The Pennsylvania Department of Transportation recently completed a Traffic Signal Enhancement Project known as SR 0051, Section A56. The project, in (PennDOT) District 11, Southwestern Pennsylvania within Allegheny County on State Route 51, included a total of 22 intersections along S.R. 0051 from Peter’s Creek Road in Jefferson Hills Borough ending with Greenlee Avenue in Brentwood Borough. The systems transversed through 6 municipalities and included three existing closed loop systems and one existing Time Base System. The Time Base System was replaced with a closed loop Spread Spectrum system while other communication improvements were made to the fiber optic systems. This project was presented at the 2006 Annual Transportation Engineering and Safety Conference on December 8, 2006 as part of a session titled Traffic Signal Operations and Maintenance and is an example of interagency and multi-municipal cooperation to facilitate the movement of traffic through a congested corridor.

The primary purpose of the project was to decrease travel time by providing more efficient local and system timings, new reliable equipment and better visibility of signal indications by installing Light Emitting Diode (LED) signals. Increased efficiency was accomplished by installing 75 new Type 170 local and four Type 170 master controllers including related local and master software, reusing seven almost new Type 170 controllers, utilizing two existing fiber optic systems, integrating an existing fiber optic system with supplemental spread spectrum radio transmission to a stand alone intersection and installing one new spread spectrum system. A “closed loop” system is one in which the local controllers respond to a central master controller through some form of interconnection.

In Pennsylvania, the local municipalities own, operate and maintain signalized installations and systems, while PENNDOT issues traffic signal permits defining the signal construction and operational standards including phasing and timings. Municipal adherence to those traffic signal permits provides for a continually functional system. In an effort to improve travel through the corridor, the Pennsylvania Department of Transportation provided 100% funding for the $513,000 project, with the agreement that the municipalities would own and maintain the completed system. By using best practice construction methods and valuable suggestions by the contractor the project was completed at 11% under the original construction estimate.

LED Indication Replacement
Historically, early LED signals were only available in red and were relatively inexpensive compared to green and yellow. We have all seen them in our computers, stereo equipment and automobiles. They use very little power and seem to last forever, often longer than the device in which they are installed. LED indications are available in all standard signal colors – red, yellow, green, orange and white. Although LED indications seem brighter, they provide the same lumens (measure of light) as incandescent indications. LED signals were easy to spot because of the “light-faint” appearance because hundreds combined to make one indication. Now they can be made behind diffuser lenses and may have very few LEDs. All indications at each intersection for this project.

Continued on page 49
IMSA Journal
excluding the pedestrian “hand-man” indications, are the LED type.

Standard traffic signal incandescent bulbs consume 135-150 watts of power, while LED type only use 8-10 watts. Pedestrian signals use about 70 watts for incandescent bulbs while LEDs use about 7 watts. There are usually 10 vehicular signals and 8 pedestrian signals at each intersection. An average standard incandescent lighted intersection uses about 2060 watts of power or $175 monthly, $2,100 annually. Remarkably, an LED lighted intersection uses 164 watts of power or less. Together with service fees and controller energy costs the average monthly bill is about $23 or $276 annually.

Power savings per intersection can average $1,824 monthly or $20,228 annually for all 22. Environmentally the power savings means that the energy can be used elsewhere in the grid, or not produced at all.

Those tiny LED indications that seem to last forever in your electronic devices are expected to have the similar longevity in signal indications. Signal indication maintenance costs are a huge factor in the operation of an intersection along with energy costs. The average life of an incandescent signal bulb is based on hours of use with an average life span of 6,000 – 8,000 hours or on average 8 months, depending on signal phasing and length of time the signal is illuminated. A single bulb which must be replaced can cost about $100. Why $100 when a bulb only costs $4? A service call means someone has to drive the expensive bucket truck to the intersection, set up MPL, replace the bulb and return to the shop.

On this project there are 22 intersections with an average of 18 signals (vehicular and pedestrian indications) with 2 indications each (yellow hardly ever burns out) or 36 indications that must be replaced biannually. Thirty-six indications times 1.5 replacements times $100 each equals $5,400 per intersection. Multiply $5,400 by 22 intersections and that equals $118,800 annually for the whole project length. Again, remarkably, LED indications last on average five years therefore maintenance is negligible for the first five years. They are guaranteed to last five years too, so if one burns out within five years you get another one. Unfortunately, the installed price for LED indications, right now cost about $100 for the red and $200 for the green and yellow but prices are falling fast. But this is about the same price as installed incandescent signals and, bought in bulk and the cost can be below $50 for each.

So the total five year signal savings of incandescent vs. LED for all 22 intersections is $794,640. (Energy savings LED vs. Incandescent = $40,128 annually, Maintenance LED vs. Incandescent = $118,800 annually = $158,928 annually X 5 years = $794,640)

Surprisingly, it’s the one on the left. That’s because taped-up burlap or plastic bags can easily come off in bad weather, requiring someone to go out and recover the signal. That means wasted time, added cost, and a possible liability to your company or municipality. Plus, if you want to test the signal, a technician has to go up and remove the make-shift covering. More time wasted. More money spent. Fortunately, there’s a better way.

That better way is the signal cover on the right from Jacket-Tech. It’s durable, reusable, easy to install, and it stays on securely until you take it off. You can even test the signal from the ground without removing the cover.

Available in a wide range of signal or sign configurations, Jacket-Tech covers save you time, save you money and give your project a smart, professional look. To order, visit www.jacket-tech.com or call 574-217-4109. You’ll probably save a bundle on duct tape, too.

Which covering costs more?
Controller Replacement
Currently, controller maintenance is only a significant problem at about six of the older signals in two municipalities. One of the oldest had been modified several times with enlarged cabinets and accessories added onto the main cabinet to provide emergency preemption and split phasing. One old controller was so old the red LED timing indications on the controller face could not be seen during the daytime without shading the controller. The contractors maintaining these installations reported repeated failures of equipment for various reasons including poor electrical grounding, memory chip malfunctions, and numerous age-related problems. Service and dependability caused numerous call outs at the worst times of day.

Fifteen local controllers were replaced out of 22 and all have new grounding, lightning arrestors and electrical services. Grounding is important because errant charges of electricity can literally “burn” components together. Since the new grounding was installed only one failure was reported due to lightning actually striking a roadway detector wire and entering the amplifiers “through the back door” on an unprotected circuit.

Interconnection and Master Controllers
In our systems, the master controllers keep all of the local controllers under supervision and “in-step” by transmitting the correct time of day operation. Without this supervision the intersections would initially provide for a great coordinated system because all would have the exact time of day while as each time of day drifted each local controller would function independently. Efficient travel progression is dependent on the exact time of day, directional determination of the volumes of traffic, cross traffic, left turn traffic or even the absence of traffic. Before our project, mainline traffic around shopping centers flowed very well in the morning and turned progressively worse throughout the day. Progressive travel flow through all of the intersections was random and two or more signals green depended on chance and volumes on competing movements. The new coordination timings through five municipalities are joined together as four interdependent systems creating improved traffic flow on S.R. 0051.
The preliminary study revealed no master controller existed for 5 local controllers meaning they were running “free”, non-interconnected and uncoordinated; one master controller experienced frequent failures; two master controllers were new which would not be replaced. This meant that two of the four master controllers on this project were replaced. In addition, all master controllers were equipped with RTC GPS clocks which receive a signal from satellites to ensure proper time of day operation.

Existing fiber optic cable interconnection existed at three of the four systems while the remaining system used Time Base Coordination. It was replaced with Spread Spectrum Radio interconnect. All fiber optic connections were examined and repaired if necessary to ensure proper functionality. One of the fiber optic systems joined an independent intersection with a Spread Spectrum Radio. All of the master and local controllers can be accessed through the PC at the District Traffic Engineering Unit headquarters or at the Traffic Control Products office in Willoughby, Ohio.

**Overhead Signage**

All overhead signage was replaced with Type IX high intensity sheeting. Studies have shown that headlights are more directed at the road and less ambient light is striking these signs, which means they can’t be seen. In addition a 50 year-old motorist needs 50% more light than younger motorists to see at the same level. These signs will reflect more light and provide for safer movement of traffic. On this project at least one dozen overhead signs were missing and were replaced as part of this project.

**Other Improvements**

Some benefits of this upgrade cannot be measured in dollars and cents except by the safety of motorists being able to be directed properly. These are the pedestrian pushbuttons, Hand-Man indications and signs. All pedestrian pushbuttons and signs were replaced with ADA type buttons to ensure that all pedestrians can safely cross the road. The new LED long life indications provide an indication displaying Man (Walk) and (Hand) Don’t Walk. Most municipalities do not frequently replace the Don’t Walk indications since they burn out so frequently and they don’t want to spend the money. The safety of the pedestrians who now use the facilities cannot be measured in dollars and cents.

**Continued Observations**

Shortly after the project concluded field observations of the traffic signal corridor timings produced by Synchro Software analysis were revised to produce better traffic flow, and still continue today. The URS Corporation was also further contracted to perform a Before/After Speed and Delay Study. The Speed and Delay Study consisted of conducting travel time runs in both directions during the AM and PM peak hours utilizing the Average Vehicle Method – Average car Technique in accordance with the Institute of Transportation Engineer’s publication, Manual of Transportation Engineering Studies.

The “After” travel time runs indicate:
- Reduced the Southbound AM peak hour delay by 20.8% with a 33.3% reduction in the number of stops.
- Reduced the Southbound PM peak hour delay by 5.9% with no change in the number of stops.
- Reduced the Northbound AM peak hour delay by 7.1% with no change in the number of stops.
- Reduced the Northbound PM peak hour delay by 8.4% with a 30% reduction in the number of stops.

These “After” travel time runs indicate that during the heavier directional peak hours (AM northbound and PM southbound from the City of Pittsburgh) that
the delay was reduced by an average of 6.5% and in the off-peak direction (PM northbound and AM southbound from the City of Pittsburgh) that delay was reduced by an average of 12%.

Conclusions
The project’s economic savings are clear with the cost being paid back by the benefits in less than five years. With energy costs rising the payback could be sooner. The public is enjoying the benefits of improved travel times as can be seen by compliments from the municipalities involved as well as motorists using the corridor. The savings in electric energy alone is truly amazing.

My personal observations for the continued success of this project and others in the future would be assured by pursuing the following recommendations:

1. Traffic Signal Systems Coordinator positions must be created whose sole responsibility would be the monitoring of the corridor systems in the transportation region. The Coordinator(s) would have the authority to make timing changes, to ensure that the system is being maintained by ordering repairs, recommending equipment types and operation software, approving qualified maintenance contractors, evaluating their services and enforcing maintenance agreements.

2. Municipalities must band together to form a regional or corridor approach to the coordination of signal systems by mutual maintenance and procurement agreements. In Western Pennsylvania progressive transportation groups are proposing such programs to share resources, expertise and utilize the economics of scale. Municipal agreements that would not only cross municipal boundaries but State transportation districts as well are being proposed.

3. A financial incentive is needed to continue the operation and maintenance of the signal installations and systems. In Pennsylvania municipalities own, operate and are expected to maintain the signals without regard to financial ability or land use. A state subsidy, which would be accountable, to maintain the systems would insure the continued optimum operation.

4. Public and private efforts would be greatly served by having a state or regional “champion” to insure these transportation initiatives succeed. Without this “champion” to coordinate these efforts all of the proposals are fragmented.

This corridor improvement project is an example of what can be accomplished when municipalities cooperate. This is not the only cross municipal system operating in the area but it is the first one with so many municipalities with such a varied corridor land use. At this time PENNDOT has Traffic Signal Maintenance Agreements with each individual municipality but no inter agency agreement. This is clearly needed because as leadership changes so do priorities. The movement of traffic and cooperation may be important today but not tomorrow.

John J. Rudik is currently retired from the Pennsylvania Department of Transportation but still remains a member of the IMSA and retains his IMSA certification. When Mr. Rudik retired he was one of the senior most traffic signal designers in the Department with over 35 years of experience. Publications include “Cooperation and Compromise Yields Award Winning Streetscape Project,” IMSA September-October 2003, and “The Installation and Use of Spread Spectrum Radio in Dormont and Turtle Creek Boroughs, Pennsylvania,” IMSA March-April 2002. John is credited with designing Pennsylvania’s first traffic signal interconnect systems using fiber optic cable in 1989 and Spread Spectrum Radio in 1998. Photography credits include cover and article photos for both publications as well as those in local and national publications.
From discussions with traffic technicians regarding vermin they find in traffic controllers, they tell me snakes and mice are common. But few of us have seen them up close. Here is a photo of a snake in a controller. The best part about this snake is that it is positioned exactly like a wire with even color coded stripping to look like a wire. It makes one think twice about moving wires around without a stick first.

When this photo was given to me the technician said: 1. What is different with the wiring in this controller? and 2. find the snake! It was difficult to find it even when I knew it was there and could see it.

Submitted by: John Rudiak

This sign used to “nudge” pedestrians across the street. That’s why we do Traffic Signal Inspection before turn-on. Photo was taken in St. Joseph, MO.

Submitted by: Dan Fuchs,
Intelligent Transportation Systems Manager
Brown Traffic Products, Inc.

This is the worst stop I have ever seen.

Submitted by Joanne Conrad,
TAPCO
Digital Division Manager

This what happens when a city grows too fast. This will make signal tech. happy!

Submitted by: Rob Prisbrey
City of North Las Vegas, Signs and Markings Technicians