

# TRAFFIC SIGNAL DESIGN

## Technical Design Manual #5



~~January 2014~~ Proposed January 2016

# TRAFFIC SIGNAL DESIGN CITY OF CHANDLER

## Table of Contents

<u>Section</u>	<u>Page</u>
Forward	
1.0 Developer's Checklist.....	1
2.0 Electrical Services.....	1
3.0 Plan Development.....	2
4.0 Signal Poles.....	3
5.0 Junction Boxes.....	4
6.0 Conduit and Conductors.....	5
6.1 Conduit.....	5
6.2 Conductors.....	5
6.3 Interconnect Requirements.....	5
6.4 Fiber Support Equipment.....	6
7.0 Controller and Cabinet.....	6
7.1 Controller.....	7
7.2 Cabinet.....	7
8.0 Detectors.....	7
8.1 Video Detection.....	7
8.2 Opticom.....	7
9.0 Signal Heads.....	7
9.1 Placement of Signal Heads.....	7
9.2 Signal Lamps.....	8
9.2.1 Vehicle Signs.....	8
9.2.2 Pedestrian Signals.....	8
10.0 Internally Illuminated Street Name Signs.....	8

TS-1	Deleted	
TS-2	Cover Sheet.....	9
TS-3	Plan Symbols.....	10
TS-4	Plan Symbols.....	11
TS-5	Plan View (Sheet 1).....	12
TS-6	Details and Schedules (Sheet 2).....	13
TS-7	Cabinet and Pole Schedule.....	14
TS-8	NEMA Phasing and Meter Pedestal.....	15
TS-9	Conductor Schedule.....	16
TS-10	<del>Cable Phasing and Color Code Schedule</del> Deleted.....	17
TS-11	Installation of I.M.S.A. Signal Cables.....	18
TS-12	Terminal <u>Block</u> Wiring Details <u>for Signals</u> .....	19
TS-13	<del>Typical Pole Layout</del> <u>Pole Placement for ADA Accessibility of Traffic Signal Push Buttons</u> .....	20
TS-14	Junction Box and Conduit Locations.....	21
TS-15	Deleted	
TS-16	Deleted	
TS-17	Deleted	
TS-17A	Signal Head Placement With Left Turn Phase	
TS-17B	Signal Head Placement Without Left Turn Phase	
TS-18	Internally Illuminated Signs.....	22
TS-19	Controller Foundation Conduit Layout Detail.....	23
TS-20	<del>Traffic Signal Sidewalk Extension Detail</del> .....	24 Deleted
TS-21	Autoscope Mounting For “J” or “K” Pole.....	254



## **FORWARD**

The purpose of this manual is to assist developers and their consultants in the planning and design of traffic signals within the city of Chandler's right of way. The guidelines contained within this manual are intended for use by professional engineers and designers with a background in the underlying fundamentals in Traffic Engineering. This manual does not provide the answers for all situations involving the design of traffic signals. It does, however, provide the tools for solving most of them. It is expected that those designing traffic signals within the City of Chandler bring to each project the skills and abilities to provide the optimum traffic control device to the public. This may include any new signal design concepts that result in a higher quality of traffic control and/or cost effectiveness. Deviations from these standards must be approved by the City of Chandler, City Transportation Engineer prior to submittal for review and approval.

This manual is divided into the following sections:

Developer's Checklist	Electrical Service
Plan Development	Signal Poles
Conduit & Conductors	Junction Boxes
Controller & Cabinet	Detectors
Internally Illuminated Street Name Signs	Signal Heads

Any questions regarding the signal design should be addressed to:

City Transportation Engineer  
City of Chandler  
215 East Buffalo Street  
Mail Stop 402  
P.O. Box 4008  
Chandler, Arizona 85224-4008  
Phone: (480) 782-3470

## **1 - DEVELOPER'S CHECKLIST**

A checklist has been developed to assist developers/consultants in the design of traffic signals in the City of Chandler. This checklist is not intended to be all inclusive, but a helpful guide in the design of traffic signals.

The following items should be researched for inclusion into the traffic signal design plans or in the development of the plans:

- Contact Blue Stake (602-263-1100) to determine existing utilities in the area.
- Survey the intersection for the development of a base plan. This survey should be performed after the intersection has been Blue Staked by the utility companies. In addition to the utilities, the survey should locate all existing roadway features within the intersection and 200 feet up each leg of the intersection. This includes face-of-curb, back-of-sidewalk, curb inlets, pavement markings, signs, walls and any landscaping that may affect the location of traffic signal equipment.
- Conduct a field visit of the intersection to verify the survey.
- Obtain maps from the utility companies and roadway as-builts from the City to supplement the survey.
- Contact the electric service company (Arizona Public Service (APS) or Salt River Project (SRP) to determine a power source location for the signal.
- Obtain existing and/or future right-of-way in the area and identify on the plans.

The developer/consultant should anticipate a minimum of two (2) submittals to the City prior to approval of the traffic signal. Upon approval of the signal, seven (7) sets of approved plans should be delivered to the City. These will be distributed as follows:

- 3 Sets - Development Services Plans Review Branch
- 2 Sets - Traffic Engineering Branch
- 1 Set - Signal Maintenance Shop
- 1 Set - Inspection

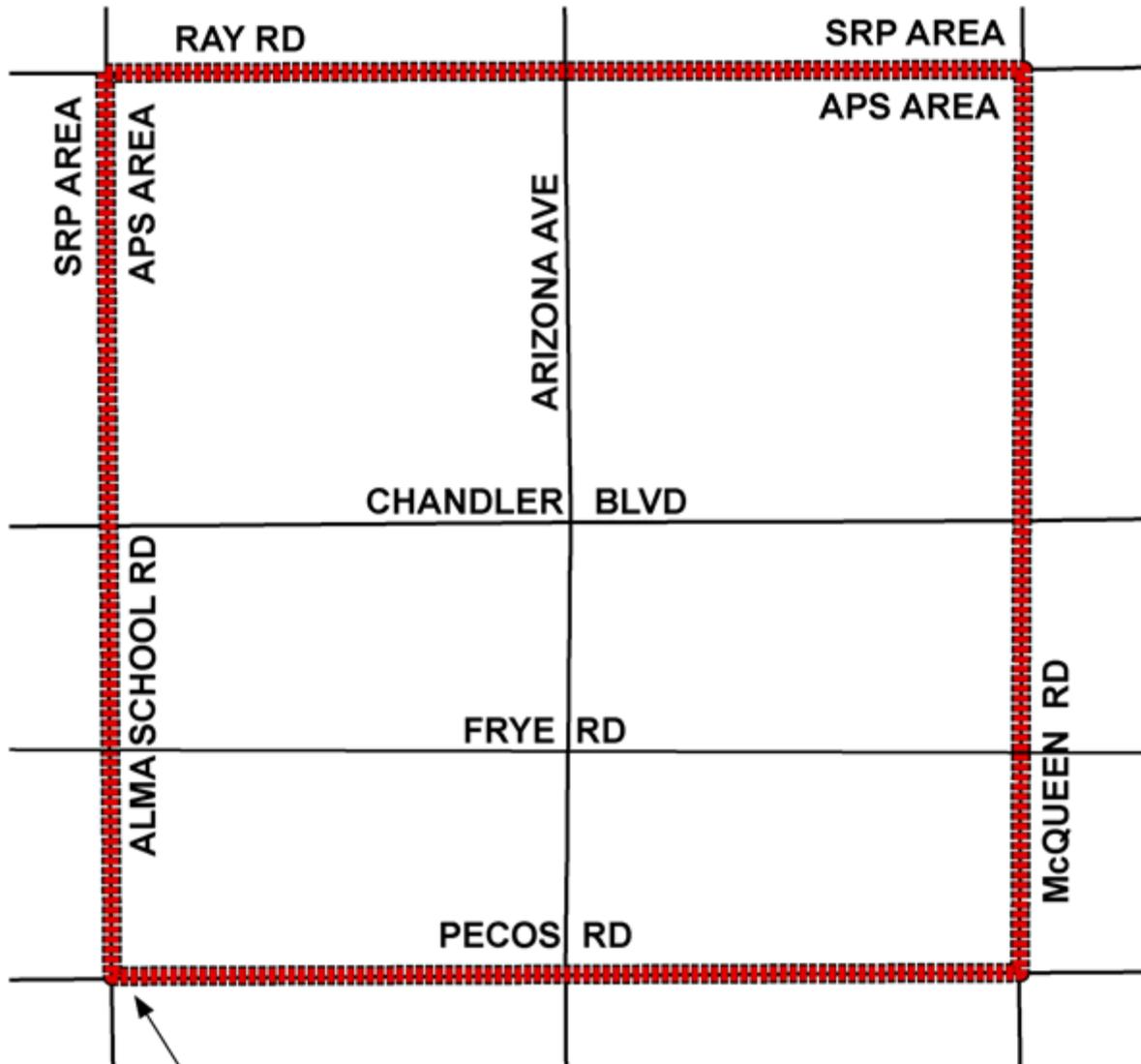
Plan approvals are limited to six (6) months after the approval date and may be renewed for another six (6) months if no changes to the existing or future intersection configuration have occurred.

## **2 - ELECTRICAL SERVICES**

The City of Chandler is served by two electrical service companies: Salt River Project (SRP) and Arizona Public Service (APS). All areas of the City are served by SRP except for the APS

area shown on the map below. The signal designer should contact the appropriate utility company early in the design process so that a “point of service” location can be identified.

All new traffic signals shall use metered power service.



AREA WITHIN BOUNDARY IS APS AREA.  
REMAINDER OF THE CITY IS SRP AREA.



**NOTE:**  
PLANS FOR STREET LIGHTS ON ARIZONA AVENUE BETWEEN CHANDLER BLVD AND FRYE RD SHALL BE SUBJECT TO SPECIAL APPROVAL.

### **3 - PLAN DEVELOPMENT**

Traffic signal plans submitted for approval by the City of Chandler should be prepared using the Computer Aided Design and Drafting (CADD) software AutoCAD(r) and comply with the City of Chandler's CADD Standards as indicated below.

The City of Chandler uses a coversheet and two plan sheets for the design of traffic signals, see Figures TS-2, TS-5 and TS-6.

**Coversheet** (*Figure TS-2*) contains the project title, vicinity map and the general Notes. Contact the City of Chandler Development Services for format and Content requirements.

**Sheet 1** (*Figure TS-5*) is used for the signal layout and contains a legend and the Notes to the contractor.

**Sheet 2** (*Figure TS-6*) contains the pole and cabinet schedule, conductor Schedule, phasing schedule and wiring diagrams.

(The schedules and wiring diagrams in Fig. TS-5 are shown in greater detail in Figures TS-9 through 12.)

All symbols used in the design of traffic signals shall conform to Arizona Department of Transportation standards. These are summarized in Figs. TS-3 and TS-4.

AutoCAD(r) has the ability to place design information on several different layers in a file. This allows the separation of different design elements onto separate layers. The following is a recommended layering structure for the design of traffic signals:

#### **SHEET 1** (*Plan View*)

Layer 1 (name – Title) shall be reserved for the border, title block, and legend.

Layer 2 (name – Ex.Roadway) shall be reserved for the existing roadway Configuration including curbs, sidewalks, striping, signing and edge of pavements

Layer 3 (name – Utilities) shall be reserved for any existing signals, including Junction boxes and conduit specifically used for traffic signal.

Layer 5 (name – New Signal) shall be reserved for all new signal equipment as Part of the signal design. Any general notes shall be included on this layer.

Layer 6 (name – Striping) shall be used for any striping or signing changes to be Added in conjunction with the signal design.

Layer 7 (name – Construction) shall be reserved for any roadway improvements Needed in conjunction with signal installation.

Layer 8 (name – Future) shall be reserved for any future improvements to the Roadway, traffic signal, etc.

#### **SHEET 2** (*Schedules and Diagrams*)

Layer 1 (name – Title) shall be reserved for the border and title block.

Layer 2 (name – Schedules) shall be reserved for the pole and cabinet, conductor and phase schedules.

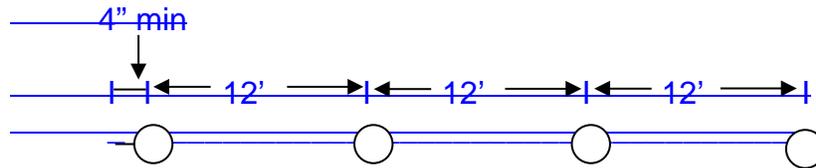
Layer 3 (name – Diagrams) shall be reserved for the wiring diagrams.

The Developer/Consultant shall submit electronic files to the City when plans are submitted for their approval signature. Approval of the design plans is contingent upon conformance to the above design formats.

#### 4 - SIGNAL POLES

The City of Chandler uses standard ADOT signal poles and foundations. It is recommended that the designer obtain a current copy of ADOT's "Traffic Signals & Lighting" Standard Drawings and the latest Special Provisions. All poles shall be per ADOT specifications, and TENON specifications.

Traffic Signal Tenon Locations layouts are shown for ADOT Standard Drawing in the Figures TS-17A and TS-17B.



Typical Tenon Locations:

See Schedule for number of Tenons

Note: Not used for mast arms 20 foot or less

#### TENON SCHEDULE

<u>Pole Type</u>	<u>Arm Length</u>	<u># of Tenons</u>
K, R	45', 50', 55'	<u>4</u>
J, Q	35', 40'	3
J, Q	25', 30'	2
E, F	15', 20'	1

The City typically requires one pole for each corner of the intersection. Where site condition dictates, 2 poles may be used. One pole shall be a type 'A' pole (or type 'G' pole depending on street lighting needs), while the other shall be a 'J' 'K' or 'Q' 'R' depending on mast arm length and whether or not a luminaire is included on the pole.

A typical pole layout placement is shown in Figure TS-13. Where signal poles cannot be placed directly adjacent to the handicap ramp to meet American Disability Act (ADA) requirements, the

~~ramp shall be modified per Detail No TS-20.~~ The desirable pole location is within 5 ft from crosswalk line and 10 ft from face-of-curb. The maximum pole location is 10 ft from crosswalk line and 20 ft from face-of-curb, with the approval of the City Engineer or designee.

## **5 - JUNCTION BOXES**

The City of Chandler uses three sizes of junction boxes, No. 5, No. 7, and No. 9. The pullboxes are required to meet ADOT's Standards and Specifications. The No. 5 junction box is placed adjacent to the electrical "point of service" location as agreed to by the utility company. The No. 7 junction box is placed on all corners of the intersection, using a No. 7 with extension (See Detail No. TS-23) in front of the traffic signal cabinet. It is generally placed behind the sidewalk at the center of the radius. If no sidewalk or curbing exists or is planned with the signal installation, then the junction box should be placed as close as possible to the ultimate location. All junction boxes containing interconnect cable shall be No. 7 with the extension or No. 9 (See Detail No. TS-22), as determined by the City Transportation Engineer. Figure TS-14 provides typical locations for junction boxes, meter pedestal, and controller.

## **6 - CONDUITS AND CONDUCTORS**

### *6.1 Conduit*

The City of Chandler uses three conduit sizes for their traffic signals; 1½-inch, 2-inch and 4-inch. The 2-inch conduit is used to connect the boxes and signal pole foundations. Two 2-inch conduits shall also be provided from the point of service. One of the 2-inch conduits shall be used between the point of service junction box and the controller cabinet foundation. The other 2-inch conduit shall be used between the point of service and the No. 7 junction box. The 4-inch conduit is used between the No. 7 junction boxes and is also used for any conduit run underneath the travelled way. Conduits shall connect the controller cabinet foundation with a No. 7 junction box. All conduits entering the controller foundation shall be oriented per Figure TS-19. (layout detail) All conduit runs shall be straight when possible. See figure TS-14 for meter pad and conduit placement.

Interconnect conduit shall be comprised of 4-inch conduit with three 1-1/4 inch innerduct, colored red, orange, and black. All unused innerduct shall have 2500 pound detectable mule tape installed, with detectable members splice across junction boxes using continuously detectable run. All interconnect conduit shall enter junction boxes using 45-degree sweeps with no less than a 36-inch radius. Interconnect conduit shall be installed at a depth no less than 48-inches. A 2-inch conduit shall be installed directly into the controller foundation exclusively for the interconnect cable. This 2-inch conduit shall run between the controller foundation and the interconnect junction box (or intersection junction box in the event that an exclusive interconnect junction box is unavailable in that corner).

### *6.2 Conductors*

The City of Chandler uses standard IMSA conductor cables for the traffic signal wiring. The following describes the type and use of conductors:

No. 14 AWG, 5 conductor is used from signal pole to inside mast arm head.  
 No. 6 AWG is used between the power supply and the controller.  
 No. 14 AWG, 7 conductor is used from signal pole to outside mast arm head.  
 No. 8 AWG bare bond (green) is used in all conduit runs.

No. 10 AWG is used for the internally illuminated street name signs and the Luminaire. In addition, a common shall be included in the runs. Streetlight Conduction shall be red and street name sign conduction shall be brown. Conductors shall be fused in the No. 7 junction box.

IMSA 20-1 signal cable, No. 14 AWG 20 conductor is used between the Controller and each pole.

### 6.3 Interconnect

Interconnect cable shall be between 48 and 144 strands (as determined by the City Transportation Engineer) with 12 fibers per buffer tube, single mode, fiber optic cable meeting the following specifications:

Fibers per cable	48 to 144 strands for main trunkline cables 6 for branch cables
Cladding diameter:	125.0 microns
Core diameter:	8.3 microns nominal
Core eccentricity:	≤1.0 micron (0.3 typical)
Temperature range:	-34°C to +74°C
Coating thickness:	50±15 microns
Cable construction:	Loose tube
Outer jacket:	Polyethylene
Bending radius:	20 x Dia. minimum
Tensile strength:	600 pounds
Strength member:	Dielectric
Mode field diameter:	9.3±0.5 microns
Zero dispersion wavelength:	1300 to 1320 nm
Zero dispersion slope:	≤0.092 picosec/nm <sup>2</sup> -km
Cutoff wavelength	1260 nm
Point discontinuities at 1300 nm:	≤0.1dB

The interconnect cable shall be fiber optic cable only. The fiber optic interconnect cable shall run continuous for the complete extent of the project limits. Full splicing of the fiber optic interconnect cable mid-project will not be allowed. Any construction requiring the relocation or replacement of twisted-pair copper shall be replaced with fiber optic cables.

All infrastructure shall be constructed “fiber friendly”. The interconnect conduit shall be 4-inch conduit with three 1 ¼ inch innerducts in three different colors. All empty innerducts shall have

2500 lb detectable mule tape installed, with detectable members spliced across pull boxes, creating a continuous detectable run. ADOT standard #9 pull boxes, or approved equivalent, shall be installed at all arterial/arterial intersections as well as end of project conditions. ADOT standard #7 pull boxes, with extension, shall be installed at ¼ mile intervals and/or points of known or future signalized intersections with collector streets. All conduit shall enter pull boxes with 45-degree sweeps (where required) with no less than a 36-inch bend radius anywhere within the conduit run. Every effort shall be made to minimize variations in the conduit profile (i.e. bends, vertical & horizontal shifts, etc.).

#### *6.4 Fiber Support Equipment*

The following equipment shall be installed in the traffic signal control cabinet. Contact Traffic Engineering for the latest approved equipment list.

- Fiber Optic Transceiver
- 8 Port Serial Server (4 Port Serial Server at collector streets)
- 4 Port Video Server
- Copper Media Modem (used with twisted pair copper cable)
- Fiber termination patch panel
- Line Interface Unit (LIU), if required.

### **7 - CONTROLLER AND CABINET**

The following equipment shall be installed in the #9 vault. Contact Traffic Engineering for the latest approved equipment list.

- Fiber optic splice enclosure (using gel cable sealing technology)
- Hanging bracket assembly.

#### *7.1 Controller*

The Controller Unit shall be a TS2, Type II EPAC 3608 Local System, wired with a “D” connector and Systems Input/Output terminal facility.

#### *7.2 Cabinet*

The Controller Cabinet shall be a TS2 Type IV per Arizona Department of Transportation Standard Specifications, 1990. It shall be fabricated from aluminum and the finish shall be unpainted and clean.

### **8 - DETECTORS**

#### *8.1 Video Detection*

The City of Chandler uses video vehicle detection at all intersections. Video detection cameras are typically mounted on the traffic signal luminaire arm. When a 'J' or 'K' pole is used, refer to Detail TS-21 for mounting requirements. Video detection system will be the Autoscope SoloPro 4 channel system or approved equal.

## 8.2 *Opticom*

The City of Chandler uses Opticom pre-emption equipment for emergency vehicles. Opticom detectors are mounted on the signal mast arms, centered between the two outside signal heads. Detectors shall be Global Traffic Technologies (GTT) model 700 series.

## **9 - SIGNAL HEADS**

### *9.1 Placement of Signal Heads*

The placement of traffic signal heads shall follow the policy outlined below (see Detail No. TS-17A and TS-17B).

1. For each unique signal display, there shall be a minimum of two (2) signal heads.
2. For six or four-lane arterials without left turn, there shall be two (2) Type F heads on the mast arm.
3. For left-turn control on arterials, two (2) Flashing Yellow Arrow heads shall be installed, one (1) on the master arm and one (1) on the far left pole.
4. For two-lane minor streets with left turn arrows, two (2) Type Q heads shall be installed, one (1) on the mast arm and one (1) on the far left pole.
5. For two-lane minor streets without left arrows, two (2) Type F head shall be installed, one (1) on the mast arm and one (1) on the far left pole.
6. For approaches with right turn deceleration lanes, one (1) far right signal head shall be installed on the far right pole.

### *9.2 Signal Lamps*

#### *9.2.1 Vehicle Signals*

All signal lamps shall be LED and must comply with Vehicle Traffic Control Signal Heads (VTCSH) standards published in the Equipment and Materials Standards of the Institute of Transportation Engineers (ITE).

#### *9.2.2 Pedestrian Signals*

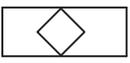
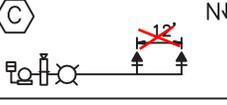
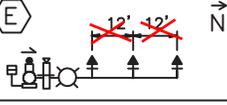
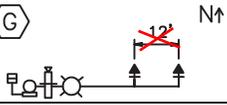
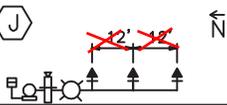
Pedestrian traffic signal lamps shall be LED type with pedestrian countdown timers and shall be enclosed in an 18" pedestrian signal housing built to the Pedestrian

Traffic Control Signal Indicators (PTCSI) standards published in the Equipment and Materials Standards of the Institute of Transportation Engineers (ITE). “Hand” and “Man” symbols shall be 12 inches in height and conform to PTCSI standards.

**10 - INTERNALLY ILLUMINATED STREET NAME SIGNS**

New traffic signal installations require internally illuminated street name signs for all roadways. Sign installations and placement shall conform to the standards and specifications outlined in the latest edition of the City of Chandler’s Standard Details, C-606 through C-610. If height restrictions and/or conflicts exist, the City may consider alternatives to the details. All designs and installations must be approved by the City Transportation Engineer. Refer to Figure TS-18 for a diagram of pole mounting.

# CABINET AND POLE SCHEDULE

CABINETS						ASSEMBLY NOTES	LOCATION		
CABINET	TYPE	EQUIPMENT							
(A) 	METER PAD	TESCO OR MYERS				FACE PEC NORTH	STATION AND OFFSET		
(B) 	IV	EAGLE - SIGNAL EPAC 300 NEMA TS2 8 PHASE CONTROLLER				INSTALL 4' SQUARE X4" CONCRETE WORK PAD IN FRONT OF FOUNDATION WITH 8" TOE IN FRONT	STATION AND OFFSET		
POLES			MAST ARMS		SIGNAL ASSEMBLIES		PED. DET. SIGN	NOTES	LOCATION
ORIENTATION PLAN	TYPE	SIG	LUM	MTG	FACE				
(C) 	Q	35'	12'	2-II 1-V	2-F 1-M/H		NOTE 1 NOTE 3 NOTE 4 NOTE 5	STATION AND OFFSET	
(D) 	A 10'			1-IV 1-V	1-Q 1-M/H	<del>T.S.11-4 R10-4b(R)</del>	NOTE 2	STATION AND OFFSET	
(E) 	R	55'	20'	3-II 1-V	1-Q 2-F 1-M/H	<del>T.S.11-4 R10-4b(L)</del>	NOTE 1 NOTE 3 NOTE 4 NOTE 5	STATION AND OFFSET	
(F) 	A 10'			1-VI 1-V	2-F 1-M/H		<b>MUTCD R10-3 (typ)</b>	STATION AND OFFSET	
(G) 	Q	35'	12'	2-II 1-V	2-F 1-M/H		NOTE 1 NOTE 3 NOTE 4 NOTE 5	STATION AND OFFSET	
(H) 	A 10'			1-IV 1-V	1-Q 1-M/H	<del>T.S.11-4 R10-4b(R)</del>	NOTE 2	STATION AND OFFSET	
(J) 	R	55'	20'	3-II 1-V	1-Q 2-F 1-M/H		NOTE 1 NOTE 3 NOTE 4 NOTE 5	STATION AND OFFSET	
(K) 	A 10'			1-VI 1-V	2-F 1-M/H	<del>T.S.11-4 R10-4b(L)</del>	NOTE 2	STATION AND OFFSET	

Remove demension text (typ)

**MUTCD  
R10-3 (typ)**

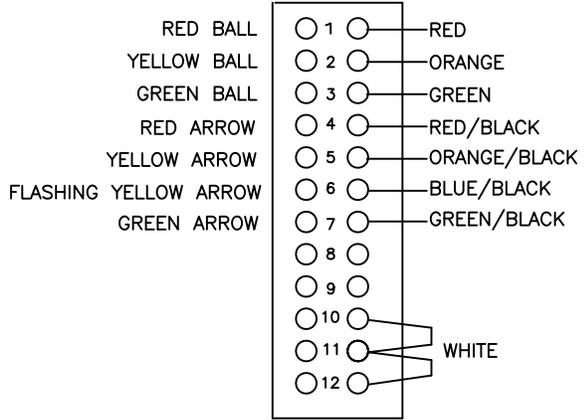
**NOTES:**

1. INSTALL GTT "OPTICOM" 700 SERIES DETECTOR ON MAST ARM.
2. TYPE I PEDESTRIAN PUSH BUTTON - T.S. 11 - 1.
3. 250 WATT LUMINAIRE, TYPE III, MEDIUM CUTOFF, 120 VOLT.
4. INSTALL ILLUMINATED STREET SIGN.
5. INSTALL AUTOSCOPE SOLO PRO MVP VIDEO DETECTION SYSTEM.
6. INSTALL 8- PORT SERIAL SERVER (4-PORT SERIAL SERVER AT COLECTOR STREETS)  
W/DB9M CONNECTORS; 8- PORT SINGLE MODE FIBER TRANSCEIVER  
W/ST CONNECTORS; 4- CHANNEL VIDEO SERVER; AND COPPER  
MEDIA MODEM (USED WITH TWISTED PAIR COPPER CABLE).

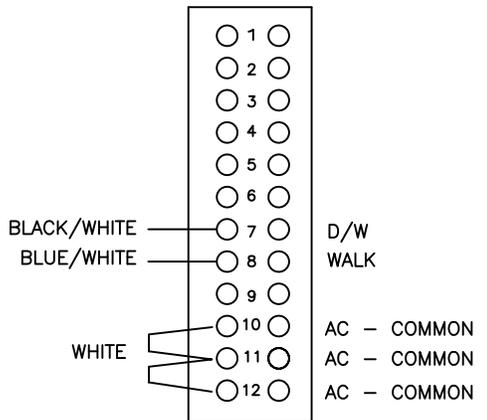


## CABINET AND POLE SCHEDULE

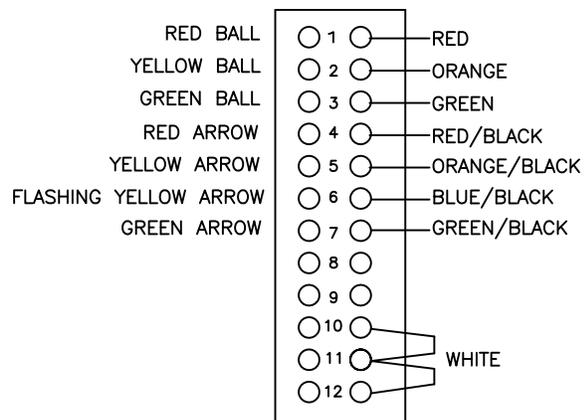
DETAIL NO.  
**TS-7**  
NTS



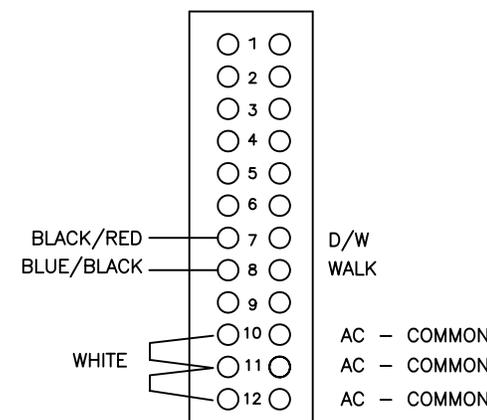
MAST ARM HEAD



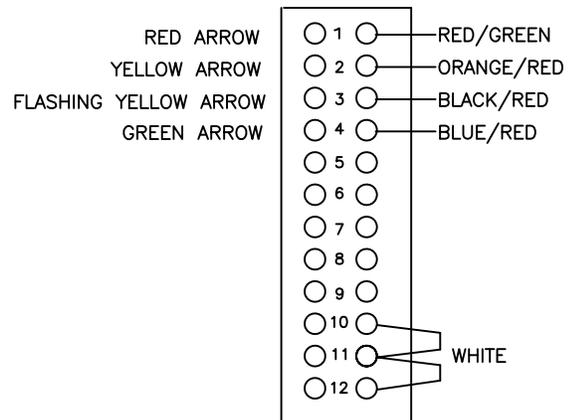
PEDESTRIAN NB/SB



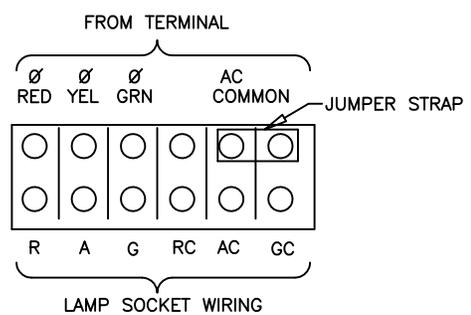
NEAR RIGHT SIDE MOUNTED HEAD  
(FRONT & BACK)



PEDESTRIAN EB/WB



FAR LEFT SIDE MOUNTED HEAD

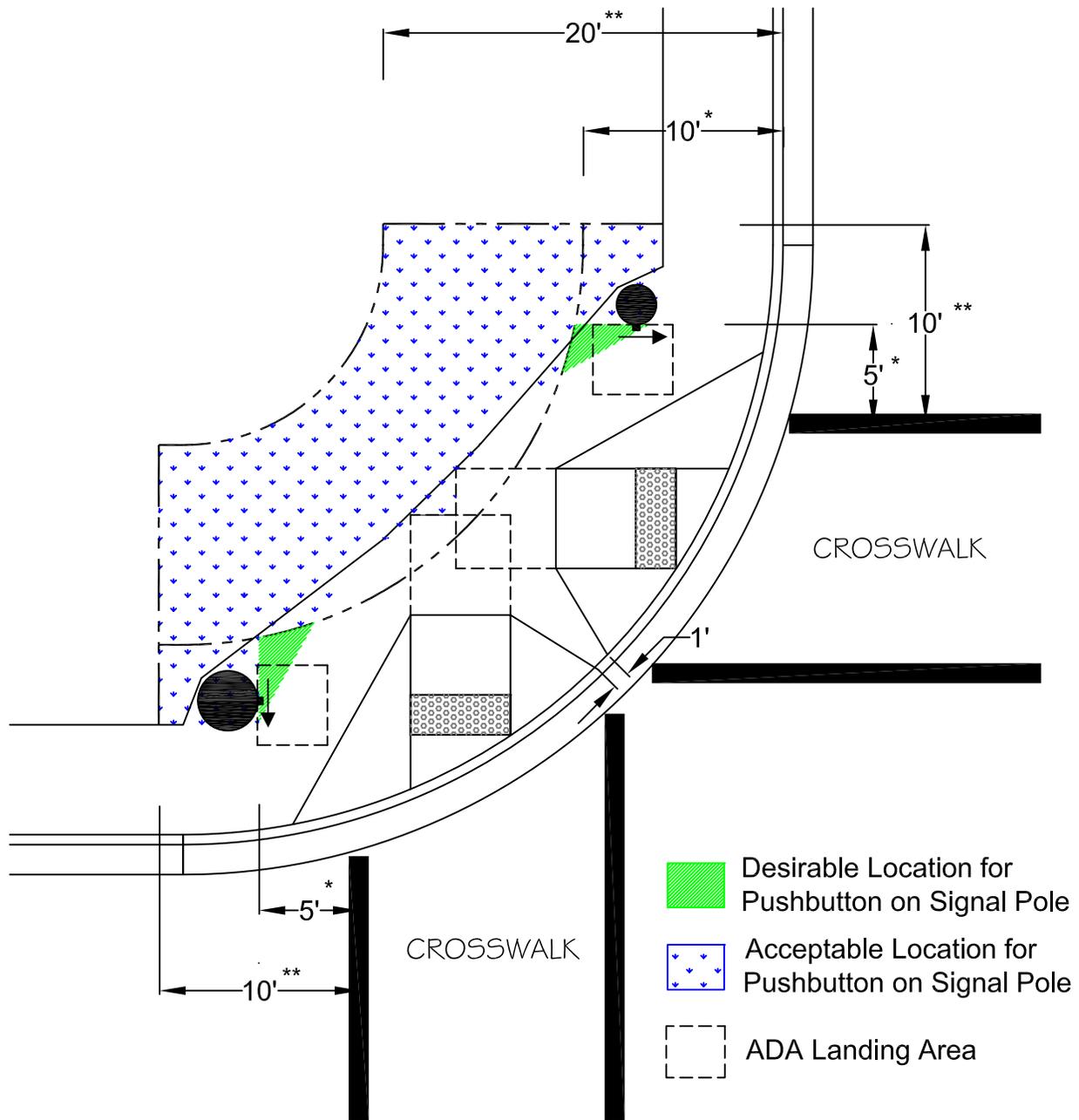


TERMINAL BLOCK IN SIGNAL HEAD



# TERMINAL BLOCK WIRING DETAILS

DETAIL NO.  
**TS-12**  
NTS



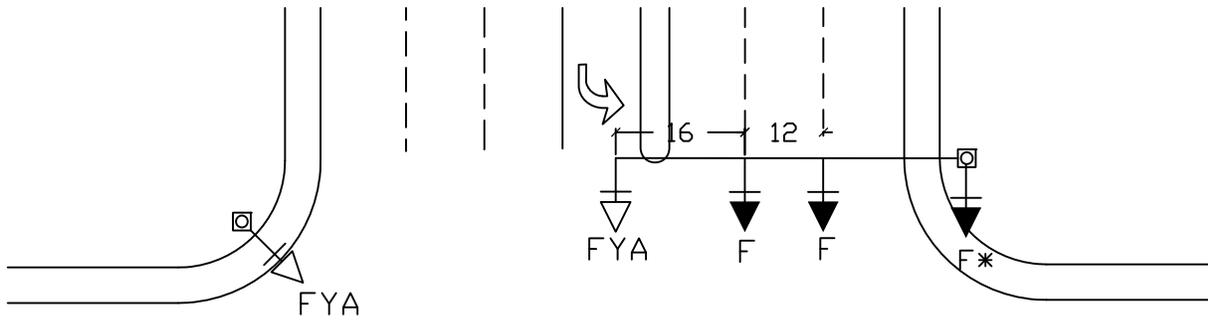
**NOTES:**

1. \* DESIRABLE LOCATION IS WITHIN 5 FT OFFSET FROM CROSSWALK LINE AND 10 FT OFFSET FROM FACE-OF-CURB.
2. \*\* MAXIMUM OFFSET IS WITHIN 10 FT OFFSET FROM CROSSWALK LINE AND 20 FT OFFSET FROM FACE-OF-CURB WITH CITY ENGINEER APPROVED DESIGN EXCEPTION.
3. SIDEWALK EXTENSION REQUIREMENTS APPLIES TO ALL POLE LOCATIONS. MUST MEET ADA FOR CLEAR FLOOR SPACE, SLOPE, HEIGHT AND REACH REQUIREMENTS.

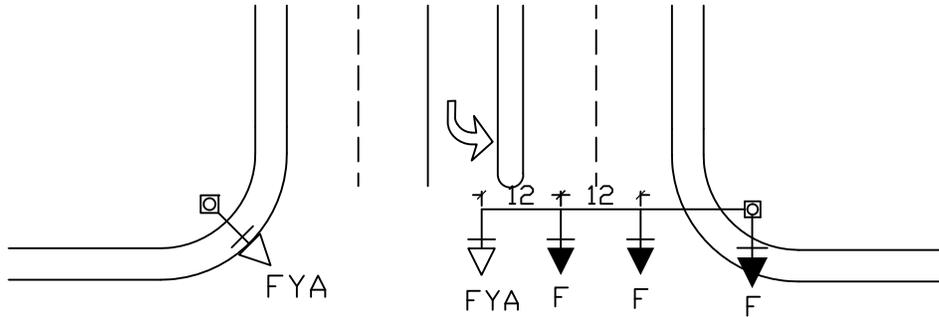


**POLE PLACEMENT FOR ADA  
ACCESSIBILITY OF TRAFFIC  
SIGNAL PUSH BUTTONS**

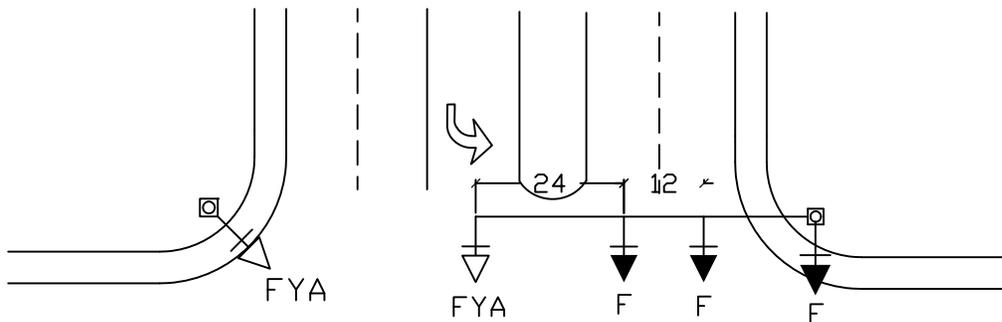
DETAIL NO.  
**TS-13**  
NTS



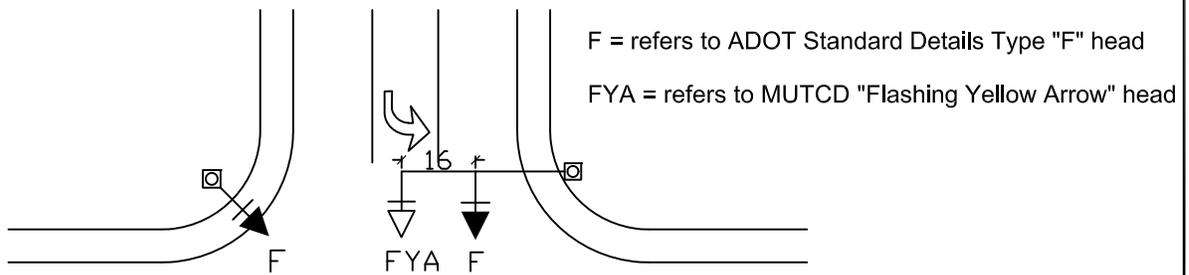
**Six Lanes With Left Turn Phase**



**Four Lanes With Left Turn Phase**



**Four Lanes With Left Turn Phase and Wide Median**



**Two Lanes With Left Turn Phase**

Legend:



Chandler + Arizona

**SIGNAL HEAD PLACEMENT  
 WITH LEFT TURN PHASE**

DETAIL NO.

**TS-17A**

NTS