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# Forensic Engineering Analysis at a Traffic Signal: Who Had the Green Light?

by Robert T. Hintersteiner, P.E. (NAFE 327F)

Forensic Engineering Evaluation and Analysis is an essential tool in resolving the facts in a traffic accident. A Forensic/Traffic Engineer is typically retained months or years after the event. Often, the parties involved in an accident at a traffic signal make conflicting statements as to which party had the Green Light. This paper presents a methodology for the analysis and evaluation of an intersection regarding the operations of the Traffic Signal by a Forensic/Traffic Engineer so that an opinion can be rendered to an attorney, and form the basis for the Forensic/Traffic Engineer's testimony should the matter go to trial.

A Forensic Engineering evaluation and analysis can determine who had the right of way by establishing who had the Green Light, who had the Red Light, or if there were simultaneous Green Lights. This is done by analyzing and evaluating items such as:

1. Statements and depositions of all parties and eyewitnesses;
2. Day of the week and time of day;
3. Traffic signal malfunction records;
4. Maintenance repair records;
5. Vehicular speed;
6. Intersection geometry;
7. Signal phasing and phasing sequence;
8. Phase timings – fixed and/or actuated;
9. Phase Timing Intervals – initial green time, vehicle maximum green time, vehicle extensions, vehicle change interval-yellow light, vehicle clearance interval-all red, and pedestrian intervals-WALK/DONT WALK;
10. Cycle length – total timings for each Green, Yellow, and Red, during each Phase;

11. Signal Progression – free operations, coordination and/or computer operation; and,
12. Type and length of the detection area.

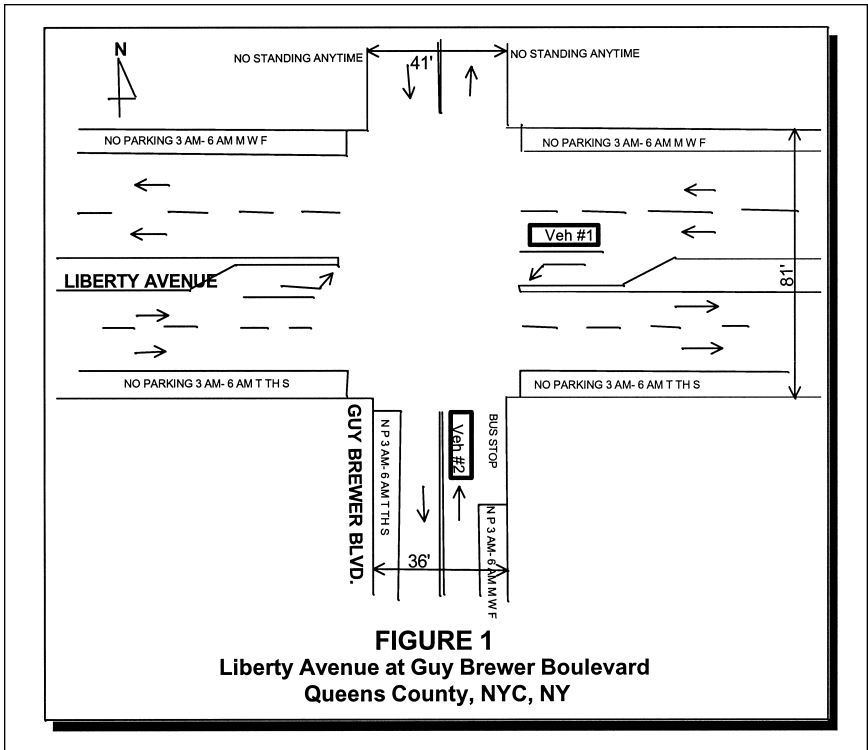
The following Case Studies illustrated the above parameters and how they are best presented to an attorney, judge, and jury. Case #1 involved determining who had the right of way when all the signal lights were out. Case #2 involved determining who had the right of way when one vehicle made a left turn in front of an opposing vehicle. Case #3 involved determining who had the right of way at a Pedestrian crossing without Pedestrian Signals. Case #4 involved determining who had the right of way when everyone had a Green light.

### **CASE #1 [All Signal Lights Were Out]**

This case concerned a two vehicle accident that occurred when the traffic signal was in an all out condition, at the intersection of Liberty Avenue and Guy R. Brewer Boulevard, Jamaica, Queens County, NYC, NY. The question for the Forensic Engineer was to determine who would have had the Green Light? A condition diagram (Figure 1) was produced from an investigation of the intersection:

The Police Accident Investigation Report stated that the subject accident occurred Wednesday, February 23, 2000, at 5:30 AM, at dawn. A review of the Farmer's Almanac for 02/03/00 showed that Sunrise was at 6:39 AM. Therefore, the subject accident occurred while it was still night. The Police Accident Report also stated that Mr. F's vehicle (Vehicle #1) was traveling westbound on Liberty Avenue, and that Mr. R's vehicle (Vehicle #2) was traveling northbound on Guy Brewer Boulevard (see Figure 1).

An analysis and evaluation of the Electrical Contractor's Maintenance Work Sheets showed that the subject intersection controller had undergone three repairs of the same type during an eleven day period. The traffic signal was Out Of Time [coordination not working] at 6:18 PM on February 22, 2000, and it was repaired by replacing the Timing Dial (M-30), which was completed by 2:20 AM on February 23, 2000. During the following two and one half hours the traffic controller failed again, and it was reported as All Out at 5:00 AM on February 23, 2000 by a passing transit bus driver. An "All Out" condition means that the controller did not have any power and that a fuse in the controller cabinet had to be replaced. A second report was made at 8:59 AM by a citizen. Repairs were made and completed by 9:55 AM. However, the type of work done, which took 15 minutes, was not stated on the Work Sheet. This controller failed some time again during the next eleven days, which was reported on March 3, 2000, at 5:19 AM. The repairs done on the controller took 30 minutes and the maintenance person relocated the pinion gear on the switching motor



and replaced the fiber gear on the Timing Dial, which was No Good. Note that the same fiber gear (a part within the Timing Dial) was replaced just days before on February 23, 2000. In addition, the fuse blew soon after the original repairs were completed on February 23, 2000 at 2:20 AM.

The Electrical Contractor, per its own Work Sheets, was under contract to respond within two hours of notification for the above type of problems. However, the first call on 2/22/00 took 7 1/2 hours for a response, the second call on 2/23/00 took over 4 1/2 hours for a response, and the third call on 3/3/00 took over 2 3/4 hours for a response. If the Electrical Contractor had responded to the first call within the 2 hour period, and had repaired the Controller properly, then the subject accident would not have occurred.

The question remained, who would have had the Green Light? Liberty Avenue was the major arterial roadway, with traffic signals located at every intersection, which were closely spaced. Therefore, the traffic signal indications could be seen from the preceding intersection. These traffic signals were under a progressive traffic pattern, as noted in the repair orders. The Guy Brewer Boulevard traffic signal could not be seen from the preceding intersection.

Mr. F (Vehicle #1) [Defendant] stated that he was traveling with the Green Lights along Liberty Avenue. This case was settled after my report was issued to the Defendant's Attorney.

### **CASE #2 [Left Turning Vehicle]**

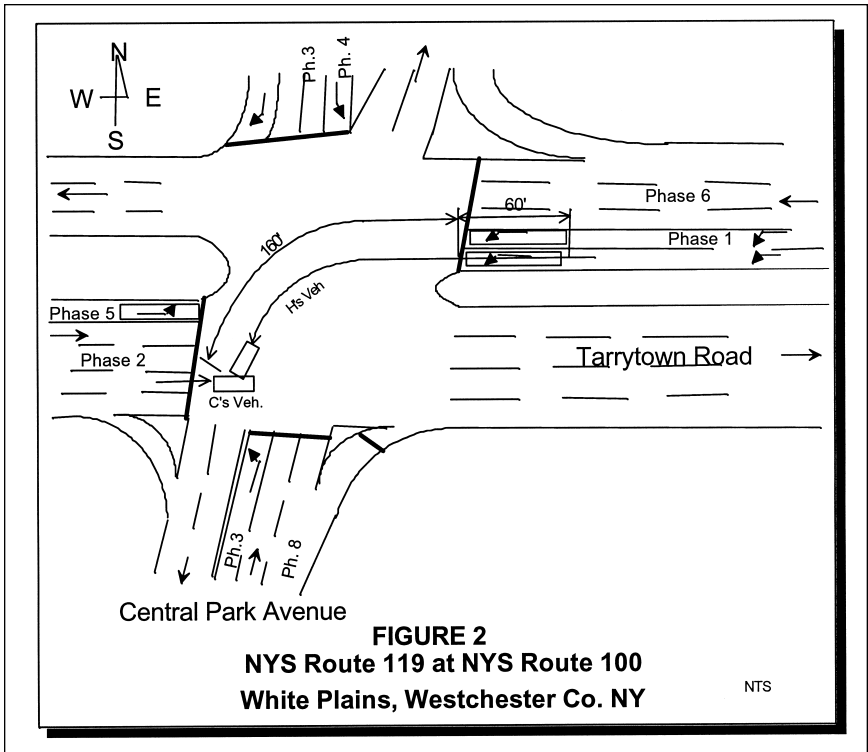
This case concerns two vehicles colliding at the intersection of Tarrytown Road and Central Avenue, in the City of White Plains, County of Westchester County, New York. The question for the Forensic Engineer was to determine who had the Green Light? A condition diagram (Figure 2) was produced from an investigation of the intersection.

Tarrytown Road (NYS Route 119) was an east west roadway with three lanes westbound and four lanes eastbound. Westbound Tarrytown Road had double left turning lanes to southbound Central Park Avenue. The left turning lanes were controlled by two protective left Green Arrows, followed by two Yellow Arrows, and then by two Red Arrow indications over the left turning lanes. Eastbound Tarrytown Road had a single left turning lane to northbound Central Park Avenue (County Center Drive). The left turn lane was controlled by a single protective left Green, Yellow, and Red Arrow indications.

Northbound Central Avenue (NYS Route 100) had two thru lanes, with a left turn lane and a right turn lane. Southbound Central Park Avenue had two thru lanes, with a left turn lane and a right turn lane.

The westbound Tarrytown Road double left turning lanes had presence detectors located within each of the left turning lanes that extended 60 feet back from the Stop Line. Presence Detection only detects a vehicle when it is directly over the detector, and when a vehicle leaves the detection area the controller is told to go into the clearance interval and to proceed to the next phase. If another vehicle enters the detection area before the preceding vehicle has cleared the detection area, then the Green Arrow Light is extended to accommodate that vehicle. Eastbound Tarrytown Road got a Green Ball Light only when the westbound left turn phase had completed timing its Green, Yellow, and All Red intervals.

The controller that operated the intersection of Tarrytown Road at Central Park Avenue had eight phase modules that controlled the timing and signal indications. They were as follows (see Figure 2):



1. Phase 1 – Westbound Tarrytown Road protected double left turning lanes.
2. Phase 2 – Eastbound Tarrytown Road thru lanes.
3. Phase 5 – Eastbound Tarrytown Road protected left turn lane.
4. Phase 6 – Westbound Tarrytown Road thru lanes.
5. Phase 3 – Northbound Central Park Avenue protected/permitted left turn lane.
6. Phase 4 – Southbound Central Park Avenue thru and right turn lanes.
7. Phase 7 – Southbound Central Park Avenue protected/permitted left turn lane.
8. Phase 8 – Northbound Central Park Avenue thru and right turn lanes.

The traffic controller has the following operations:

1. Phases 1 and 2 could not be Green at the same time. If Phases 1 and 2 were on at the same time, the traffic controller would place all the traffic signal lights at this intersection on Emergency Flashing Operation.
2. Protected left turns occur only when there are no conflicting vehicle and pedestrian traffic.
3. Permitted left turns occur when there are conflicting vehicle and pedestrian traffic and the left turning vehicles have to yield the right of way.
4. Protected/Permitted left turns occur when turning traffic proceeds during a Green Arrow indication followed by a Green Ball indication.

An investigation of the subject accident revealed that Ms. C [Plaintiff] stated in her police accident report that she was traveling eastbound on Tarrytown Road, and that she was stopped at the light, and then proceeded straight thru the intersection in the second lane from the right curb, on the Green Light.

Ms. H [Defendant] stated in the police report that she was traveling westbound on Tarrytown Road, making a left turn with a Green Light from one of the double left turning lanes. Ms. H further stated in her deposition that she had a Green Arrow and had put on her left turn signal, and that she was about three to four car lengths from the intersection. With an average car length of 20 feet, she would have been between 60 to 80 feet from the Stop Line, and her speed was between 5 to 10 MPH.

To determine who had the right of way, an evaluation of timings for each phase was taken from the traffic signal timing sheets. Phase 1, Minimum Green Arrow interval, was 5 seconds, that is 5 seconds for the start of the Westbound Green Left Turn Phase. After the Initial Green time, the Green would keep extending an additional 1 second as long as a vehicle was located within the detection area, up to a maximum Green interval of 12 seconds. Upon loss of vehicle detection or upon reaching the Maximum Green interval, the signal would immediately change to a Yellow Arrow Change Interval of 3 seconds, followed by an All Red Clearance Interval of 2 Seconds, for a total of 5 seconds. Phase 2, eastbound Green Ball indications, would start immediately after the All Red Clearance Interval from Phase 1.

The Detection Area was located within the westbound double left turning lanes and it extended 60 feet east from the Stop Line. The path Ms. H traveled from the Stop Line to the Point of Impact was approximately 160 feet (see Figure 2). The total distance that Ms. H had to travel was approximately 220 feet

Ms. H's Speed	ft per sec	60 feet	160 feet	220 feet
5 MPH	7.35	8.16	21.77	29.93
10 MPH	14.70	4.08	10.88	14.96
15 MPH	22.05	2.72	7.26	9.98

from the start of the Detection Area to the Point of Impact, and Table 1 shows the time it would have taken Ms. H to transverse the left turn at various speeds.

The following two scenarios illustrate Ms. H's actions as she was making the left turn in relationship to the Left Turning Signal Indications:

1. If Ms. H entered the Detection Area during the initial Green Interval of 5 seconds, then she would have had 10 seconds to clear the intersection [5 seconds of Green and 5 seconds of Vehicle Clearance Intervals].
  - a. At 5 MPH and after passing the Stop Line, she would have had 2 seconds of Green Arrow Indication plus 5 seconds of vehicle clearance time, which was less than the 22 seconds of time required to clear the intersection.
  - b. At 10 MPH and after passing the Stop Line, she would have had 1 second of Green Arrow Indication plus 5 seconds of vehicle clearance time, which was less than the 11 seconds of time required to clear the intersection.
  - c. At 15 MPH and after passing the Stop Line, she would have had 2 seconds of Green Arrow Indication plus 5 seconds of vehicle clearance time, which would have been the time required to clear the intersection

**Therefore, Ms. H was traveling too slowly to safely clear the intersection during the Clearance and Change Intervals.**

2. If Ms. H did not enter the detection area during the first 5 seconds of Initial Green Arrow time then she would have had 5 seconds to clear the entire intersection.
  - a. At 5 MPH she would have taken 30 seconds to clear the intersection from the start of the Detection Area.
  - b. At 10 MPH she would have taken 15 seconds to clear the intersection from the start of the Detection Area.



- c. At 15 MPH she would have taken 10 seconds to clear the intersection from the start of the Detection Area.
- d. At 5 MPH, while entering the Detection Area after the start of the Yellow Arrow Indication, she would have crossed the intersection against the Red Arrow Indication.
- e. At 10 MPH, while entering the Detection Area after the start of the Yellow Arrow Indication, she would have crossed the Stop Line 1 second after the Red Arrow Indication started, and she would have crossed the intersection against the Red Arrow Indication.
- f. At 15 MPH, after passing the Stop Line, she would have had 0.74 seconds of Yellow Arrow Indication plus 2 seconds of Red Arrow Indication, and she required an additional 4 to 5 seconds to clear the intersection.

**Therefore, Ms. H had to go through the Red Arrow Indication.**

Thus, Ms. H would have had to run the Red Arrow Lights, and this case was settled after my report was issued to the Plaintiff's Attorney.

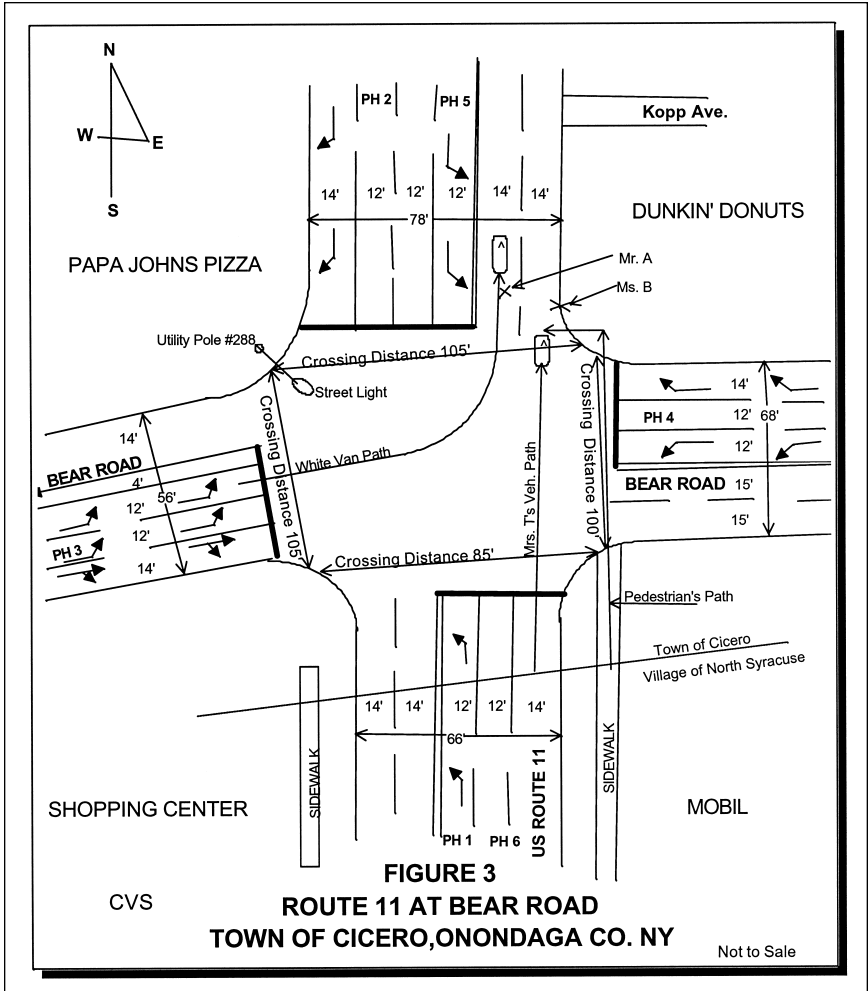
### **Case #3 [Pedestrian Crossing Without Pedestrian Signals]**

This case concerned two pedestrians crossing US Route 11 at Bear Road and being struck by two vehicles in the Town of Cicero, County of Onondaga, New York. The question for the Forensic Engineer was to determine did the pedestrian have a adequate time to cross the intersection? A condition diagram (Figure 3) was produced from a investigation of the intersection.

US Route 11 was a north south highway with two lanes northbound and two lanes southbound, and with left turning lanes. The pedestrian sidewalks were located in the Village of North Syracuse and extended to the Town of Cicero's town line.

Bear Road was an east west roadway with three lanes approaching Route 11 and two leaving. The intersection was located in the Town of Cicero (Figure 3). The east approach was 68 feet in width, and the west approach was 56 feet in width.

The traffic signal operation for the Route 11 thru movement (Phases 2 & 6) used Phase 6 for the northbound thru traffic and Phase 2 for the southbound thru traffic. The timings for these Phases had the Minimum Green Indication set for 15 seconds and the Maximum Green Indication set for 25 seconds, followed by 3.8 seconds of Yellow Indication and a 1.0 second All Red Indication. An All Red Indication means that all signals heads are Red before the opposing traffic gets a Green Indication.



The Bear Road east and west approaches operated separately, making this a split phase operation. The eastbound traffic from Bear Road operated under Phase 3, which had two lanes turning left and a single lane for thru and right turns. The left turn signal indication had an arrow signal indication, to inform motorists that the eastbound movement was protected from all opposing vehicular and pedestrian traffic. The timings for this Phase had a Minimum Green Indication set for 6 seconds with a Maximum Green Indication set for 30 seconds, followed by 3.5 seconds of Yellow Indication and a 1.0 second All Red Indication.

The westbound traffic from Bear Road operated under Phase 4, which had one lane for left turns, a thru lane, and a right turn lane. The signal indications

were ball indications except for the left turn arrow. The timings for this Phase had a Minimum Green Indication set for 6 seconds with a Maximum Green Indication set for 20 seconds, followed by 3.8 seconds of Yellow Indication and a 1.0 second All Red Indication.

There were no pedestrian signals, pedestrian push buttons, nor crosswalk lines located at the subject intersection to inform pedestrians where to cross and how much time they had to cross the intersection safely. Street lighting was located along the west side of Route 11 by the Village of North Syracuse, which included the intersection of Bear Road. There were no street lights located on US Route 11 north of Bear Road, and also on both approaches of Bear Road in the Town of Cicero. A review of the documents obtained from the NYS DOT revealed that numerous letters were received since 1991 regarding the unsafe pedestrian crossing conditions across Route 11. The NYS DOT's position was that they could not do anything to improve pedestrian safety until the law was changed. No pedestrian studies were conducted along Route 11.

An investigation of the subject accident revealed that it occurred at about 2:10 AM when Mr. A and Ms. B were walking north on the east side of Route 11 toward Bear Road after leaving a pub. They crossed Bear Road from the southeast corner to the northeast corner. When they started to cross Route 11 from the northeast corner to the northwest corner, they were struck by Ms. T's vehicle in the right lane (Figure 3).

The Dodge Durango that Ms. T was driving showed two points of impact, one on the left side and one on the right side of the front grill, indicating that Ms. T struck both pedestrians at the same time. Ms. B was propelled to the right along the curb on the east side of Route 11. Mr. A was propelled into the northbound left thru lane, where he was struck and dragged by a white van.

Ms. T stated that she had a Green Light when she approached the intersection and a vehicle made a left turn in front of her from the southbound lane to the eastbound lane on Bear Road before she arrived at the intersection. Mr. M, a third pedestrian, stated that he was following Mr. A and Ms. B, and as he was crossing Bear Road an eastbound white van made a left turn onto northbound Route 11, passing the accident site, and then the van struck and dragged Mr. A.

When the pedestrians crossed the east approach of Bear Road, they could see only a narrow side view of the two signal indications facing westbound Bear Road (Phase 4). These westbound traffic signals would only turn Green when a vehicle activated the vehicle detectors located within westbound Bear Road. When the pedestrians crossed the north approach of Route 11, they could see only a narrow side view of the three overhead traffic signal indications for

southbound traffic (Phases 2 & 5). These three traffic signals always showed a Green Indication until a vehicle was detected on Bear Road.

When a pedestrian crossed any of the approaches to the subject intersection he could observe only a side view of the signal heads controlling that approach. This did not tell a pedestrian when it was safe to cross, because the other approaches had continuous traffic movement across the unmarked crosswalk. When Route 11 had a Red Indication eastbound, Bear Road (Phase 3) had a Green Arrow Indication, indicating a vehicle on Bear Road had the right of way without conflicting with vehicles and pedestrians. In addition, there were two lanes turning left, and any pedestrian would be caught between two side by side left turning vehicles. When the westbound Bear Road (Phase 4) traffic had a Green Indication, the eastbound traffic was stopped. The length of the unmarked crosswalks are shown in Figure 3, and a pedestrian would require at least 26 seconds to cross the north approach (105 feet/4 fps). The Green Indication extended from a minimum of 6 seconds to a maximum of 20 seconds, causing a pedestrian to be stranded in the middle of Route 11 traffic. There were no Pedestrian Push Buttons or Pedestrian Signals provided to permit a pedestrian to safely cross Route 11 and Bear Road.

The New York State Department of Transportation 1983 Manual of Uniform Traffic Control Devices Part 273 Pedestrian Signals requires the following:

1. **Section 273.1 Purpose.**

*“Pedestrian signal indications are traffic signal indications intended for the exclusive purpose of controlling pedestrian traffic.”*

2. **Section 374.4 Justification (a) Mandatory warrants.**

*“Pedestrian indications shall be provided in conjunction with traffic control signals under any [of] the following conditions: (3) When, in the presence of sufficient pedestrian activity, vehicle indications are not visible to pedestrians, or are in a position which does not adequately serve pedestrians.”*

The traffic signal located on Route 11 at Bear Road did not provide a way for pedestrians to cross safely because there were no Pedestrian Signals. There were no pedestrian traffic studies conducted by the NYS DOT as to the pedestrian activity at the subject intersection. Traffic studies were conducted in 1994, which did not include a pedestrian crossing study. NYS DOT was aware of pedestrian crossing problems because of the numerous requests for the installation of pedestrian crossings along Route 11.

3. **Section 374.4 Justification (b) Permissive warrants.**

*“Pedestrian indications may be provided under any of the following conditions: (3) When multi-phase indications, as with split phasing timing, would tend to confuse pedestrians guided only by vehicular signal indications.”*

The subject intersection had a split phasing operation between Phase 3 and Phase 4 which would operate separately only when vehicles were detected. In addition, Phase 3 (eastbound Bear Road) had protected double left turning lanes during Green Arrow, Yellow Arrow, and Red Arrow Indications. This means that vehicles using the double left turning lanes had the right of way without other vehicle or pedestrian conflicts. The white van was going eastbound on Bear Road and made a left turn onto Route 11 when Mr. A was struck and dragged.

4. **Section 273.7 Operation. (c) Change interval.**

*“Following the walk interval, the change interval should provide pedestrians in the crosswalk with sufficient time to complete their crossing before conflicting vehicular traffic movements are released. Normal walking speed is approximately four feet per second.”*

The minimum crossing time for a pedestrian to cross the Route 11 north approach was 26.25 seconds (105 feet/4 fps). The Minimum Green time for westbound Bear Road (Phase 4 - current crossing movement) was 6 seconds with a Maximum of 20 seconds. There was no time for a pedestrian to cross this intersection safely. The time for the traffic controller to clear Route 11 and respond to a single vehicle detection on Bear Road and return to US Route 11 Green would have been 15.3 seconds (4.8 sec. for Route 11 Yellow & All Red + 6 sec. for Bear Road Green + 4.5 sec. for Bear Road Yellow and All Red Indications) which was less than the minimum time needed for a pedestrian to cross. A pedestrian would not have had enough time to cross Route 11 even if he started out at the beginning of the Bear Road Green Indication.

**New York State Vehicle and Traffic Law** requires the following:

1. **Section 110. Crosswalk**

*“a) That part of a roadway at an intersection including within the connections of the lateral lines of the sidewalks on opposite sides of the highway between the curbs or, in the absence of curbs between the edges of the traversable roadway.”*

Since the intersection of Route 11 at Bear Road had defacto crosswalks, the NYS DOT should have provided Pedestrian Push Buttons

and Pedestrian Indications to direct and provide the required timing to safely protect pedestrians crossing this extremely wide intersection.

2. **Section 1150. Pedestrians subject to traffic regulations**

*“Pedestrians shall be subject to traffic-control signals as provided in section eleven hundred eleven of this title, but at all other places pedestrians shall be accorded the privileges and shall be subject to the restrictions stated in this article.”*

3. **Section 1111. Traffic-control signal indications**

*“Unless otherwise directed by a pedestrian-control signal as provided in section eleven hundred twelve, pedestrians facing any steady green signal, except when the sole green signal is a turn arrow, may proceed across the roadway within any marked or unmarked crosswalk.”*

The NYS DOT did not provide any Green or Pedestrian Signal Indications at the unmarked crosswalk to inform pedestrians when it was safe to cross the roadway.

**Thus, I was able to show that the conditions that existed at the subject intersection caused pedestrians to walk against the traffic signal and into conflicting traffic when crossing any of the four approaches.**

**Case #4 [Defective Traffic Signal – Everybody Had A Green Light]**

This case concerns three vehicle involves in an accident on Braddock Avenue at Gettysburg Street and 92nd Avenue, Bellerose, Queens County, New York City, New York. The question for the Forensic Engineer was to determine who had the Green Light when every driver and witness stated that they had the Green Light?

All Traffic Lights consisted of 3 section 8 inch heads with Red, Yellow, and Green Indications. Northbound Gettysburg Street had two overhead signal heads. One head was in alignment with the northbound lane and one head was blocked by overhanging tree limbs on the left side of Gettysburg Street. Southbound Gettysburg Street had two overhead signal heads. Both signal heads were clearly visible without obstructions. Westbound Braddock Avenue had one overhead signal over the right lane and one post mounted signal located on the center island. Eastbound Braddock Avenue had one overhead signal over the right lane and one post mounted signal located on the center island.

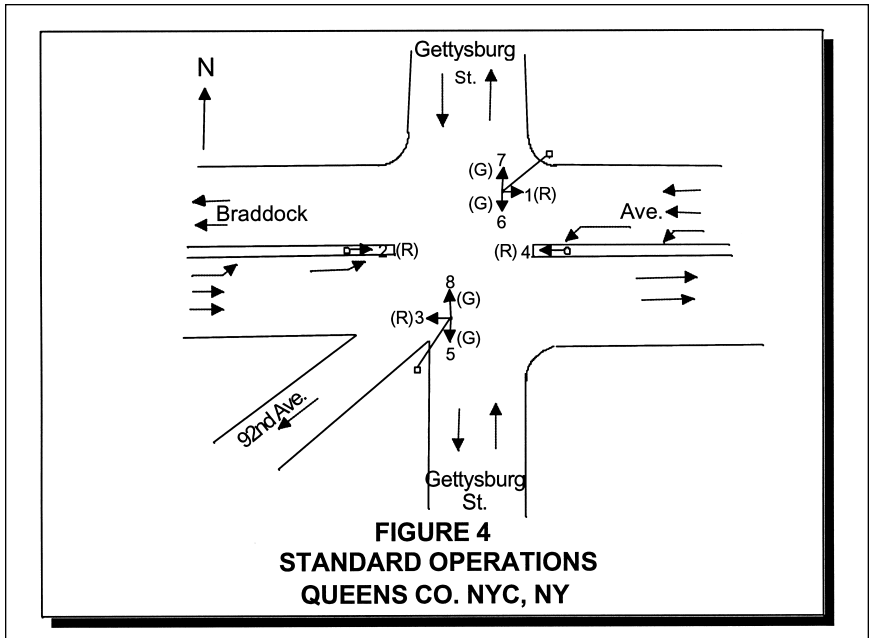
The traffic signal pole located on the Northeast Corner had a Mast Arm Pole with three signal heads: one signal head was facing southbound traffic; one signal head was facing northbound traffic; and one signal head was facing

westbound traffic. The traffic signal pole located on the Southwest Corner had a Mast Arm Pole with three signal heads: one signal head was facing southbound traffic; one signal head was facing northbound traffic; and one signal head was facing eastbound traffic. The traffic signal pole located on the east center island had a Pedestal Pole with one signal head located on the center island, with one signal head facing eastbound traffic. The traffic signal pole located on the west center island had a Pedestal Pole with one signal head located on the center island, with one signal head facing westbound traffic. Two Pedestrian Signal Heads were located on each of the following corners: the northwest corner, the northeast corner, the southeast corner, and the southwest corner. The traffic controller and power supply were on the Mast Arm Pole located on the northeast corner.

The Police Accident Report stated that the accident occurred at about 8:10 PM (Dusk). Mr. R stated the he was stopped in the westbound Braddock Avenue left turn lane, waiting to make a left turn at the Stop Light. **This indicates that Mr. R was facing two RED indications.** Mrs. E-A stated in her Deposition that she observed the traffic light was Green one block away traveling Northbound on Gettysburg Street, about 300 feet, and that the traffic light did not change. Ms. S-A (her daughter) stated in her Deposition that she saw one Green traffic signal, then looked away and looked back, and saw the same Green light. **This indicates that both Mrs E-A and Ms. S-A saw one GREEN indication as they approached and entered the intersection.** Mrs. E-A stated in her Deposition that Ms. M, a witness to the subject accident, said to her that she was following Mr. P and that she saw a Green light when Mrs. E-A came right out in front of Mr. P. **This indicates that Ms. M and Mr. P both saw two GREEN indications as they approached the intersection.** Mr. P stated in his Deposition that he was traveling Eastbound on Braddock Avenue, and he saw an overhead Green light at the intersection, and he did not remember seeing a traffic pole in the east center median. The Police Report stated that the Traffic Pole was damaged. Mr. P stated in his Deposition that Mr. W had said that there were problems with the traffic signal, including Greens in both directions, and near misses at this intersection prior to the subject accident.

Figure 4 shows the traffic signal indications under normal operations as depicted in the NYC DOT Bureau of Traffic Operations Signal Plan.

The NYC DOT Bureau of Traffic Operations provided the following Signal Timing information for the date of the subject accident (10/11/93). As of January 12, 1994, the NYC DOT indicated that Braddock Avenue had a Green - 32.4 sec., Yellow - 2.4 sec., & All Red -1.2 sec. = 36 seconds, and that Gettysburg Street had a Green - 20.4 sec., Yellow - 2.4 sec., & All Red - 1.2 sec. = 24 seconds, for a total cycle length of 60 seconds. However, on a second



request made on May 21, 1996, the NYC DOT indicated that Braddock Avenue had - Green - 31.8 sec., Yellow - 3.0 sec., & All Red - 1.2 sec. = 36 seconds, and Gettysburg Street had Green - 19.8 sec., Yellow - 3.0 sec., & All Red - 1.2 sec. = 24 seconds, for a total cycle length of 60 seconds.

The Traffic Signal Plan showed that one 10 Conductor signal cable extended from the traffic controller on the northeast corner underground to the pole base located on the east center island, which was spliced to the signal head wires. This 10 Conductor cable was also spliced to the 10 Conductor cable which extended underground from the east center island to the base of the Mast Arm Pole located on the southwest corner, which was spliced to the signal head wires. Signal cables are color coded to aid in splicing and assigning signal indications and phasing. There was one 7 Conductor signal cable connected to all the pedestrian signal heads. The 7 Conductor wire was spliced to the pedestrian signal head wires at the base of each pole with pedestrian signals.

The Electrical Contractor's Maintenance Records were obtained from the NYC DOT Bureau of Traffic Operations, and they showed the following:

1. On 10/03/93 at 6:37 AM, the maintenance log showed that there was an "All Out - pole in east center island missing, insulated cable, and re-energized." Arrived at 7:10 AM and completed the work at 7:30



AM. The Contractor did not replace the pole, but only separated the wires and insulated the damaged wires. No mention was made of which wires were insulated. When the S-1 pole was hit, the wires were pulled out of the conduit. As the wires were pulled out of the conduit, the plastic covering or insulation was stripped off the wires by the sharp edge of the conduit. Black electrical tape was used to insulate each wire in the cable. The maintenance men stated that they checked only the signal indications they repaired or replaced to see that they were working properly, not the entire intersection. In addition, the fuse to the controller had to be replaced so that the traffic controller could be re-energized.

2. On 10/04/93 at 6:25 PM, the maintenance log showed that there were “3 lamps out: (1) Only one GREEN facing west on mast arm southwest corner facing west was out (east center island pole was missing). (2) RED lamp on southwest corner facing south on mast Arm. (3) RED lamp out on northeast corner facing north. Checked splices at east center island, they were OK.” This indicates that within 12 hours after the 10/03/93 repair, three critical lamps had burnt out, resulting in no GREEN indications facing eastbound traffic, and only one RED indication facing both northbound and southbound traffic.
3. On 10/10/93 at 11:50 AM, the maintenance log showed that there was an “S-1 pole down on east center island, repaired cable, straightened anchor bolts, installed S-1 pole and heads, made connection & focused.” As stated above, the east center island S-1 pole and signal indications were replaced about 6 days after the S-1 Pole was reported missing, or about 32 hours before the subject accident.
4. On 10/12/93 at 0:55 AM, the maintenance log showed that there was a “Lamp Out”. This indicated that if the RED lamp was burned out on the southwest corner mast arm facing south, this would have caused only one GREEN indication to be seen going northbound, as stated in Mrs. E-A and Ms. S-A’s Depositions. The RED lamp was replaced 4 to 5 hours after the subject accident. Mr. P stated in his Deposition that he saw two Yellow trucks working on the traffic signal between 12:00 to 1:30 AM on 10/12/93.
5. On 10/13/93 at 1:40 PM, the maintenance log showed that there was a “Post Missing - Replaced missing Post.” The post on the east center island was knocked down on 10/11/93 as a result of the subject accident. This pole was reinstalled 2 days (about 42 hours) after the subject accident.

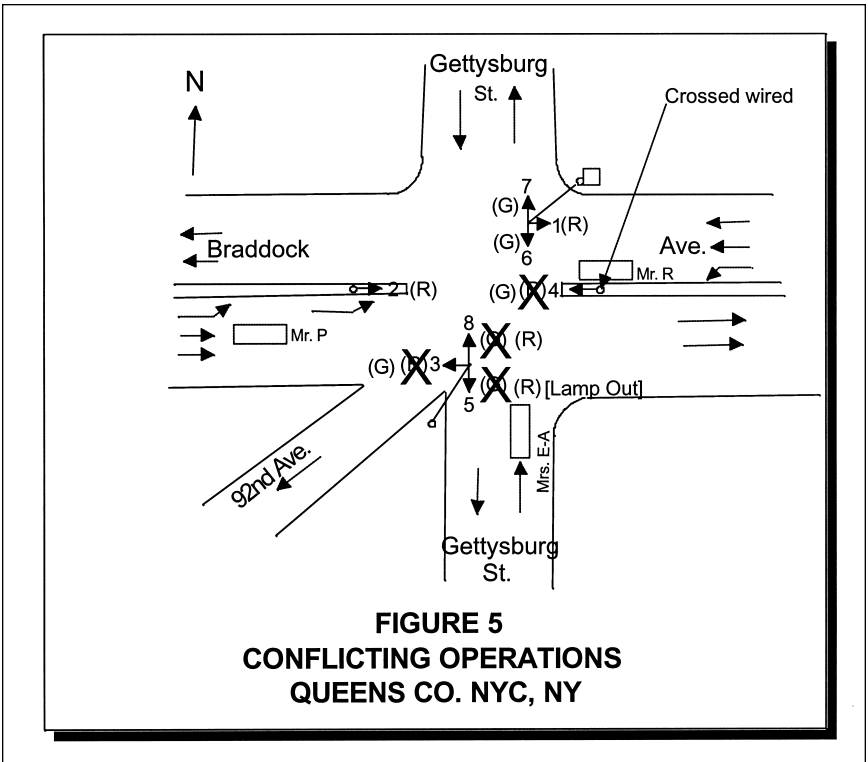
The question to be resolved was were all or some of the witnesses lying or were they all telling the truth? How could all the witnesses be right? After carefully analyzing the maintenance records I determined that the Contractor's maintenance personnel compounded the problems at the subject intersection. The key problem centered on the missing traffic pole which was assigned to the east center island, which was reported missing on 10/03/93. The maintenance crew repaired the signal wire between the controller to the east center island and the southwest corner mast arm. Splices were made at the east center island to connect the signal on the southwest corner mast arm pole. The connection to the signal cable were made in the base of the traffic pole on the east center island. However, at that point the wires were reversed, causing the following conflicting signal indications, which resulted in the subject accident:

1. Braddock Avenue Westbound – Two (2) **RED** Indications facing east.
2. Braddock Avenue Eastbound – Two (2) **Green** Indications facing west.
3. Gettysburg Street Southbound – One (1) **Green** Indication facing north on the northeast corner Mast Arm Pole. One (1) **Red** Indication facing north on the southwest corner Mast Arm Pole. (**Note: Conflicting Signal Indications**).
4. Gettysburg Street Northbound – One (1) **Green** Indication facing south on the northeast corner Mast Arm Pole. One (1) **Red** Indication (Lamp Out) facing south on the southwest corner Mast Arm Pole. (**Note: Conflicting Signal Indications**).

Figure 5 shows the traffic signal indications on the day of the subject accident, which were caused by conflicting signals as a result of improper splicing of the signal cable.

With the **RED** lamp out Ms. S-A stated that she only saw one **GREEN** Indication facing northbound traffic. Ms. M stated to Mrs. E-A that she was following a vehicle and they had a **GREEN** Light. Under the above stated scenario, conflicting **GREEN** Indications would have occurred.

**Thus, due to the insulating of the signal wires with black electrical tape, each individual wire looked the same as the others, without displaying the standard wire color coding to match the signal indications and phases. The Contractor switched the Braddock Avenue signal indications with the Gettysburg Street signal indications, resulting in the conflicting Greens as shown in Figure 5.**



**FIGURE 5  
CONFLICTING OPERATIONS  
QUEENS CO. NYC, NY**

The NYCDOT Bureau of Traffic Operations required its Electrical Contractor to comply with the Signal Maintenance Agreement contract document specifications, which stated the following:

1. **Section 8 TEMPORARY REPAIRS** (page II-11) “... the Contractor shall immediately provide a temporary installation satisfactory to the Commissioner and maintain same until it is replaced with permanent standard equipment. Permanent equipment shall replace temporary equipment within 24 hours.”

As explained above, the east center island S-1 pole and signal indications were replaced about 6 days after the S-1 Pole was reported missing, or about 32 hours before the subject accident.

2. **Specifications Division 2 - Details of Items, Section 2, Item 1. Foundations, Posts, and Sidewalk-Boxes** (page II-34) states that “The following classes of combined foundations and posts are to be maintained: 1B - Signal Post, Type S-1 Series.”

3. **Specifications Division 2 - Details of Items, Section 2 Item 9. Cable** (page II-40) states that *“The Contractor shall locate and correct trouble in all underground and above ground cable owned by the Department. The Contractor shall furnish all splicing and other standard materials and shall make all splices in conformance with best accepted practices. Cable shall be pulled into conduit in one length without splicing.*

*All conductor joints shall be made up using the Pigtail Joint or the Compression Type Splicer or the connector sleeve type splicer.*

*D. The (Polyethylene base) tape shall be wrapped with one-half over the conductor, connector or joint, insulation, and one and one-quarter (1-1/4”) inches back on the exposed insulation.*

*So far as practicable all splices in underground cables shall be made so as to occupy the center of the side wall of the manhole or pull box, but shall come between the hangers. No splice will be permitted in a duct or between rack and duct.”*

**The 10/03/93 work order stated that the damaged wires were re-insulated, which was not in accordance with acceptable industry practices. All exposed wire had to be removed or the entire cable had to be replaced. There was no acceptable industry standard for re-insulating stripped wires.**

When the S-1 pole was hit, the wires were pulled out of the conduit. As the wires were pulled out of the conduit, the plastic covering or insulation was stripped off the wires by the sharp edge of the conduit. The Electrical Contractor did not replace the pole, but only separated the wires and re-insulated the damaged wires with black electrical tape. No record was made of which wires was thus insulated.

One 10 Conductor cable came from the controller cabinet on the northeast corner, and the other 10 Conductor cable came from the mast arm pole on the southwest corner. The proper procedure was to replace both 10 Conductor cables. Therefore, since the wires had black tape around them, they all looked alike, resulting in the Braddock Avenue signal indications being switched with the Gettysburg Street signal indications, thus creating conflicting Greens.

This case was decided the Plaintiff, and the City of New York was found negligent. The Electrical Contractor who did not follow generally accepted industry standards was removed from liability in this case through a judgment of the court.

These four cases show that proper Forensic Engineering Evaluation and Analyses can determine who had the Green light. A careful analysis of all the intersection traffic signal data along with the evaluation of the statements of all parties and witnesses involved can determine who had the right-of-way. Each case is unique and all the data and facts must be carefully studied before a Forensic Engineering Evaluation and Analysis can be rendered.