this became a task to look up each date and someone had to arrive first thing each day to make the necessary changes.

The switches were replaced on the lights with RF100 modules and the control was taken care of by a TU102. As the building is loaded with variable frequency drives, Motorola Electronic Ballast and Compact Florescent lights, the contractor installed two AF310s (band pass filter), back to back, on the circuit and powered both the TU102 and the lights from this filtered circuit. The ON and OFF actions are performed by both scheduled overrides and logic statements in order to perform the number of necessary actions on all the days for the entire year. The on-off times are scheduled to compensate for daylight savings time. Duplicate birth dates are wired to the same RF100, as the lamps for each name only total 8 watts. Benefits are that all dates and names are now done for the entire year and there is only a requirement for a change when new names are added. There are not any missed dates and someone does not have to arrive at the crack of dawn to make the changes.

Type of Installation: **CHURCH**

Control Application: Church Sign

Comments: This was a 120/208 3-phase building. The installer put a repeater coupler and a TP110 at the panel. The TP110 controlled the church sign, a heat pump at the sanctuary and a heat pump at the Education building. The system was programmed because no one wants to go in an hour early to turn heat or AC ON. At the back of the sound room and on either side of pulpit there are 3 bulb floodlight arrays. The installer used a 4-button transmitter as the control panel and put a fixture module on each lighting array. An electric screen, motor driven, is used to shine songs on a screen. When the service starts, they can lower or raise screen. This system is controlled from the sound room.

Type of Installation: **CANADIAN PARLIAMENT BUILDING**

Control Application: Tape Recorders

Comments: The Canadian Parliament wanted to turn ON tape recorders when the House of Parliament sits to record the Ministers of Parliament {Court Jesters}. PCC was chosen because of reliability.

Type of Installation: **MUNICIPAL**

Control Application: City Hall Lighting and Heat Pumps

Comments: A 250,000 square feet building is being controlled with a front end control, 70 TB134s, 100 RF100s, 80 RS101s, 3 CR134s, 20 CP000s, 2 CP010s, and 2 CA000s. This was a $30,000 job with

design constraints. This is an historical building made out of stone which is a multi-tenant facility that needed to retrofit a controls system to pulse out lighting after hours and control heat pumps after hours. The reason this job is unique is because the low voltage wire was quoted to run about $150,000 because they would have to drill through stone. The local Utility funded the job, which paid about 80% of the job. The building was a 12/+2/8 system and needed local overrides in 150 individual tenant spaces. Not only local override, but also a central control system with touch-tone phone override.

The client also needed to monitor tenant usage, so all-local tenant's overrides were wall transmitters. A local transmitter would control fixture receivers or wall receivers in the individual offices. However, the central controller would document hours of override when individual tenants pushed their transmitters. The heat pumps, 37 in total, used isolated contact modules to switch a simple setback thermostat for off peak office control. The building also had basement flooding and tenants in the basement. Thus, it was advantageous to have a water monitoring system, which would throw an alarm in the building engineer's office.

Type of Installation: LANDFILL

Control Application: Wastewater Pumps

Comments: A $3,000 total job with a huge landfill. This landfill had developed a huge mountain but on the southern end the owner is developing a new landfill. The operator had to lay common pipe for federal regulations to drain the fill and feed the water back into a pump house and treat the water before it gets back to the environment. The operator could not bury lines in the area, so 480-volt delta was strung about 1 mile on high telephone poles to control 2 horsepower pumps buried along the 1 mile line. Thus, the customer needed a way to control pumps individually through dry contract response from a computer in the pump house. The operator did not want to bury wire.

An AX000, 480-volt module was used at the site. The ESC visited the site and an electrical contractor came out and installed a module at the pump at the furthest location then hooked the AX000 transformer at the pump. The system monitors levels in the tank to decide which pump comes on next. When affluent is pumped into the tank and reaches a certain level, then another pump is turned on to balance outflow from the landfill as well as the flow of treated water back to the earth.

Type of Installation: WASTEWATER TREATMENT PLANT

Control Application: Agitation equipment

Comments: The Brisbane City Council water supply & sewage treatment plant has two large tanks 50 meters long by 30 meters wide. A control trolley with agitation equipment runs on rails across each tank in a North-South-East & West direction. The trolleys are controlled in a control room that is remote from the tanks and the operators can not see the trolleys. A requirement arose to provide directional indication of each control trolley. This created a problem as each trolley was fed by a cable reel with three phase and neutral supply via a slip ring assembly and they could not transfer this information from each trolley without replacing or duplicating spring operated cable reels.

A TB334 six channel Interface Transmitter was installed in the control panel of each trolley, with each channel indicating the direction of travel. (I.e. North-South-East & West). This was accomplished by connecting an auxiliary contact from each of the trolley directional drive starters to a channel of the TB334 so that when the trolley was traveling North the auxiliary contact of this motor starter closed on channel 1 of the TB334 Transmitter which transmitted a signal to the Receiver placed in the control room. The same thing was done for the South, East and West applications. The receivers in the control room were connected to relays and their contacts were interfaced with the existing Bailey Instrument Control system that then indicated the direction of the trolleys via the Bailey mimic panel. The above system has now been in reliable operation for over twelve months and it was a very cost effective and more convenient way to solve their problem as the alternative would have been to replace the Spring Operated Cable Reelers that would have created engineering problems.

Type of Installation: **JAIL**

Control Application: Lighting integrated with security system

Comments: The architectural design team for the new State of the Art correctional facility decided that a Request for Design Proposal would be required for this project in order to achieve the ever changing requirements of the County and other law agencies involved in the daily operation of the facility. The criteria for design included, precise operating requirements of all control points. Security computer system, touch screen in each POD and master control of all systems via the central security control room.

PCC units selected operate on a 277 volt three phase four-wire system with a CR334 repeater/coupler installed at the main electric service entrance. Control of all loads utilizing the security computer system was directed through a TU102 unit. Components for the system were mounted within NEMA 1 enclosures on special racks, with all wiring connected to approval terminal connectors. Enclosure panels controlled both 277 volt and 120 volt loads. Electrical loads controlled in each of the nine different POD configurations included the following: Shower water and lights, 120 volt wall receptacle, television system, public telephones, cell night lights, three levels of general day room lighting and outdoor recreation lighting. With the completion of the installation, testing was completed in each POD for the on-site engineering firm to insure total operation of all control circuits and acceptance of the POD. After the completion of each POD, total system testing was begun via the security system utilizing both the local POD touch screen and the central security system. The installing security computer company completed software configuration for the interface of PCC and the security computer system. Final approval and acceptance of the system by both the engineering review team and the owners was completed and the warranty period began three weeks after the initial testing was started.

Type of Installation: **AIRPORT**

Customer: Palm Springs Airport

Control Application: To control the real and papa lights on the runways at the airport from the control tower.

Comments: One AX000 to go from 480 volts to 120 volts. Four RB304's that are all on the same phase as the AX000 were used as receivers.

Type of Installation: **BOTANICAL GARDENS**

Control Application: Various HVAC devices

Comments: A multi-building complex is controlled by five Paragon EC128 units interfaced to a TI100 (64 channel dry contact interface transmitter). Approximately 200 points of control including window AC, chilled and hot water valves and air handlers are controlled with this integrated system. A Paragon Control Panel provides temperature and demand inputs.

Type of Installation: **HOSPITAL**

Control Application: Landing Lights

Comments: The Barry's Bay Memorial Hospital has a helicopter-landing pad for emergency situations. The hospital wanted to turn ON the emergency helicopter landing pad lights 15 minutes prior to the helicopter landing from the nursing station inside the hospital a distance of 300 feet.

Type of Installation: **ARMY BASE**

Control Application: HVAC and Lighting

Comments: The Australian Army Headquarters Anglesea Hobart Tasmania decided on a program of cost savings throughout the state of Tasmania and one of the areas they were looking at

was energy savings and energy monitoring. The army is housed in nine separate bases throughout the island state of Tasmania with buildings being some of the oldest and best-maintained building in Australia. With this in mind and the buildings being classified by the National Trust of Australia, rewiring of the buildings and the installation of additional new control cabling was ruled out, leaving only the option of control for heating, power and lighting via a Powerline Carrier System. The Army carried out an in depth investigation of the various Powerline Carrier Systems around the world to select a system to be installed in Tasmania. After providing extensive information and being involved in very detailed meetings the Army decided to install PCC.

The original program was to install a small system in the Anglesea Barracks Headquarters building that dated back to the year 1860. The base buildings structure had to remain virtually intact during this refurbishment, lending it to control via PCC for its electrical heating, hot water and lighting loads. A central location was determined in the facilities section for the installation of the TU102 Transceivers. This group is the engineering and new projects division of the Army and they have the ability to determine priorities for control of the energy use. The Anglesea Barracks is twelve square acres (equivalent to one city block in Hobart) and it has three high voltage supply points to feed forty-seven separate buildings. A signal-coupling conductor coupled two of the supplies and the third supply was treated as a separate installation with its own TU102 controlling loads.

Each supply had a 415/240 volt ring main running underground around a defined area with a number of pillar type fuse panels located to feed various buildings from these panels. Five CR334 Coupler/Repeaters were installed to obtain a reliable and strong signal to all buildings at this location. Heating and lighting is now controlled on a needs basis with the onus being on the Army and civil personnel to turn their heater and individual lighting ON as required. The program they use switches the heating OFF approximately every two hours; therefore heaters in areas that have no personnel will not be operated. This varies for accommodation and mess areas together with hot water requirements through the base.

This system of control at Anglesea Barracks achieved very good cost savings and a reasonable pay back period against the capitol expenditure so it was duplicated in the eight remaining Barracks throughout Tasmania with control for override and programming with the facilities branch personnel on a dedicated computer. All the remote Barracks have a TU102 Transceiver that is programmed from Anglesea Barracks. Each TU102 is connected to a Hayes compatible error corrected modem via the telephone system back to Anglesea Barracks. At the Anglesea there is a transfer switch so that the facility's personnel can select communications with the local TU102 transceiver or the remote Barracks TU102 Transceivers. A TU102 was located in the administration building with the energy officer being in control of the key board or program changes. Each room was filled with a RF310 Receiver that was located into the existing control circuit for that room. The Receiver controlled a room switch and thermostat that operated a contactor on a central heating load center.

The new system had to be installed with minimum interruption to the school and the PCC system was installed along with programming the TU102 in four man-days. The desired control system could have been installed economically with a hard-wired system. The benefits that have been gained with the PCC system are:

1. Heating of rooms, which are only occupied.
2. Holiday program when heating is not required.
3. Keyboard overrides when climatic conditions require.
4. Common point of control by one person with screen based status of program.
5. Out of hours override for outside group functions and meetings.
6. Savings on electricity of $8,500.00 per annum allowing a payback of 1.1 years.

The software in the dedicated computer at Anglesea Barracks allows the facility's personnel to program into it the telephone numbers of the remote Barracks. The facility's personnel can select the Barracks they want to communicate with or monitor status of various loads by accessing the

software and selecting the Barracks they require. The software then has the modem dial up the selected Barracks and they can then carry out program changes, monitor status of various loads by viewing the screen, or carry out manual override switching of selected loads. As the army is generally on the move with camps and training programs being held at different times throughout the year, it is necessary to be able to modify time programming for these camps on a time table style program. A lap top computer has been installed into a carrying case with an error-connected modem and all the Barracks base programs have been loaded into the computer. This gives the facility's personnel further flexibility as they can now access all eight remote bases and the main base at Hobart from any location in Australia where there is a power supply and a telephone socket provided they have the password for access.

Type of Installation: HYDROELECTRIC DAM

Control Application: Control of heat and light at dam site

Comments: This request came from B.C. Hydro in order for them to reduce their peak demand of electricity and also so that they are seen to be complying with their own "Power Smart Project." The PCC will be used to control the lighting throughout the dam and buildings from a central location (the navigation lock operating tower) so that all lights can be turned OFF when the complex is unoccupied and turned on, when required, by operating personnel. The system will also be used to reduce electrical demand during the winter by turning OFF the heat when the main hoist motors are operating.

The station service at the Hugh Keenleyside Dam is supplied by two 2000 KVA transformers at 600 volts three phase. Although the secondaries of these transformers are connected Wye and are solidly grounded the neutral has not been extended to the MCC's and the system is considered to be three phase three wire when installing electrical equipment. For reasonable flexibility it was proposed that the lighting be divided into eight zones and the heating into four zones. Each receiver operates one or more relays that, in turn, control the lighting and heating. These relays are mounted in the MCC's or in moisture proof boxes mounted adjacent to the remote lighting panels. Power to operate the relays will be from a 120 volt circuit.

Three CP400s will be required to ensure the signal is generated on all phases. It was also necessary to install a CR334 coupler/repeater to ensure adequate signal strength at all receivers. At the master location, the security system dry contact would operate (via a TB134 transmitter) to turn all lighting zones ON or off. The TD or TK transmitter would permit individual control of each lighting zone. When either of the main hoists (two 200 H.P. motors per hoist) operate, a dry contact through a TB134 transmitter would operate heating zones. An OFF signal would be sent when the motors started and an "ON" signal would be sent when the motors stopped. The normally open contact in the RB304 would be used for control of the heaters.

Type of Installation: FACTORY

Control Application: Control of strip light fixtures on three levels over a conveyer

Comments: A conveyer system with strip light fixtures on three levels over a conveyer is controlled on all three levels independently.

Type of Installation: FACTORY

Control Application: Distance of transmission of hard wire

Comments: The Teledyne Jet Engine Plant in Toledo, OH was ordered by the U.S. Air Force to install outside perimeter lighting around its quarter mile long plant. The lighting is part of a security package at the plant that manufactures jet engines for military applications. Sixteen, 480 VAC remote switches, coupling devices and a simple PCC wall-mounted timer unit were used to control the lights.

The PCC system allowed Teledyne personnel to either zone control or individually control any of the sixteen lights. One of the unique things about this installation was the signal coupling involved with injecting the PCC signal on three different 480 VAC-delta power busses. The company that designed

the system had to use three 480V 3-phase system in the building to supply energy to the outside lights. This required pulling quarter mile long twisted pairs of wires from one end of the plant to the other end and then coupling the PCC signals to the 3-phase delta wiring at the far end. All the coupling components were mounted in a large, waterproof Hoffman enclosure that was attached to a block wall in the building's powerhouse section.

A 1200 foot run was made from the powerhouse to the guard station room at the front of the building to supply 125 VAC power to the wall timer in the guardroom. This 125 VAC was obtained from an AX000 125V-480VAC conversion transformer unit. This hookup provided the means for PCC signals from the wall timer to reach the signal coupling components in the powerhouse section. The wall timer was programmed to turn all lights ON at about 5 P.M. and then turn them OFF at 7 A.M. the next morning. During the in between times, codes were sent every 15 minutes to refresh either ON or OFF conditions of the lights. In extreme weather conditions, guards could go to the guardroom and provide any current light command issued by the wall timer unit.

Type of Installation: **FACTORY**

Control Application: Rooftop Fans

Comments: Provide start/stop control and indicate status of large rooftop fan units in a large tire manufacturing plant. Manual control must be provided for 15 units. Switches must be a two-position selector switch with integral pilot light mounted in the face of a NEMA 12 (dust-light) enclosure. The fan units are fed from various substations throughout the plant. 4160 volt primary, 480 volt secondary. Upon activation at any switch, a PCC signal should activate a receiver module to start the fan unit's motor starter. After starting, a contact transmitter should send a signal back to indicate that the unit did in fact start.

SCC conductors were wired in order to connect the secondaries of the high voltage substation. Two SCC pairs were installed (1-4 conductor cable) to provide a transmit path, and a receive path in order to prevent over driving the CA000's. The industrial grade switches were connected to the input of a TI100 inside the enclosures in order to provide the necessary NEMA rating. This strategy can be used in explosion proof areas as well. The TI100 initiates the on/off signal and fires a CR134. The signal is sent down the SCC and arrives at the CA000 that amplifies the signal and activates the RB304 receiver. When the motor's starter is activated, auxiliary contacts activate a TB334 that sends a confirmation signal back on the second SCC pair which in turn activates an RF100 receiver module that turns ON the pilot light inside the industrial grade selector switches. An AF300 (low pass filter) was used to isolate the TB334 transmission from the rest of the system in order to prevent the signal from getting back onto the first SCC pair and over driving the amplifiers within it's own distribution system.

Type of Installation: **BAKERY**

Control Application: Large Warning Horns

Comments: To install large horns in 12 locations to alert workers that they need to evacuate the building because of an earth quake or any other kind of an emergency. The transmitter is one TB100 at the security office with a TK000 keypad. One CR334 on one of the two 277/480 volt distributions provided coupling. One circuit with the signal on it was put on the second distribution without using any coupling and all the receivers were run OFF that phase. The receivers used were RB304 connected to the horns. The reason for using PCC is that this bakery will change completely inside every six months. If they had to hard wire they would have to rewire the horns each time.

Type of Installation: **RETAIL**

Control Application: Store Lighting

Comments: Saks Fifth Avenue, with approximately 20 locations around the country, adopted a basic control scheme that utilizes 2 TP110s to control store lighting and Point of Sale (P.O.S.) terminals. In more than 75% of installations, a SCC pair is used to create a multiplexed system free of interference.

Type of Installation: RETAIL

Control Application: Remote Operation

Comments: Store occupants did not like the idea of employees leaving at closing via the back alley for safety reasons, but the store lights were controlled by circuit breakers in the rear stock room. If the employees departed via the front of the store the owner usually found lights ON the following morning. Six sets of florescent lights - five in the showroom and one in the stockroom - were connected to an RS101 mounted next to the panel box. At the front of the store was a switch for the sign light, an RF100 was installed to control the sign. A TB100 with a TK040 was installed where the old sign light switch was. Operation was simple, sign light, store lights, and stockroom light plus all on/off. While installing product with owner present, the security alarm company arrived on site to program for open/close reports. The owner requested a TB100 connected to the auxiliary relay of the security panel, and now the lights go on/off automatically upon arming/disarming the store security system.

Type of Installation: BOWLING ALLEY

Control Application: Lighting Control

Comments: A bowling alley has five (5) rows of 2 tube 8' fixtures that run opposite the bowling lanes. When a customer wants to bowl, the proprietor must turn ON all the lights to light just one lane. One Hundred twenty (120) RF100s were installed to enable the customer to light only the lanes that were actually being used.

Type of Installation: THE GIANT 3-D METAL PEACH

Control Application: Control banks of lights on three dimensional sign

Comments: The owner needed to turn ON and OFF four banks of colored lights (weather indicator) that are revolving and powered from a slip power ring, with the following specifications:

1. Mount color lights on the inside of a revolving message board and be able to switch colored banks remotely, via modem.
2. Switch lights without any wired control connections to the stationary building.
3. Switch stationary lights from a remote location via a telephone modem.
4. Switch lights by a zone of like colors to indicate the next day's weather: RED=rain, BLUE=cold, PEACHY=fair weather.
5. Provide remote control of rotating message board to stop rotation on a specific sign (one of three) in the event winds exceed 25 M.P.H.. High winds blowing into the rotating tri-message panel while the larger sign rotated in the wind could pull OFF message panels and send them flying towards the ground from 16 stories up.

The response from the owner has been very positive concerning ease of operation. He is able to switch lighting zones with a simple touch tone code. This allows him to color the "Peach" with the next day's weather report. The owner has purchased air/roof lights for an estimated 25 more "peaches" throughout the southeast.

Project Description: A stationary Peach mounted on the roof of a 13 story building with a revolving message board (with light fixtures on the back side of the message board, that also rotate three different panels of advertising).

Control Components:

1. Remote touch tone phone.
2. PCC TIE/ECS modem.
3. Coupling/Amplification for PCC PLC from 120V to single phase 277V
4. Control Panel in building penthouse with PCC modules for stationary lights to illuminate the message board.
5. Control panel on the secondary side of a slip ring that allows the message board to revolve and receive power from slip ring to slip ring.

6. PCC modules mounted in control panel feeding circuits through a photocell controlled 6 pole lighting contractor.
7. PCC module mounted in control panel wired in series with a proximity sensor.

Control Strategy:

1. Owner calls modem from touch-tone telephone, upon answer, modem responds with a tone, owner enters three-digit security code.
2. Modem allows access; owner enters commands; *module number # for ON * module number # for OFF.
3. Modem sends PLC signal out 120V line cord. Signal is coupled and amplified to 277/480V through AX000 to CA000.
4. Signal exits 480V breaker panel on a 50 amp circuit to slip ring on roof.
5. Power and signal are passed to revolving sign by slip ring.
6. Signal controls PCC module that was addressed with touch-tone telephone.
7. Owner usually sets the colors indicating the weather each day and a multipole contactor is controlled by a photocell each dusk. This allows the lights to be addressed during work hours but not come ON until dusk.
8. In the event the winds are too high for the sign to rotate, the owner can switch the DC drive motor OFF with a specific message. A module wired in series with a Proximity Sensor allows the owner to call via modem, switch ON the module that powers the sensor, which then looks for a cam point to stop the sign. Module OFF removes power from the sensor and allows the sign to rotate.

Type of Installation: TRANSPORTATION

Control Application: Delivery Trucks

Comments: At a small rural lot, a milk delivery company kept 10-12 trucks for local delivery. Each morning a tractor trailer with driver and helper arrive at this lot and transfer product to smaller trucks. At 6:00 AM the small delivery truck drivers show up to begin their routes. The drivers plugged in block heaters during the late afternoon upon their arrival. However, the trucks were still warm, the day was still nice, and the heater was not needed, wasting electricity and prematurely burning out the heaters. To solve the problem, each outlet was changed to an RR120, so it didn't matter which outlet was used. Since the client only wanted the heaters activated below 30 degrees F and from 2:00 AM, because it took four hours to warm the block, a time clock and an adjustable temperature sensor were connected in series to a TB134.

Type of Installation: BRIDGE LIGHTS

Control Application: Lighting

Comments: One Australia was the entry for the American's Cup challenge. The trials for this yacht were being carried out of Southport on the Gold coast and became a world attraction. Because of this the Gold Coast City Council wanted to have nighttime decorative lighting on the Nerang river bridge at Southport. This bridge is approximately 3/4 kilometer long and it is illuminated at nighttime by 20 high-pressure light fittings located on 7-meter high metal street poles. A lighting company designed and made up five yacht shapes using fibre lighting tube. These yachts had five-meter high sails with a four-meter long hull and fibre optic tubing formed at the base of the hull in wave formation to give the water effect. The five yachts were placed on alternate street lighting poles from the center of the bridge going to the start and finish of the bridge. This meant the yachts were approximately 100 meters apart. The wiring for the fibre optics for each light was connected to each street pole and came on at night with the street light photoelectric cell.

The council decided this was still not spectacular enough for a major world wide event as they wanted to create the impression that the yachts were moving in the water, however to do this by conventional wiring methods would be very costly. They approached a consulting engineer to see if he had any ideas of how it could be done without involving hundreds of meters of piping and cabling. The consulting engineer advised the council that Brylyn Enterprises had a system that could do this without the need to install cabling. A controller was designed incorporating a four-way cam and each cam was connected across the channels of a TB334. This controller was connected to the street lighting circuit in the pole. A RF310 was placed in each of the five poles that had yachts mounted on them. The RF310 was used to activate the light driver for the fibre optic lighting. The cams were set so that cam 1 operated B1, cam 2-B2 cam 3-B3 and cam 4-B4. The cams were then set so that B1 was energized, followed by B2 two seconds later, followed by B3 two seconds later etc. The lights then stayed ON for three minutes and the process was repeated.

Type of Installation: SHIP UNLOADER

Control Application: Control of Unloader

Comments: Alcoa has a ship unloader that runs along a very long pier. The ship unloader is fed from a three-phase bus system with collector trolleys. They required a control signal to be sent from the ship unloaders control cabin to a control room located on the ground at the end of the pier. As the ship unloader was fed from a bus system it was very difficult to install an additional control cable. A TB334 interface transmitter with control switches connected to the channels was installed in the cabin of the unloader and the signals were sent to receivers located in the control room via the three-phase bus supply. As there was no neutral to the cabin a 415 volt to 240 volt transformer was used with CP400s (passive coupler) across the transformer to pass the signal through the transformer. The motors driving the ship unloader are all variable speed drives; however they were suitably filtered and did not cause any problems with the system.

Type of Installation: RAILROAD YARD

Customer: State Rail Authority

Control Application: Lighting

Comments: The State Rail authority rail siding at Tottenham in Melbourne covers an area of approximately three square kilometers. The yard is lit by high-pressure lights being mounted on poles covering this area. The yard is a twenty four-hour operation and the railways required security lighting and working lighting in defined areas. They required all lights to be controlled from a central control station with a photoelectric cell activating security lighting and manually operated switches to bring on additional lighting in defined areas to full light condition. A TI100 was located in the control station and RF310 receivers were located in weather proof cabinets mounted on the poles to control contactors for the lighting circuits. All of this sounds fairly straight forward, however the signals had to be transmitted over a distance of three kilometers via a signal coupling conductor coupling four separate supply points. Had PCC not been available the project would not have proceeded as all the lighting and poles were existing and the lights were locally controlled. The cost to achieve a centrally controlled system using conventional wiring methods has been prohibitive.

Type of Installation: SKI LODGE

Control Application: Snow Making Machines

Comments: In this situation, 480 VAC lines already had been run up a ski hill and safety was not a priority. A normal hill had 3 phase providing power to lights already. The owner wanted to add better snow making machines since the owner only had a cat machine with water hooked up to it to make the snow. Now the owner will run water up the hill/pole and at each pole a snow making machine will be installed. Lights, lifts and snow machines will all run off of one (1) 480 VAC system, so if operators are going to do any repairs at all, everything must be turned OFF. The contractor put 480 VAC modules on

each pole, so you can turn off individual lights or pick or choose which light to operate. So installer put 480 VAC modules on each pole, so you can turn OFF individual lights or pick or choose which light to operate. Operator has a switch for each snow machine, and now lights can be controlled separately from the lift or snow machine

Type of Installation: MINI-STORAGE WAREHOUSE

Control Application: Lights

Comments: A customer owned a 64 unit mini-storage warehouse complex. The Mini-Storage renters turn ON the lights of their storage units when they arrive, and then they often don't turn OFF the lights when they leave. To solve this problem, many owners of Mini-Storage Warehouses use TIMERS, which are manually activated to turn ON the lights, and which automatically turn OFF the lights after 30 minutes. Unfortunately, these timers can be and often are expensive and unreliable. The owner of this Mini-Storage complex wished to control the shut-off of each unit's lighting without timers from a central location. PCC equipment was the most efficient and effective approach. Now, a PCC Transmitter in the adjacent office sends an OFF signal every 15 minutes to the PCC Receiver Switches controlling the lights in each storage unit.

Type of Installation: FLEA MARKET

Control Application: Lights

Comments: A 625 Ft. main building, with eleven 300 foot wings has a street light at the end of each wing and four street lights at the ticket booths at the street. These lights are controlled by a TB100, a TK040, a RF100, three CR134s, and two CP000s because of the three electric services in the building. There are also four exhaust fans throughout the complex, which are controlled with a TB100, TK060, and four RS101s. The added controls save energy as well as the time it took to walk through these large buildings to turn all of these items ON. Future plans include controlling all of the inside lights and fans as well as possibly controlling the magnetic locks on approximately 350 doors which are currently unlocked manually each business day.

Type of Installation: LAN SYSTEM

Control Application: File Servers

Comments: GTE has a large LAN network throughout the entire United States. In each of their local offices the LAN system connects to the central GTE computer in Dallas. In each remote location, a technician was assigned to administer the local network. Each local installation has between 20 and 250 file servers attached to the LAN. A major problem with the LAN network was the fact that the microprocessor chip in the file server would occasionally "freak out" and lock up, resulting in certain file servers being dropped out of the network. When these "lock ups" occurred, the central computer in Dallas would notify the central LAN administrator who would then page the local administrator. Upon receiving the notice, the local administrator would have to search through the computer room to find the appropriate file server that was "locked up". This resulted in a lot of wasted time for the administrator and a lot of down time on the LAN. In most cases the administrator was able to fix the problem by merely turning the dead file server OFF then back ON to restart the microprocessor.

GTE decided to wire each file server to an AF100 (plug in filter) then plug the unit into an RR110 receptacle. Each file server was given a unique address. A CP290 was installed in each location along with a modem. Once the system was operational, an error message would be received in Dallas. Then the central LAN administrator would call the local office modem connected to the CP290 and turn ON then OFF the receptacle controlling the "locked up" file server. This procedure took less time than it previously took to page the local administrator. Over 98% of the remote "toggles" fixed the "lock up" problem. The resulting timesavings were over 95%. GTE has written a program that automatically can activate the "toggle" without supervisor intervention during off-hours.

Type of Installation: **ADVERTISING SIGNS**

Control Application: LED Signs

Comments: ISA sells advertising to large grocery and drug store chains. ISA contracts with major consumer product companies, such as Proctor & Gamble, to put advertising (Cheer $4.78) on LED signs located in multiple shopping aisles of these stores. All of the advertising messages were generated and sent to the individual stores from New York. Unfortunately, since the LED signs had microprocessor chips the signs occasionally “locked up”. When this happened, ISA would have to dispatch an electrician to assess the cause of the “lock up”, at great cost to ISA. In most cases, the electrician turned the sign OFF then ON resulting in the sign coming back on the system. ACT provided ISA with a front-end controller that sent X-10 signal to a receptacle (RR120) to “toggle” the sign if the central office received a report that a sign was “locked”. The controller had a modem plus RS485 communication also. ISA reduced their field calls by over 90% and reduced the cost associated with these calls by over 95%.

Type of Installation: **RESIDENTIAL**

Control Application: Apartment Project Alarm

Comments: In rural Northern Michigan are many small FHA Apartment projects that are not on a municipal sewer system. Therefore, most of them have dosing tanks with pumps that pump into drain fields. This pumping system has two safeguards. One is an override system that brings on both pumps in lieu of one, if water levels rise to high, but does not ring an alarm. The other is an alarm float that rings a small bell and lights a small light at the station site upon total pump failure. The problem with the system was two folds. First, the alarm site is often hundreds of feet from the apartment site and alarms went unnoticed. The second was that the system only rang an alarm upon total pump failure and did not have any alarm when the system went into emergency override.

The ESC engineered a system of double alarms. The first alarm is a new one that comes ON and locks in, with a manual reset required, when the system uses the override float in lieu of the regular floats. This is backed up by the regular total failure alarm float. Latching ice cube relays were added to both of these alarms to close contacts going to a TB134. In the apartment building CP000 couplers were installed at the main service along with AF310 filters from each phase to ground. After suggesting several different ways to ring alarms in the building, management chose the option to have a small plug-in alarm panel constructed that could be plugged-in within the managers unit. The beauty of this alarm is that it simply plugs into any wall outlet. When the manager is away for the weekend he simply gives it to the assistant manager and he plugs it in within his unit. The alarm panel has two alarm levels. The first is the override alarm, which is a RF100 beeper. The second is the total failure alarm, which also is a fixture module that lights an amber light and sounds a major 100-dB alarm horn, which is mounted in the alarm box. The total interior alarm system is mounted in a 12" x 4" electrical junction box, with a plug-in cord. This system is very easy to move around the building whenever movement is needed. In the past the system often had total pump failure without anyone knowing about it. With the advent of the new override alarm plus the construction of the interior alarm panel there has never been a total failure alarm. All alarms are now caught at the override stage. With the interior PCC alarm system no alarms go unnoticed and with the override alarm all repairs can be made before a total failure alarm occurs.

Type of Installation: **RESIDENTIAL**

Control Application: Wine Cellar Air Conditioning

Comments: A customer had a water flow wine room-cooling system that used a lot of water. The electrician installed a room air conditioner, which was controlled (cycled) by Powerline Carrier. An in-wall temperature sensor into a microprocessor was installed to send a signal to the PCC.

Type of Installation: RESIDENTIAL

Control Application: Pond Pump and Lights

Comments: A circulating pump and under water lights were installed in the inside pond with two RF100 units that received signal from a microprocessor. When the front door was opened the pump and the lights came ON and stayed ON until 10:00 PM or when the customer scheduled the OFF command. Of course, a wall switch could also control the pump and lights.

Type of Installation: RESIDENTIAL

Control Application: Birdbath Water Heater

Comments: This is a simple application where the customer is an avid bird watcher and desired that the water in her birdbath be maintained at an optimum temperature to encourage the birds to use the birdbath, especially in the winter months. The application uses a small 100 watt in-line water heater, circulating pump and a temperature sensor. The pump is scheduled via the TU102 and also controlled by the same logic statement that turns ON the water heater. The pump is controlled by an RB104 (1 relay output receiver), with the isolated contacts of the RB104 providing interlock protection for the in-line water heater, which is controlled by an RF100. When the water temperature drops 3 degrees below the desired temperature, the logic statement turns ON the circulating pump and the in-line heater. The RB104 controlling the pump must turn ON before the heater can turn on. When the desired temperature is reached the heater is turned off. Redundant logic statements were programmed where an ON function is also performed at 5 and again at 10 degrees below the target temperature and an OFF function is also programmed for 3, 5, and 10 degrees above the desired temperature. This was to insure that the bath did not “boil” any of the birds. The customer added logic to turn ON just the circulating pump, when the water gets too warm in the summer to provide some degree of cooling.

Type of Installation: RESIDENTIAL

Control Application: Cave, Water Slide, Hot Tub etc.

Comments: In one application PCC modules were used to control a water slide, cave, waterfall hot tub, cool tub, and all associated lighting up the side of a hill. The customer wanted to control all of these items from the house, the hot tub area, the bottom of the path, and the cave entrance. Control was provided to the small pumps and the large pump with a RB104. The lighting was controlled with RS101s and RD141s. Multiple transmitters were placed as needed in the desired locations. A desktop transmitter was used in the house to control lighting on the entire hill. The system was coupled with a CP000.

Type of Installation: RESIDENTIAL

Control Application: Domestic Water Well

Comments: A client situated on a 60-acre estate drilled a new well next to the stables that was 600 feet away from the main house. The customer was searching for an alternate method of control since he did not want to trench through lawn and landscaping to run wires to the house. The well site was chosen by the drilling contractor as an optimum location. Underground pipe already existed from the house to the stables and a 100 AMP service supplied from the main house a sub-panel located at the stables.

A TB134 was installed at the existing well pressure control switch located on the water storage tank in the main house. Connect blue and red, thus ON transmitted upon demand and OFF transmitted upon reaching preset pressure. The 240 VAC contact located at the stables operates via a 120 volt coil. An RB104 was selected to control the contact. Since the potential existed for water damage due to continual pump running, several safety precautions were taken.

1. A pressure switch was installed underground (below frost) to monitor line pressure. If pressure exceeds 100 PSI the remote 20 AMP double pole breaker is turned off.
2. After careful study of the pump run time, it was discovered the pump never runs longer than 4 minutes, 30 seconds. Thus, a maximum run timer was installed with OFF set at six minutes, a 33 percent greater time than normally required.

3. Relief valves were plumbed outside.
4. A power monitor relay was added to the line side of the pump contact in the event of a power failure in excess of 90 seconds. A zone is tripped on the security system notifying the central station of pump failures, which in turn contacts the homeowners.

Type of Installation: RESIDENTIAL

Control Application: Intelligent automatic garage door opener

Comments: This client requested a driveway vehicle sensor only activated by vehicles, not dogs or deer. A Preferred Technology Cartel that detects a metal mass moving was installed. Two outputs: one momentary upon vehicle detection, the other timed and only works at night (photocell controlled). A TB134 connects to momentary relay output. The first address sends a command to X-10 SC46 remote chimes to notify of vehicle presence. Chimes can be added anywhere throughout residence. A CP000 is coupling two legs. The second address of TB134 connects to timed/photo controlled relay. Upon activation it turns ON any light set to same address and OFF at preset time. Of course, lights can be turned ON at the receiver or by additional transceivers. The third address turns ON RR130 (split receptacle) for about 15 seconds then OFF again. The radio remote will only work during this window. This prevents passersby opening door. This outlet is also active when garage lights are ON to allow local use of door and exit use. Only RF unit of opener powered by this outlet. The fourth address operates RF transmitter. Sequence described: Homeowner's car enters driveway, Cartel senses vehicle, sounds chime, turns ON outside lights if dark, activates garage door opener outlet, and the fourth activates an RB104 that trips the RF-transmitter. The signal is received by the homeowner's equipped car, and a RF transmitter signal is sent back to the door from the car and the door opens just for this car.

Type of Installation: RESIDENTIAL

Control Application: Ceiling Fans

Comments: An existing porch with two pull chain lights and no access above was remodeled into a sun room and client wanted ceiling fan with lights and a switch by the door. Fortunately, the Murray Feiss fans had a large bonnet that allowed installation of both an RD110 (fixture dimmer) and RF100; RD110 for lights and RF100 for fan. The exterior porch light was also fitted with an RD110, and in place of the old wall switches a TB100 and a TK050 was installed. Now the old porch light switch location controls fans, lights, and porch lights.

Type of Installation: RESIDENTIAL

Control Application: Control lights of detached garage from house

Comments: An extremely typical scenario across the country is a residence with detached garage, which are usually added on later. In this situation there is, however, a 60 amp sub panel in the garage. The four light switches were retrofitted with RS101's. A TB100 with TK040 was installed in the house for remote operation. A CP000 was installed to ensure operation. A diesel-operated commercial vehicle stored in this garage required the fuel heater to be plugged in during cold weather as required. The outlet was retrofitted with an RR120. Now the owner can turn the heater ON and OFF from the house.

Type of Installation: RESIDENTIAL

Control Application: Garden pond

Comments: Client has a garden pond with an UV sterilizer unit, two pumps, sand filters, two valves, and a light. Since the client travels frequently, the pond needed to be automated to ensure water quality. Since all above items were plugged into a multi-outlet strip, four RR130's and 1 RR120 were installed. Local control was via a TD100. Later, an automatic water level was added by inserting a solenoid valve into the existing water line and a float switch at pond level. A TB134 was connected to a float switch and an RS101 at the solenoid valve in the basement for local control and visual indication.

Type of Installation: RESIDENTIAL

Control Application: Remodel of home

Comments: This was an early 1900's home that was remodeled. Throughout the house there were old style push button marble maintained light switches. The owner said the switches had to be kept in place to do the job. TB134's were used on the maintain light switches for manual operation that sent signals to RB104's (fixture relays) that were in 6000 series wire mold down in the basement of the house. Four Unity panels controlled the system. With all of the new lights that were installed, RD140's (dimmer switch) were used on the inside and outside lighting. Also used on the job were RS101's and RR130's. Coupling was done with one CR134. CP020 was used with a CP010 to a CA000 to get to the distribution that feeds the one guest house, pool house and equipment for the pool. A pair of wires was run back from that distribution to the Unity system for two-way communication. The Unity panels were filtered to eliminate a looping effect and the signals could be used for logic statements. Also on this job were TB100's and one JDS telephone override with two Panasonic pocket telephones, one for the gardener to turn ON and OFF the sprinkler system in the area he was working in and the other for general convenience in the house.