

NAME OF CONTRACTOR \_\_\_\_\_

PROPOSAL AND SPECIFICATIONS  
FOR  
TRAFFIC SIGNAL INSTALLATION AT  
THE INTERSECTION OF  
142<sup>ND</sup> AVENUE AT 18<sup>TH</sup> STREET

PROJECT NO. PT 2230 – Traffic Signal Installation at the intersection of 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street,  
Dorr Township, Allegan County.

DORR TOWNSHIP,  
ALLEGAN COUNTY

JULY 2, 2014

BOARD OF COUNTY ROAD COMMISSIONERS  
OF ALLEGAN COUNTY, MICHIGAN

1308 Lincoln Road, Allegan, MI 49010

ALLEGAN COUNTY ROAD COMMISSION  
ADVERTISEMENT FOR BIDS  
COUNTY LOCAL ROAD CONSTRUCTION

Sealed bids will be received by the Allegan County Road Commission at their office at 1308 Lincoln Road (M-89), Allegan, Michigan until 11:00 a.m., Local Time, July 2, 2014, and, at such time, be publicly opened and read aloud for the following:

PROJECT NO. PT2230 – Traffic Signal Installation at the intersection of 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street, Dorr Township, Allegan County.

Complete specifications and bid forms are available at the Road Commission office and online at [www.alleganroads.org](http://www.alleganroads.org) under Materials & Service Bids.

All bids must be submitted on forms furnished by the Road Commission and sealed in envelopes with the name and address of the bidder, and the item bid upon clearly marked thereon.

A bid deposit of at least 5% of the bid amount will be required for this item. The bid deposit may be in the form of certified check, cashier's check or bid bond.

The Commission reserves the right to reject any or all bids, to waive minor technicalities, and to accept the bid that is deemed to be in the best interest of the County of Allegan.

BOARD OF COUNTY ROAD COMMISSIONERS  
OF ALLEGAN COUNTY, MICHIGAN

Bruce Culver, Chairman  
Robert Kaarlie, Vice-Chairman  
John Kleinheksel, Member

PROJECT NO. PT 2230 – Traffic Signal Installation at the intersection of 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street,  
Dorr Township, Allegan County.

BID and AWARD

Date\_\_\_\_\_

Board of County Road Commissioners  
Of Allegan County  
1308 Lincoln Road  
Allegan, MI 49010

Gentlemen:

The undersigned has examined the plans, specifications, and location of the work described herein and is fully informed as to the nature of the work and the conditions relating to its performance and understands that the quantities shown in the estimate are approximate only and are subject to either increase or decrease; and hereby proposed to furnish all necessary machinery, tools, apparatus and other means of doing the work, do all the work, furnish all the materials except as otherwise specified herein, and, for the unit prices named in the accompanying unit price schedule, to complete work in strict accordance with the plans and specifications therefore.

The undersigned further proposes to such extra work as may be ordered by you, prices for that are not included in the itemized bid, compensation therefore to be made on the basis agreed upon before such extra work is begun.

The undersigned agrees to complete all items of work on or before October 31, 2014.

The contractor shall submit a progress schedule subject to approval of the project engineer prior to the award of the contract.

The undersigned encloses a certified check, cashier’s check, or Bid Bond, representing 5% of the bid, in the amount of \$\_\_\_\_\_, payable to the Allegan County Road Commission as a guarantee of good faith. If the contract is awarded to the undersigned, and the undersigned fails to furnish satisfactory bonds to the Road Commission within fifteen (15) days after being given notice of award said check will be forfeited to the Allegan County Road Commission as liquidated damage.

THE CONTRACT

The Contract Documents consist of the bid documents, this Agreement, Conditions of the Contract (General Supplementary, Special and other Conditions), Drawings, Specifications, Addenda issued prior to execution of this Agreement, other documents listed in this Agreement and Modifications issued after execution of this Agreement; these form the Contract, and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiation, representations or agreements, either written or oral. If anything in the other Contract Documents is inconsistent with this Agreement, this Agreement will govern.

PROJECT NO. PT 2230 – Traffic Signal Installation at the intersection of 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street, Dorr Township, Allegan County.

ALLEGAN COUNTY ROAD COMMISSION  
ALLEGAN, MICHIGAN  
ITEMIZED UNIT PRICE BID SCHEDULE

ITEM OF WORK	QUANTITY	UNIT PRICE	TOTAL
Mobilization, Max. ____	1 LS		
Sidewalk, Rem	6 Syd		
Sidewalk, Conc, 4 inch	50 Sft		
Post, Steel, 3 lb	60 Ft		
Sign, Type III, Rem	3 Ea		
Sign, Type IIIB	25 Sft		
Barricade, Type III, High Intensity, Double Sided, Lighted, Furn	2 Ea		
Barricade, Type III, High Intensity, Double Sided, Lighted, Oper	2 Ea		
Lighted Arrow, Type C, Furn	2 Ea		
Lighted Arrow, Type C, Oper	2 Ea		
Minor Traf Devices	1 LS		
Plastic Drum, High Intensity, Furn	50 Ea		
Plastic Drum, High Intensity, Oper	50 Ea		
Sign, Type B, Temp, Prismatic, Furn	450 Sft		
Sign, Type B, Temp, Prismatic, Oper	450 Sft		
Traffic Regulator Control	1 LS		
Conduit, DB, 1, 1 1/2 inch	20 Ft		
Hh, Round	1 Ea		
Cable, Sec, 600V, 1, 3/C#6	150 Ft		
Conduit, Directional Bore, 1, 3 inch	50 Ft		
Case Sign, Rem	1 Ea		
Case Sign (LED), Four Way, 24 inch by 30 inch	1 Ea		
Controller and Cabinet, Rem	1 Ea		
Controller and Cabinet, Digital Type	1 Ea		

Controller Fdn, Base Mount	1 Ea		
Pedestal, Alum	2 Ea		
Pedestal, Fdn	2 Ea		
Power Co. (Est. Cost to Contractor)	1,000 Dlr		
Serv Disconnect	1 Ea		
Serv Disconnect, Rem	1 Ea		
Span Wire	1 Ea		
Span Wire, Rem	1 Ea		
TS, Span Wire Mtd, Rem	2 Ea		
TS, Four Way Span Wire Mtd (LED)	2 Ea		
TS, Pedestrian, Two Way Bracket Arm Mtd (LED) Countdown	2 Ea		
TS, Pedestrian, Two Way Pedestal Mtd (LED) Countdown	2 Ea		

TOTAL OF BID \$ \_\_\_\_\_

The undersigned bidder agrees that the following is a complete and accurate list of all sub-contractors to be utilized is awarded this contract and any change from this list will be permitted only with the consent of the Board of County Road Commissioners of Allegan County. **LIST NAME OF EACH SUB-CONTRACTOR AND BRIEF DESCRIPTION OF WORK TO BE DONE.**

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I hereby state that all of the information I have provided is true, accurate and complete. I hereby state that I have the authority to submit this bid, which will become a binding contract if accepted by the Board of County Road Commissioners of Allegan County. I hereby state that I have not communicated with nor otherwise colluded with any other bidder, nor have I made any agreement with nor offered or accepted anything of value from an official or employee of the Board of County Road Commissioners of Allegan County that would tend to destroy or hinder free competition.

In case the bidder is a co-partnership, each member must sign this proposal.

In case the bidder is a Corporation, this proposal must be executed by its duly authorized officials in accordance with its articles of incorporation and a certified copy of such articles must be attached hereto.

I hereby state that I have read, understand and agree to be bound by all the terms of this bid document.

SIGNATURE: \_\_\_\_\_ NAME: \_\_\_\_\_  
(Type or Print)

TITLE: \_\_\_\_\_ DATE: \_\_\_\_\_

FIRM NAME: \_\_\_\_\_ PHONE: \_\_\_\_\_

ADDRESS: \_\_\_\_\_  
(Street Address) (City) (State) (Zip)

**FOR COUNTY USE ONLY – DO NOT WRITE BELOW**

ACCEPTED BY: BOARD OF COUNTY ROAD COMMISSIONERS  
OF THE COUNTY OF ALLEGAN, MICHIGAN

\_\_\_\_\_  
Chairman

\_\_\_\_\_  
Vice-Chairman

\_\_\_\_\_  
Member

\_\_\_\_\_  
Date

ALLEGAN COUNTY ROAD COMMISSION  
ALLEGAN, MICHIGAN

GENERAL SPECIFICATIONS

MICHIGAN DEPARTMENT OF TRANSPORTATION-STANDARD SPECIFICATIONS

The work covered by the plans and specifications will be done in accordance with the 2012 Michigan Department of Transportation Standard Specifications for Construction, except as qualified in supplemental specifications and special conditions of the Allegan County Road Commission or as agreed to in writing at the time of the award of the contract.

DEFINITION OF TERMS

See Section 101 of Michigan Department of Transportation Standard Specifications for Construction.

SPECIAL CONDITIONS

Special requirements, regulations or directions applying to a particular project may be made a part of these specifications.

THE WORK

The work consists of the completed services, construction and/or paving by the Contract Documents and includes all materials and labor incorporated or to be incorporated therein.

RESPONSIBILITIES OF CONTRACTOR

- A. Responsibility for and Supervision of Construction. Unless otherwise stated herein, Contractor will be solely responsible for all construction under this Contract, including the methods, techniques, sequences, procedures, and means, and for coordination of all work. Contractor will supervise and direct the work to the best of Contractor's ability, and give it all attention necessary for such proper supervision and direction.
- B. Discipline and Employment. Contractor will maintain at all times strict discipline among Contractor's employees, and contractor agrees not to employ for work on the project any person unfit for without sufficient skill to perform the job for which he or she was employed.
- C. Furnishing of Labor, Materials, etc. Unless otherwise stated herein, Contractor will provide and pay for all labor, materials, and equipment, including tools, construction equipment, and machinery, utilities, Including water, transportation, and all other facilities and services necessary for the proper completion of work on the project in accordance with the Contract Documents.
- D. Payment of Taxes; Procurement of Licenses and Permits. Contractor will pay all taxes required by law in connection with work on the project in accordance with this agreement including sales, use, and similar taxes, and will secure all licenses and permits necessary for proper completion of the work, paying the fees for such licenses and permits.
- E. Compliance with Laws and Regulations. Contractor will comply with all laws and ordinances, and the rules, regulations or orders of all public authorities relating to the performance of the work under and pursuant to this Agreement including, but not limited to, the Occupational Safety and Health Act of 1970, the Michigan Occupational Safety and Health Act, and the rules and regulations of the Michigan Construction Safety Commission.

RESPONSIBILITIES OF CONTRACTOR (CON'T):

F. Responsibility for Negligence of Employees and Subcontractors. Contractor assumes full responsibility for acts, negligence or omissions of all of Contractor's employees on the project, for those of Contractor's subcontractors and their employees, and for those of all other persons doing work under a contract with Contractor.

G. Responsibility for Safety. Unless otherwise stated herein, at Contractor's expense, Contractor will take all necessary precautions (including, without limitation, the furnishing of traffic control, barricades, traffic control devices, flaggers, warning lights, signs, warning signs, safety channels, channelization devices, guards, fences, walks, flags, cables and lights) for the safety of, and the prevention of injury, loss and damage to, persons and property (including, without limitation, in the term persons, members of the public, employees, Contractor's subcontractors and their respective employees, other contractors, their subcontractors and respective employees) on, about or adjacent to the location where the work is being performed, and will comply with all applicable provisions of safety rules, ordinances, codes, regulations, and orders of duly-constituted public authorities including, but not limited to, the Michigan Manual of Uniform Traffic Control Devices.

H. Responsibility of Subcontractors. The Contractor will require any subcontractor hired by the Contractor for the purpose of performing any of the work described by the Contract documents to be bound by all of the terms and conditions of the Contract documents and to perform the work in accordance with the Contract documents. Each and every condition of the Contract documents, including without limitation, the RESPONSIBILITIES OF THE CONTRACTOR, will be made a condition of each subcontract entered into by the Contractor in conjunction with the performance of the work.

INDEMNIFICATION

To the fullest extent permitted by law, the Contractor will indemnify, defend, and hold harmless The Board of County Road Commissioners of Allegan County, its officers, employees, representatives and agents from and against any and all claims, damages, demands, payments, suits, actions, recoveries, judgements, losses and expenses, including attorney fees, interest, and court costs, which are made, brought or recovered against the Board of County Road Commissioners of Allegan County, arising out of or resulting from performance of the Contractor's work under this Contract, provided that such claims, damages, losses, demands, payments, suits, actions, recoveries, judgements and/or expenses are attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including loss of use resulting therefrom, but only if caused in whole or in part, by the act, omissions, fault, negligence or breach of the conditions of this Contract by negligent acts or omissions of the Contractor, the Contractor's sub-subcontractors, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss or expense is caused in part by a party indemnified hereunder. The Contractor will not, however, be obligated to indemnify the Board of County Road Commissioners of Allegan County, for any damage or injuries caused by or resulting from the sole negligence of the Board of County Road Commissioners of Allegan County. Such obligation will not be construed to negate, abridge or otherwise reduce other rights or obligations of indemnity which would otherwise exist as a party or person described in this paragraph.

In claims against any person or entity indemnified under this Agreement by an employee of the Contractor, the Contractor's sub-subcontractors, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this paragraph will not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or the Contractor's subcontractors under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.



## INSURANCE

A. Contractor's Insurance. Prior to start of the Contractor's work, the Contractor will procure for the Contractor's work and maintain in force until the completion of the work, workers' compensation insurance, employer's liability insurance, comprehensive general liability insurance and all insurance required of the contract under the contract documents.

The Board of County Road Commissioners of Allegan County will be named as an additional insured on each of these policies except for worker's compensation.

The insurance will include contractual liability insurance covering the Contractor's obligations under its agreement of indemnification as set forth herein.

B. Minimum Limits of Liability. The Contractor's comprehensive general and automobile liability insurance as required herein, will be written with limits of liability not less than the following:

a. Comprehensive general liability including completed operations

(1) \$ 500,000 each occurrence

b. Property damage

(1) \$ 500,000 each occurrence

C. Number of Policies. Comprehensive general liability insurance and other liability insurance may be arranged under a single policy for the full limit required or by combination of underlying policies with the balance provided by an excess or umbrella liability policy.

D. Cancellation, Renewal or Modification. The Contractor will maintain in effect all insurance coverage required under this Agreement at the Contractor's sole expense and with insurance companies acceptable to the Board of County Road Commissioners of Allegan County.

All insurance policies will contain a provision that the coverage afforded thereunder will not be cancelled or not renewed nor restrictive modifications added at any time after a certificate of insurance required under agreement has been issued and before the work; as defined herein, has been completed, until at least thirty (30) days prior thereto written notice has been given to the Board of County Road Commissioners of Allegan County unless otherwise specifically required in the Contract Documents.

Certificates of insurance or certified copies of policies acceptable to the Board of County Road Commissioners of Allegan County will be filed with the Board of County Road Commissioners of Allegan County prior to the commencement of the Contractor's work.

In the event that the Contractor fails to obtain or maintain any insurance coverage required under this Agreement, the Board of County Road Commissioners of Allegan County may:

1. Purchase such coverage and charge the expense thereof to the Contractor, and
2. Withhold from any payment due or to become due to the Contractor an amount sufficient to protect the Board of County Road Commissioners of Allegan County from such claims, damages, demands, payments, suits, actions, recoveries, judgements, losses and expenses, including attorney fees, interest and court costs, and
3. Terminate this agreement.

Nothing contained in this Agreement, nor the Board of County Road Commissioners of Allegan County's compliance there with, will relieve the Contractor from its obligations under the Contract to purchase and maintain required insurance or to indemnify the Board of County Road Commissioners of Allegan County.

### PROGRESS CLAUSE

The successful bidder will be required to submit a Progress Schedule, giving an outline of his proposed order of work and to indicate the dates for completion of the work. This outline, when approved by the Road Commission, will become a part of the contract.

### PROSECUTION OF THE WORK

The Contractor will begin the work on the date agree upon with the Engineer. He will prosecute the work in the order given in the Progress Schedule, with force and equipment adequate to complete the sections within the time limit therein fixed for completion. In case of failure to proceed with the work as rapidly as is provided in the Progress Schedule, or if it appears at any time that such work is not being prosecuted in such a manner as to insure its completion within time specified, the Road Commission will have the right to require the contractor to furnish and place in operation such additional force and equipment as the Road Commission will deem necessary to bring the work up to the Progress Schedule; and in case of the Contractor's neglect to do so, the Road Commission may place such working force and equipment on the work and charge the Contractor the cost of the labor and such rental and depreciation rates for the plan and equipment as in its judgement is reasonable, and for such time as the plant and equipment are in service.

### ESTIMATED QUANTITIES

The quantities listed in the proposal are the estimated quantities. Increases or decreases in quantities will not be considered as a basis for adjustment in unit prices and Articles 103.02 of M.D.O.T. Standard Specifications for Construction will not apply in this regard.

### FINAL PAYMENT

Final payment will not be made until the contractor will have filed with the Board of County Road Commissioners the consent of the Surety of the payment of the final estimate and satisfactory evidence by affidavit or otherwise that all his indebtedness by reason of the contract has been fully paid or satisfactorily secured. In case such evidence is not furnished, the Road Commission may retain out of any amount due said contractor sums sufficient to cover all lienable claims unpaid.

### AFFIRMATIVE ACTION POLICY (EQUAL EMPLOYMENT OPPORTUNITY EMPLOYER)

The Allegan County Road Commission will require the Contractor to submit an Affirmative Action Policy stating that they are an equal employment opportunity employer and will recruit, hire and promote in all job classifications without regard to race, color, religion, sex or national origin, except where sex is a bona fide occupational qualification. The Affirmative Action Policy will be signed by the Contractor or one of the Company's Authorized Officers.

### CONTRACT BONDS

The Successful Bidder will furnish satisfactory performance and lien bonds, each in the amount of not less than one hundred (100) percent of the total contract price. Such bonds will be on forms provided and will meet the regulations of the Allegan County Road Commission and the requirements specified in the laws of Michigan.

No bonds will be required for contracts of less than \$5,000.00.

### M.D.O.T. – PREQUALIFICATION

Contractors bidding on this work must be prequalified by the Michigan Department of Transportation to do similar work on State or Federal Aid Secondary projects.

LIQUIDATED DAMAGES

Failure to complete the project on or before the completion date specified will be assessed according to the following schedule:

Original Contract Amount	Liquid Damages Per Calendar Day
\$ 0 to 49,999	75
50,000 to 99,999	150
100,000 to 499,999	450
500,000 to 999,999	900
1,000,000 to 1,999,999	1,300
2,000,000 to 4,999,999	1,550
5,000,000 to 9,999,999	2,650
10,000,000 and above	3,000

The liquidated damages may be delayed if the contractor meets the requirements set forth in Section 108.10 of the 2012 Standard Specifications for Construction. Approval of the project engineer is required.

ALLEGAN COUNTY  
ROAD COMMISSION

**PROGRESS CLAUSE**

WT:JNB

1 of 1

05-20-14

Contractor shall begin work on the date agreed upon with the Engineer. The Contractor shall not begin any work prior to this date without written permission from the Engineer. In no case, shall any work be commenced prior to receipt of formal notice of award by the Township.

The work on this contract shall consist of a traffic signal installation at the intersection of 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street in Dorr Township.

The entire project shall be completed on or before **October 31, 2014**.

The low bidder(s) for the work covered by this proposal will be required participate in a Pre-Construction Meeting with Road Commission representatives. The Contractor must provide a detailed Progress Schedule to the Road Commission at, or prior to, this meeting. The date for the Pre-Construction Meeting will be set after the project has been awarded.

The named subcontractor(s) for specialty and/or designated items, as shown in the proposal, which materially affect the work schedule, shall also be present at the Pre-Construction Meeting. They are also required to sign the Progress Schedule to indicate their approval of the dates of work set forth in the Progress Schedule.

Road Commission representatives will arrange the time and place for the Pre-Construction Meeting.

The Progress Schedule shall include, at a minimum, the controlling work items for the completion of the project, and the planned dates that these work items will be controlling operations. The final project completion date shall also be included in the Progress Schedule.

Failure on the part of the Contractor to carry out the provisions of the Progress Schedule, as established, may be considered sufficient cause to prevent bidding future projects until a satisfactory rate of progress is again established.

Contractor shall coordinate their work effort on this project with other construction or maintenance projects that may occur within the same timeframe so as to remain on schedule. No extra compensation or adjustments in contract unit prices will be allowed on account of delay or failure of others to complete scheduled work items.

ALLEGAN COUNTY  
ROAD COMMISSION

SPECIAL PROVISION  
FOR  
**MAINTENANCE OF TRAFFIC**

WT:JNB

1 of 1

04-29-14

**a. Description.** The work on this contract consists of a traffic signal installation at the intersection of 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street in Dorr Township, Allegan County.

**b. General.** The Contractor shall maintain traffic continuously throughout the project in accordance with subsections 104.07 and 104.11 and Sections 812 and 922 of the Michigan Department of Transportation (MDOT) 2012 Standard Specifications for Construction, including any Supplemental Specifications, the 2011 Michigan Manual of Uniform Traffic Control Devices, and as specified herein. The Contractor shall furnish and install all traffic control devices necessary for the maintenance of traffic.

1. The Contractor shall notify the Engineer one week in advance of any lane closures or major traffic shifts.

2. The Contractor shall coordinate their operations with other contractors and/or maintenance crews performing work within or adjacent to the Construction Influence Area. No additional compensation will be provided for coordination required with other projects.

3. The Contractor shall obtain any necessary permits from local governing agencies prior to the placement of any construction signing. The costs incurred to obtain these permits shall be included in the pay item "Minor Traf Devices" and will not be paid for separately.

4. Any dirt or debris deposited on the roadway by Contractor, or his subcontractors, shall be removed immediately by the Contractor.

**c. Construction Influence Area (CIA).** The CIA shall include the right-of-way of the 142<sup>nd</sup> Avenue and 18<sup>th</sup> Street intersection, as well as a distance of approximately a ¼ mile in advance on each intersection approach for advance construction signing.

**d. Traffic Restrictions.**

1. The Contractor shall maintain at least one lane of through traffic in each direction at all times. The Contractor shall also maintain full width of the intersection during the hours of 7:00 AM – 9:00 AM and 4:00 PM – 6:00 PM.

2. Local traffic shall be maintained at all times. Access to adjacent driveways shall be maintained at all times.

3. All traffic lanes must be open to traffic whenever work is not in progress. All temporary traffic control devices must be taken down or covered when work is not in progress.

4. The Contractor shall maintain access for emergency vehicles at all times. The Contractor will be required to assist emergency vehicles in gaining access into, around, and through the work zone at all times.

5. Nighttime and weekend work will not be permitted unless otherwise authorized by the Engineer.

6. No work shall be conducted during the Memorial Day, 4<sup>th</sup> of July, or Labor Day holiday periods, as defined by the Engineer. In addition, no work will be permitted during community events, fairs, or festivals as directed by the Engineer.

**e. Traffic Control Devices.** All traffic control devices and their usage shall be in accordance with the 2011 Michigan Manual of Uniform Traffic Control Devices, as amended, and as specified herein.

1. All diamond shaped warning signs shall be 48 inches by 48 inches with black legends on reflectorized orange backgrounds unless otherwise noted.

2. Temporary signs shall be installed per MDOT Work Zone Device Special Details WZD-100-A and WZD-125E.

3. Barricades and plastic drums shall be as shown in MDOT Work Zone Device Special Detail WZD-125E.

4. Materials for temporary traffic control devices shall be in accordance with Section 922 of the MDOT 2012 Standard Specifications for Construction, as amended.

**f. Construction.** All work shall comply with Section 812 of the MDOT 2012 Standard Specifications for Construction, as amended.

**g. Measurement and Payment.** Measurement and payment for maintenance of traffic items shall be in accordance with Section 812 of the MDOT 2012 Standard Specifications for Construction, as amended.

1. Payment for barricades, lighted arrows, plastic drums, and temporary signs will be based on the maximum number of units required at any one time for the entire project. Moving of units from one location to another is considered included in the appropriate pay item.

2. No additional compensation will be provided for unused temporary traffic control items.

3. Any additional maintenance of traffic items used to expedite construction shall be at the Contractor's expense.

### MINIMUM MERGING TAPER LENGTH "L" (FEET)

OFFSET FEET	POSTED SPEED LIMIT, MPH (PRIOR TO WORK AREA)									
	25	30	35	40	45	50	55	60	65	70
1	10	15	20	27	45	50	55	60	65	70
2	21	30	41	53	90	100	110	120	130	140
3	31	45	61	80	135	150	165	180	195	210
4	42	60	82	107	180	200	220	240	260	280
5	52	75	102	133	225	250	275	300	325	350
6	63	90	123	160	270	300	330	360	390	420
7	73	105	143	187	315	350	385	420	455	490
8	83	120	163	213	360	400	440	480	520	560
9	94	135	184	240	405	450	495	540	585	630
10	104	150	204	267	450	500	550	600	650	700
11	115	165	225	293	495	550	605	660	715	770
12	125	180	245	320	540	600	660	720	780	840
13	135	195	266	347	585	650	715	780	845	910
14	146	210	286	374	630	700	770	840	910	980
15	157	225	307	400	675	750	825	900	975	1050

TAPER LENGTH "L" IN FEET

THE FORMULAS FOR THE MINIMUM LENGTH OF A MERGING TAPER IN DERIVING THE "L" VALUES SHOWN IN THE ABOVE TABLES ARE AS FOLLOWS:

"L" =  $\frac{W \times S^2}{60}$  WHERE POSTED SPEED PRIOR TO THE WORK AREA IS 40 MPH OR LESS

"L" = S x W WHERE POSTED SPEED PRIOR TO THE WORK AREA IS 45 MPH OR GREATER

- L = MINIMUM LENGTH OF MERGING TAPER
- S = POSTED SPEED LIMIT IN MPH PRIOR TO WORK AREA
- W = WIDTH OF OFFSET

#### TYPES OF TAPERS

##### UPSTREAM TAPERS


- MERGING TAPER
- SHIFTING TAPER
- SHOULDER TAPER
- TWO-WAY TRAFFIC TAPER

##### DOWNSTREAM TAPERS

(USE IS OPTIONAL)

#### TAPER LENGTH

- L - MINIMUM
- 1/2 L - MINIMUM
- 1/3 L - MINIMUM
- 100' - MAXIMUM
- 100' - MINIMUM (PER LANE)

 TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL	TABLES FOR "L", "D" AND "B" VALUES		
	DRAWN BY: CON:AE:djf	JUNE 2006	SHEET 1 OF 2
CHECKED BY: BMM	PLAN DATE:	M0020a	
FILE: K:/DGN/TSR/STDS/ENGLISH/MNTTRF/M0020a.dgn		REV. 08/21/2006	

DISTANCE BETWEEN TRAFFIC CONTROL DEVICES "D"  
AND LENGTH OF LONGITUDINAL BUFFER SPACE ON  
"WHERE WORKERS PRESENT" SEQUENCES


"D" DISTANCES	POSTED SPEED LIMIT, MPH (PRIOR TO WORK AREA)									
	25	30	35	40	45	50	55	60	65	70
D (FEET)	250	300	350	400	450	500	550	600	650	700

GUIDELINES FOR LENGTH OF  
LONGITUDINAL BUFFER SPACE "B"

SPEED* MPH	LENGTH FEET
20	33
25	50
30	83
35	132
40	181
45	230
50	279
55	329
60	411
65	476
70	542

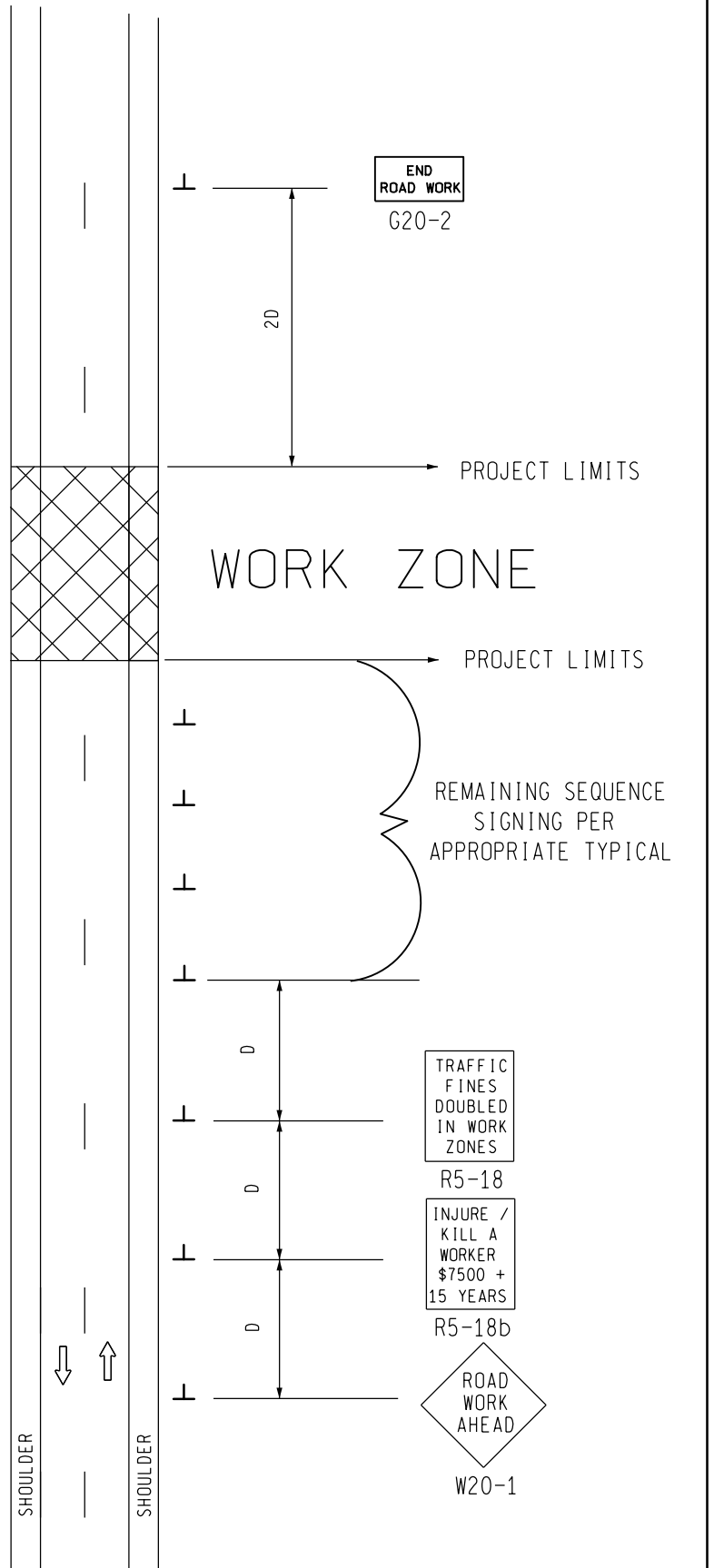
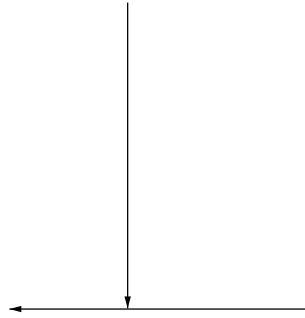
\* POSTED SPEED, OFF PEAK 85TH PERCENTILE SPEED PRIOR TO WORK STARTING, OR THE ANTICIPATED OPERATING SPEED

1 BASED UPON AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) BRAKING DISTANCE PORTION OF STOPPING SIGHT DISTANCE FOR WET AND LEVEL PAVEMENTS (A POLICY ON GEOMETRIC DESIGN OF HIGHWAY AND STREETS), AASHTO. THIS AASHTO DOCUMENT ALSO RECOMMENDS ADJUSTMENTS FOR THE EFFECT OF GRADE ON STOPPING AND VARIATION FOR TRUCKS.

 TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL	TABLES FOR "L", "D" AND "B" VALUES		
	DRAWN BY: CON:AE:djf CHECKED BY: BMM	JUNE 2006 PLAN DATE:	M0020a
FILE: K:/DGN/TSR/STDS/ENGLISH/MNTTRF/M0020a.dgn      REV. 08/21/2006			



SIGN PLACEMENT  
IS THE SAME FOR  
BOTH DIRECTIONS



SIGN = 48 f+2 - TYPE B  
FOR ONE DIRECTION OF TRAFFIC  
W20-1 QUANTITY INCLUDED WITH  
APPROPRIATE TYPICAL FOR  
SEQUENCE SIGNING

<p>TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL</p>	<p>TYPICAL ADVANCE SIGNING TREATMENT FOR INTERMEDIATE AND SHORT TERM STATIONARY WORK ZONE OPERATIONS WHERE ALL TRAFFIC CONTROL DEVICES ARE REMOVED AT END OF EACH WORK DAY ON AN UNDIVIDED TWO-WAY ROADWAY</p>	
	<p>DRAWN BY: CON:AE:djf CHECKED BY: BMM:CRB</p>	<p>OCTOBER 2011 PLAN DATE:</p>
<p>FILE: PW RD/TS/Typicals/Signs/MT NON FWY/M0050a.dgn REV. 10/13/2011</p>		

NOT TO SCALE


## NOTES

30. THE APPROPRIATE ADVANCE SIGNING SEQUENCE(S), (M0030a THROUGH M0080a) SHALL BE USED ON ALL PROJECTS.
35. THESE SIGNS ARE INTENDED TO BE USED WITHIN THE LIMITS OF THE TEMPORARY SEQUENCE SIGNING AS IS SHOWN ON 1 OF 2. THESE SIGNS ARE NOT TO BE INTERMINGLED WITH ANY OTHER TEMPORARY SEQUENCE SIGNING EXCEPT AS SHOWN.



### SIGN SIZES

G20-2	-	48" x 24"
R5-18	-	48" x 60"
R5-18b	-	48" x 60"
W20-1	-	48" x 48"

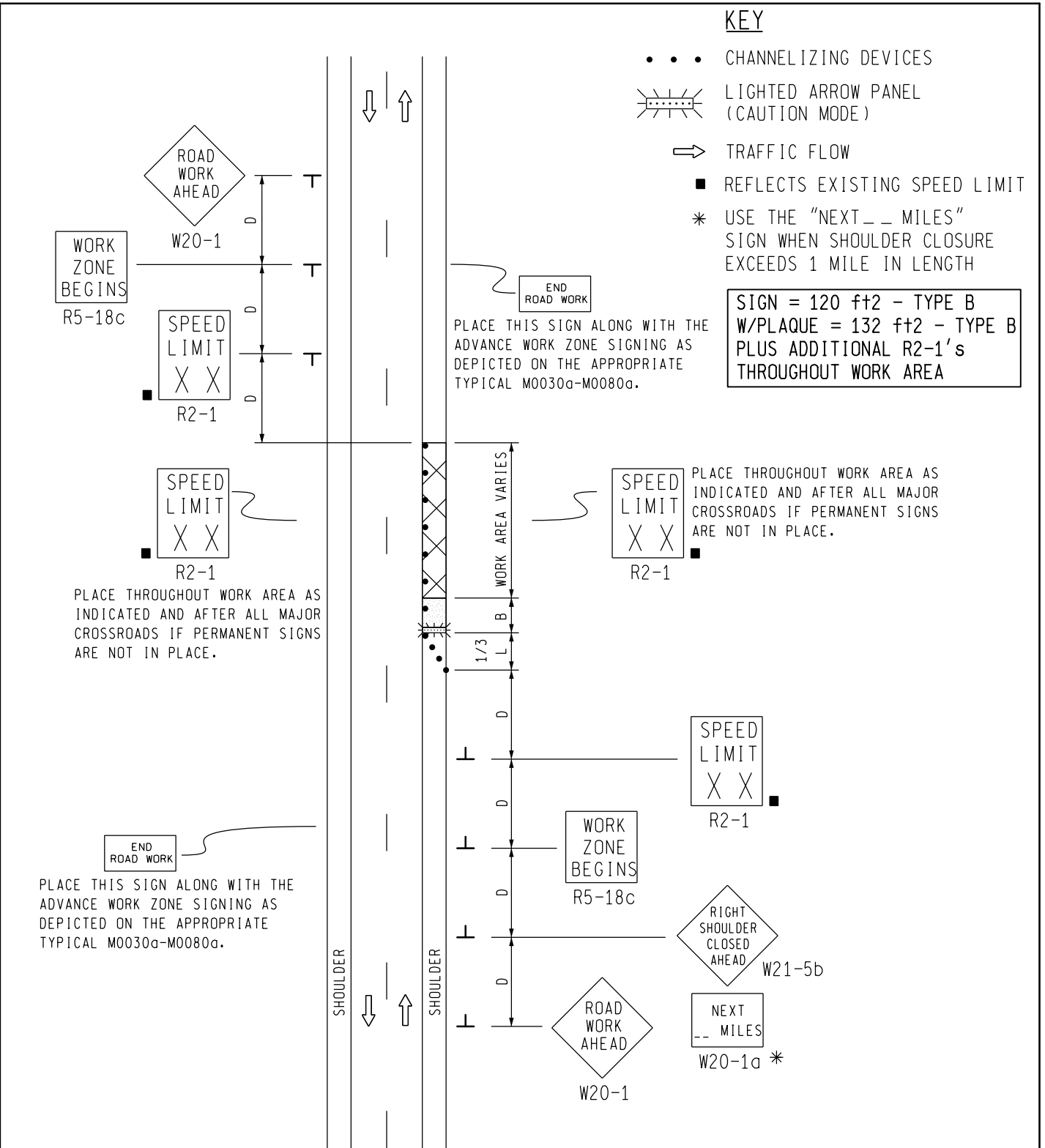
NOT TO SCALE

 TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL	TYPICAL ADVANCE SIGNING TREATMENT FOR INTERMEDIATE AND SHORT TERM STATIONARY WORK ZONE OPERATIONS WHERE ALL TRAFFIC CONTROL DEVICES ARE REMOVED AT END OF EACH WORK DAY ON AN UNDIVIDED TWO-WAY ROADWAY	
	DRAWN BY: CON:AE:djf	OCTOBER 2011
CHECKED BY: BMM:CRB	PLAN DATE:	M0050a
FILE: PW RD/TS/Typicals/Signs/MT NON FWY/M0050a.dgn		REV. 10/13/2011

**KEY**

- • • CHANNELIZING DEVICES
-  LIGHTED ARROW PANEL (CAUTION MODE)
-  TRAFFIC FLOW
- REFLECTS EXISTING SPEED LIMIT
- \* USE THE "NEXT -- MILES" SIGN WHEN SHOULDER CLOSURE EXCEEDS 1 MILE IN LENGTH

SIGN = 120 ft± - TYPE B  
 W/PLAQUE = 132 ft± - TYPE B  
 PLUS ADDITIONAL R2-1's  
 THROUGHOUT WORK AREA



PLACE THROUGHOUT WORK AREA AS INDICATED AND AFTER ALL MAJOR CROSSROADS IF PERMANENT SIGNS ARE NOT IN PLACE.

PLACE THROUGHOUT WORK AREA AS INDICATED AND AFTER ALL MAJOR CROSSROADS IF PERMANENT SIGNS ARE NOT IN PLACE.

PLACE THIS SIGN ALONG WITH THE ADVANCE WORK ZONE SIGNING AS DEPICTED ON THE APPROPRIATE TYPICAL M0030a-M0080a.

PLACE THIS SIGN ALONG WITH THE ADVANCE WORK ZONE SIGNING AS DEPICTED ON THE APPROPRIATE TYPICAL M0030a-M0080a.

**MDOT**  
 Michigan Department of Transportation  
 TRAFFIC AND SAFETY  
 MAINTAINING TRAFFIC  
 TYPICAL

TYPICAL TEMPORARY TRAFFIC CONTROL  
 FOR A SHOULDER CLOSURE ON A TWO  
 LANE TWO-WAY ROADWAY  
 NO SPEED REDUCTION

DRAWN BY: CON:AE:djf  
 CHECKED BY: BMM:CRB

OCTOBER 2011  
 PLAN DATE:

M0110a

SHEET  
 1 OF 2

NOT TO SCALE

FILE: PW RD/TS/Typicals/Signs/MT NON FWY/M0110a.dgn REV. 10/04/2011


## NOTES

1. D = DISTANCE BETWEEN TRAFFIC CONTROL DEVICES  
 $1/3 L$  = MINIMUM LENGTH OF TAPER  
 B = LENGTH OF LONGITUDINAL BUFFER  
 SEE **M0020a** FOR "D," "L," AND "B" VALUES
2. ALL NON-APPLICABLE SIGNING WITHIN THE CIA SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
3. DISTANCES BETWEEN SIGNS, THE VALUES FOR WHICH ARE SHOWN IN TABLE D, ARE APPROXIMATE AND MAY NEED ADJUSTING AS DIRECTED BY THE ENGINEER.
- 3A. THE "WORK ZONE BEGINS" (R5-18c) SIGN SHALL BE USED ONLY IN THE INITIAL SIGNING SEQUENCE IN THE WORK ZONE. SUBSEQUENT SEQUENCES IN THE SAME WORK ZONE SHALL OMIT THIS SIGN AND THE QUANTITIES SHALL BE ADJUSTED APPROPRIATELY.
- 4E. THE MAXIMUM RECOMMENDED DISTANCE(S) BETWEEN CHANNELIZING DEVICES SHOULD BE EQUAL IN FEET TO THE POSTED SPEED IN MILES PER HOUR ON TAPER(S) AND TWICE THE POSTED SPEED IN THE PARALLEL AREA(S).
5. FOR OVERNIGHT CLOSURES, TYPE III BARRICADES SHALL BE LIGHTED.
6. WHEN CALLED FOR IN THE FHWA ACCEPTANCE LETTER FOR THE SIGN SYSTEM SELECTED, THE TYPE A WARNING FLASHER, SHOWN ON THE WARNING SIGNS, SHALL BE POSITIONED ON THE SIDE OF THE SIGN NEAREST THE ROADWAY.
7. ALL TEMPORARY SIGNS, TYPE III BARRICADES, THEIR SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL MEET NCHRP 350 CRASHWORTHLY REQUIREMENTS STIPULATED IN THE CURRENT EDITION OF THE MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, THE STANDARD PLANS AND APPLICABLE SPECIAL PROVISIONS. ONLY DESIGNS AND MATERIALS APPROVED BY MDOT WILL BE ALLOWED.
8. WHEN BUFFER AREAS ARE ESTABLISHED, THERE SHALL BE NO EQUIPMENT OR MATERIALS STORED OR WORK CONDUCTED IN THE BUFFER AREA.
- 29A. THE TYPE OF REFLECTIVE SHEETING USED FOR THE W20-1a PLAQUE SHALL BE THE SAME AS THE TYPE USED FOR THE PARENT SIGN.

### SIGN SIZES

DIAMOND WARNING	- 48" x 48"
W20-1a PLAQUE	- 48" x 36"
R2-1 REGULATORY	- 48" x 60"
R5-18c REGULATORY	- 48" x 48"

NOT TO SCALE

 TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL	TYPICAL TEMPORARY TRAFFIC CONTROL FOR A SHOULDER CLOSURE ON A TWO LANE TWO-WAY ROADWAY NO SPEED REDUCTION	
	DRAWN BY: CON:AE:djf CHECKED BY: BMM:CRB	OCTOBER 2011 PLAN DATE:
FILE: PW RD/TS/Typicals/Signs/MT NON FWY/M0110a.dgn REV. 10/04/2011		






PLACE THROUGHOUT WORK AREA AS INDICATED AND AFTER ALL MAJOR CROSSROADS IF PERMANENT SIGNS ARE NOT IN PLACE.

PLACE THIS SIGN ALONG WITH THE ADVANCE WORK ZONE SIGNING AS DEPICTED ON THE APPROPRIATE TYPICAL M0030a-M0080a.

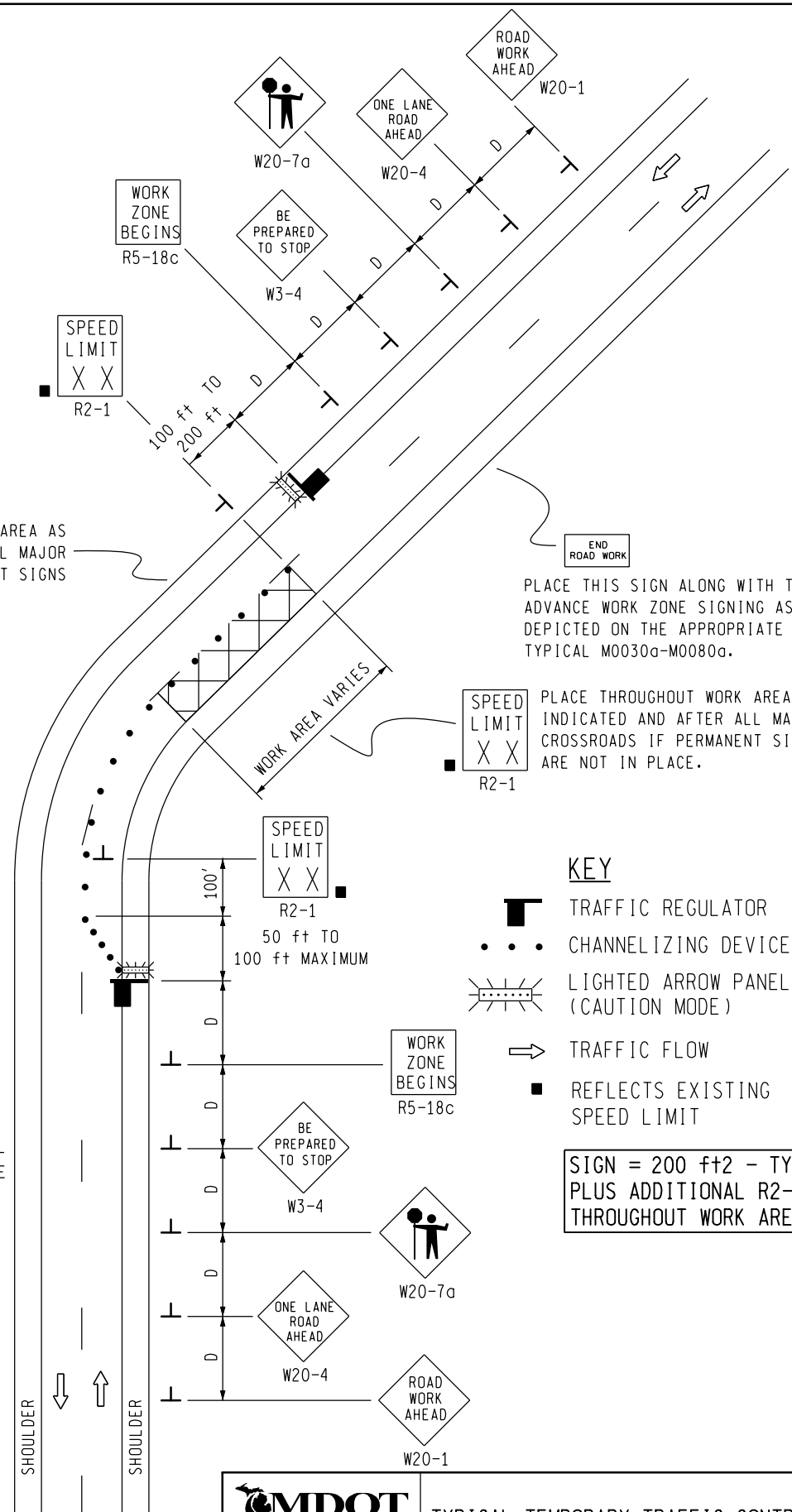
PLACE THROUGHOUT WORK AREA AS INDICATED AND AFTER ALL MAJOR CROSSROADS IF PERMANENT SIGNS ARE NOT IN PLACE.

PLACE THIS SIGN ALONG WITH THE ADVANCE WORK ZONE SIGNING AS DEPICTED ON THE APPROPRIATE TYPICAL M0030a-M0080a.


**KEY**

-  TRAFFIC REGULATOR
-  CHANNELIZING DEVICES
-  LIGHTED ARROW PANEL (CAUTION MODE)
-  TRAFFIC FLOW
-  REFLECTS EXISTING SPEED LIMIT

SIGN = 200 ft± - TYPE B PLUS ADDITIONAL R2-1's THROUGHOUT WORK AREA



NOT TO SCALE

 Michigan Department of Transportation TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL		TYPICAL TEMPORARY TRAFFIC CONTROL FOR A TWO-LANE TWO-WAY ROADWAY WHERE ONE LANE IS CLOSED UTILIZING TRAFFIC REGULATORS, NO SPEED REDUCTION	
DRAWN BY: CON:AE:djf CHECKED BY: BMM:CRB	OCTOBER 2011 PLAN DATE:	M0140a	SHEET 1 OF 2
FILE: PW RD/TS/Typicals/Signs/MT NON Fwy/M0140a.dgn REV. 10/04/2011			


## NOTES

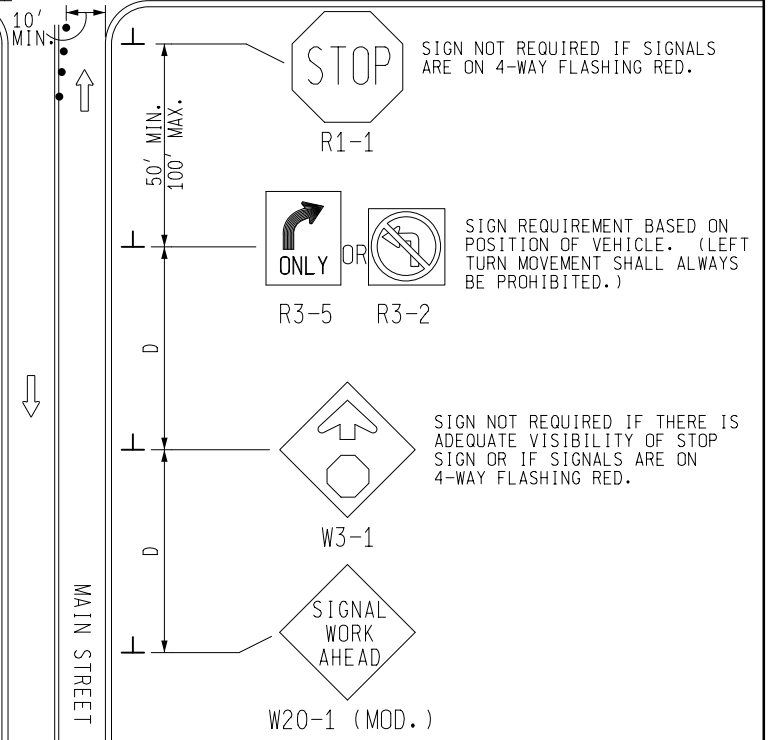
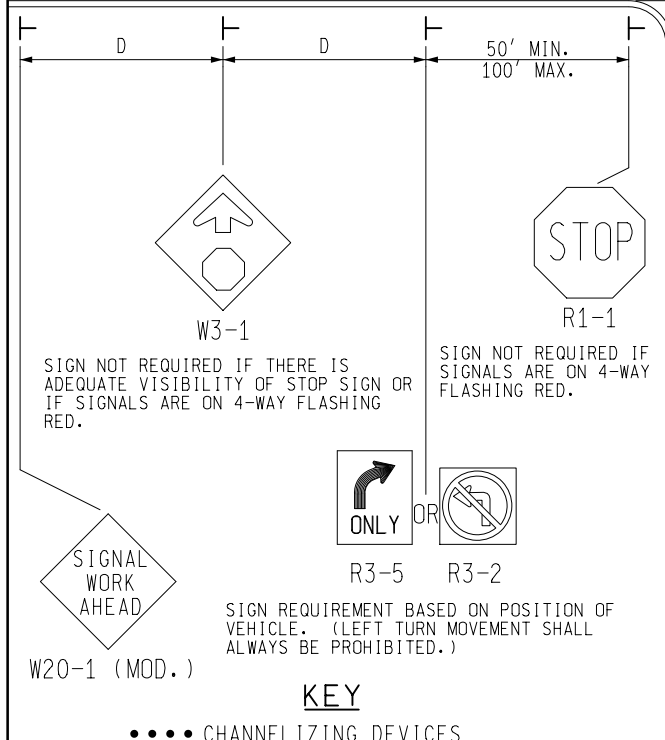
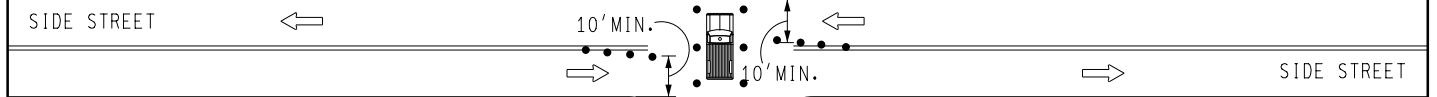
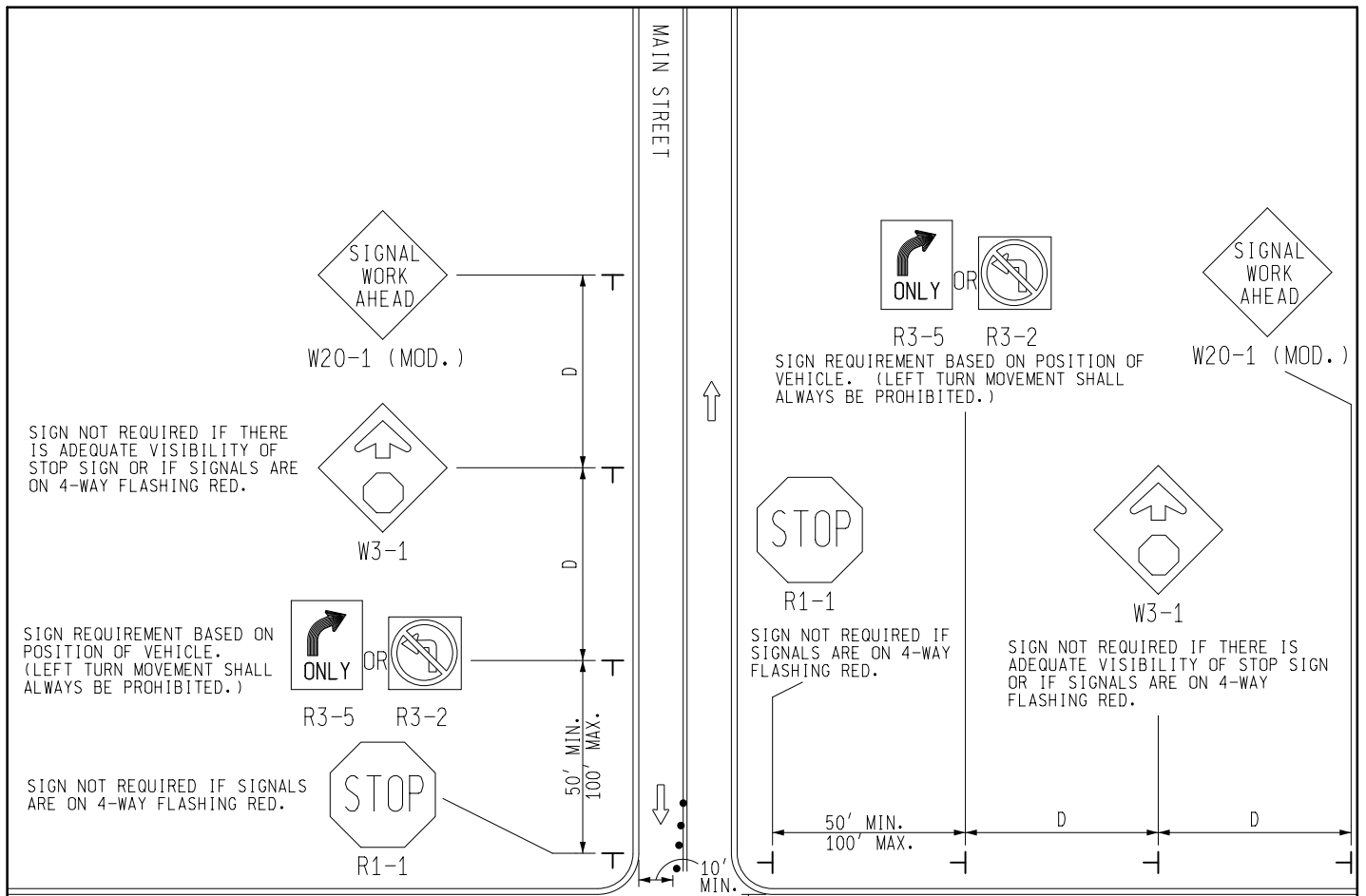
- 1H. D = DISTANCE BETWEEN TRAFFIC CONTROL DEVICES AND LENGTH OF LONGITUDINAL BUFFERS  
SEE **M0020a** FOR "D" VALUES.
2. ALL NON-APPLICABLE SIGNING WITHIN THE CIA SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
3. DISTANCES BETWEEN SIGNS, THE VALUES FOR WHICH ARE SHOWN IN TABLE D, ARE APPROXIMATE AND MAY NEED ADJUSTING AS DIRECTED BY THE ENGINEER.
- 3A. THE "WORK ZONE BEGINS" (R5-18c) SIGN SHALL BE USED ONLY IN THE INITIAL SIGNING SEQUENCE IN THE WORK ZONE. SUBSEQUENT SEQUENCES IN THE SAME WORK ZONE SHALL OMIT THIS SIGN AND THE QUANTITIES SHALL BE ADJUSTED APPROPRIATELY.
- 4A. THE MAXIMUM RECOMMENDED DISTANCE(S) BETWEEN CHANNELIZING DEVICES IN THE TAPER AREA(S) SHOULD BE 15 FEET AND SHOULD BE EQUAL IN FEET TO TWICE THE POSTED SPEED IN MILES PER HOUR IN THE PARALLEL AREA(S).
5. FOR OVERNIGHT CLOSURES, TYPE III BARRICADES SHALL BE LIGHTED.
6. WHEN CALLED FOR IN THE FHWA ACCEPTANCE LETTER FOR THE SIGN SYSTEM SELECTED, THE TYPE A WARNING FLASHER, SHOWN ON THE WARNING SIGNS, SHALL BE POSITIONED ON THE SIDE OF THE SIGN NEAREST THE ROADWAY.
7. ALL TEMPORARY SIGNS, TYPE III BARRICADES, THEIR SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL MEET NCHRP 350 CRASHWORTHLY REQUIREMENTS STIPULATED IN THE CURRENT EDITION OF THE MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, THE STANDARD PLANS AND APPLICABLE SPECIAL PROVISIONS. ONLY DESIGNS AND MATERIALS APPROVED BY MDOT WILL BE ALLOWED.
9. ALL TRAFFIC REGULATORS SHALL BE PROPERLY TRAINED AND SUPERVISED.
- 9A. IN ANY OPERATION INVOLVING MORE THAN ONE TRAFFIC REGULATOR, ONE PERSON SHOULD BE DESIGNATED AS HEAD TRAFFIC REGULATOR.
10. ALL TRAFFIC REGULATORS' CONDUCT, THEIR EQUIPMENT, AND TRAFFIC REGULATING PROCEDURES SHALL CONFORM TO THE CURRENT EDITION OF THE MICHIGAN MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES (MMUTCD) AND THE CURRENT EDITION OF THE MDOT HANDBOOK ENTITLED "TRAFFIC REGULATORS INSTRUCTION MANUAL."
11. WHEN TRAFFIC REGULATING IS ALLOWED DURING THE HOURS OF DARKNESS, APPROPRIATE LIGHTING SHALL BE PROVIDED TO SUFFICIENTLY ILLUMINATE THE TRAFFIC REGULATOR'S STATIONS.
- 12E. THE MAXIMUM DISTANCE BETWEEN THE TRAFFIC REGULATORS SHALL BE NO MORE THAN 2 MILES IN LENGTH UNLESS RESTRICTED FURTHER IN THE SPECIAL PROVISIONS FOR MAINTAINING TRAFFIC. ALL SEQUENCES OF MORE THAN 2 MILES IN LENGTH WILL REQUIRE WRITTEN PERMISSION FROM THE ENGINEER BEFORE PROCEEDING.
13. WHEN INTERSECTING ROADS OR SIGNIFICANT TRAFFIC GENERATORS (SHOPPING CENTERS, MOBILE HOME PARKS, ETC.) OCCUR WITHIN THE ONE-LANE TWO-WAY OPERATION, INTERMEDIATE TRAFFIC REGULATORS AND APPROPRIATE SIGNING SHALL BE PLACED AT THESE LOCATIONS.
14. ADDITIONAL SIGNING AND/OR ELONGATED SIGNING SEQUENCES SHOULD BE USED WHEN TRAFFIC VOLUMES ARE SIGNIFICANT ENOUGH TO CREATE BACKUPS BEYOND THE W3-4 SIGNS.
15. THE HAND HELD (PADDLE) SIGNS REQUIRED BY THE MMUTCD TO CONTROL TRAFFIC WILL BE PAID FOR AS PART OF FLAG CONTROL.
- 28E. THE TRAFFIC REGULATORS SHOULD BE POSITIONED AT OR NEAR THE SIDE OF THE ROAD SO THAT THEY ARE SEEN CLEARLY AT A MINIMUM DISTANCE OF 500 FEET. THIS MAY REQUIRE EXTENDING THE BEGINNING OF THE LANE CLOSURE TO OVERCOME VIEWING PROBLEMS CAUSED BY HILLS AND CURVES.

### SIGN SIZES

DIAMOND WARNING - 48" x 48"  
 R2-1 REGULATORY - 48" x 60"  
 R5-18c REGULATORY - 48" x 48"

NOT TO SCALE

 TRAFFIC AND SAFETY <b>MAINTAINING TRAFFIC          TYPICAL</b>	<b>TYPICAL TEMPORARY TRAFFIC CONTROL FOR          A TWO-LANE TWO-WAY ROADWAY WHERE ONE          LANE IS CLOSED UTILIZING TRAFFIC          REGULATORS, NO SPEED REDUCTION</b>		
DRAWN BY: CON:AE:djf	OCTOBER 2011	<b>M0140a</b>	SHEET
CHECKED BY: BMM:CRB	PLAN DATE:		2 OF 2
FILE: PW RD/TS/Typicals/Signs/MT NON FWY/M0140a.dgn REV. 10/04/2011			



**KEY**

•••• CHANNELIZING DEVICES

⇨ TRAFFIC FLOW

WORK VEHICLE WITH FLASHING OR ROTATING LIGHTS

SIGN (R1-1 MIN.) = 19.36 ft ± - TYPE A
SIGN (WITH R3-2) = 144 ft ± - TYPE B
OR
SIGN (WITH R3-5) = 158 ft ± - TYPE B

NOT TO SCALE



TRAFFIC AND SAFETY  
MAINTAINING TRAFFIC  
TYPICAL

TYPICAL TEMPORARY TRAFFIC CONTROL FOR TRAFFIC SIGNAL WORK IN INTERSECTION ON A TWO LANE ROADWAY WITH WORK DURATION GREATER THAN ONE HOUR

DRAWN BY: JK

(SPECIAL DETAIL)

CHECKED BY: MB:CRB

PLAN DATE:

M2800a

SHEET

1 OF 2

FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2800a.dgn REV. 10/17/2011


## NOTES:

- 1N. D = DISTANCE BETWEEN TRAFFIC CONTROL DEVICES SEE M0020a FOR "D" VALUES
  2. ALL NON-APPLICABLE SIGNING WITHIN THE CONSTRUCTION INFLUENCE AREA (CIA) SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
  3. DISTANCES BETWEEN SIGNS, THE VALUES FOR WHICH ARE SHOWN IN TABLE D, ARE APPROXIMATE AND MAY NEED ADJUSTING AS DIRECTED BY THE ENGINEER.
  - 4C. THE MAXIMUM RECOMMENDED DISTANCE(S) BETWEEN CHANNELIZING DEVICES IN THE TAPER AREA(S) SHOULD BE 15 FEET.
  7. ALL TEMPORARY SIGNS, TYPE III BARRICADES, THEIR SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL MEET NCHRP 350 CRASH WORTHY REQUIREMENTS STIPULATED IN THE CURRENT EDITION OF THE MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, THE STANDARD PLANS AND APPLICABLE SPECIAL PROVISIONS. ONLY DESIGNS AND MATERIALS APPROVED BY MDOT WILL BE ALLOWED.
  32. THESE SIGNS SHALL BE LEFT IN PLACE AT THEIR PRESCRIBED LOCATIONS UNTIL ALL TEMPORARY TRAFFIC CONTROL HAS BEEN REMOVED.
  35. THESE SIGNS ARE INTENDED TO BE USED WITHIN THE LIMITS OF THE TEMPORARY SEQUENCE SIGNING AS IS SHOWN ON 1 OF 2. THESE SIGNS ARE NOT TO BE INTERMINGLED WITH ANY OTHER TEMPORARY SEQUENCE SIGNING EXCEPT AS SHOWN.
- EXISTING SIGNAL SHALL BE EITHER 4-WAY FLASHING RED, BAGGED, OR TURNED OFF.
  - WORK AREA AND TAPERS DELINEATED BY 28" CONES (DAYTIME) OR GRABBER CONES (NIGHTTIME).
  - IF THE AERIAL BUCKET IS LOCATED OVER ACTIVE TRAVEL LANE(S), THE CONTRACTOR MUST HAVE A DESIGNATED PERSON "SPOTTER" ENSURING THAT THE LOWEST POINT OF THE BUCKET DOESN'T TRAVEL BELOW THE MINIMUM 14 FOOT VERTICAL CLEARANCE REQUIREMENTS, THE SPOTTER SHOULD KNOW THE ACTUAL HEIGHT OF THE SIGNAL TO DETERMINE THE MINIMUM WORKING HEIGHT.
  - SUFFICIENT VERTICAL DISTANCE FROM ACTIVE TRAFFIC MUST BE MAINTAINED AT ALL TIMES. IF THE WORK OPERATION REQUIRES THE MINIMUM 14 FOOT WORKING HEIGHT TO BE COMPROMISED, THE CONTRACTOR SHALL EITHER UTILIZE AN ALTERNATE SET UP OR PLACE THE INTERSECTION IN A 4 WAY STOP USING APPROPRIATE SIGNING AND USE A TRAFFIC REGULATOR TO CONTROL TRAFFIC THROUGH THE INTERSECTION.
  - ALL SIGNS SHOULD BE CONTAINED WITHIN THE SIGNAL INFLUENCE AREA.

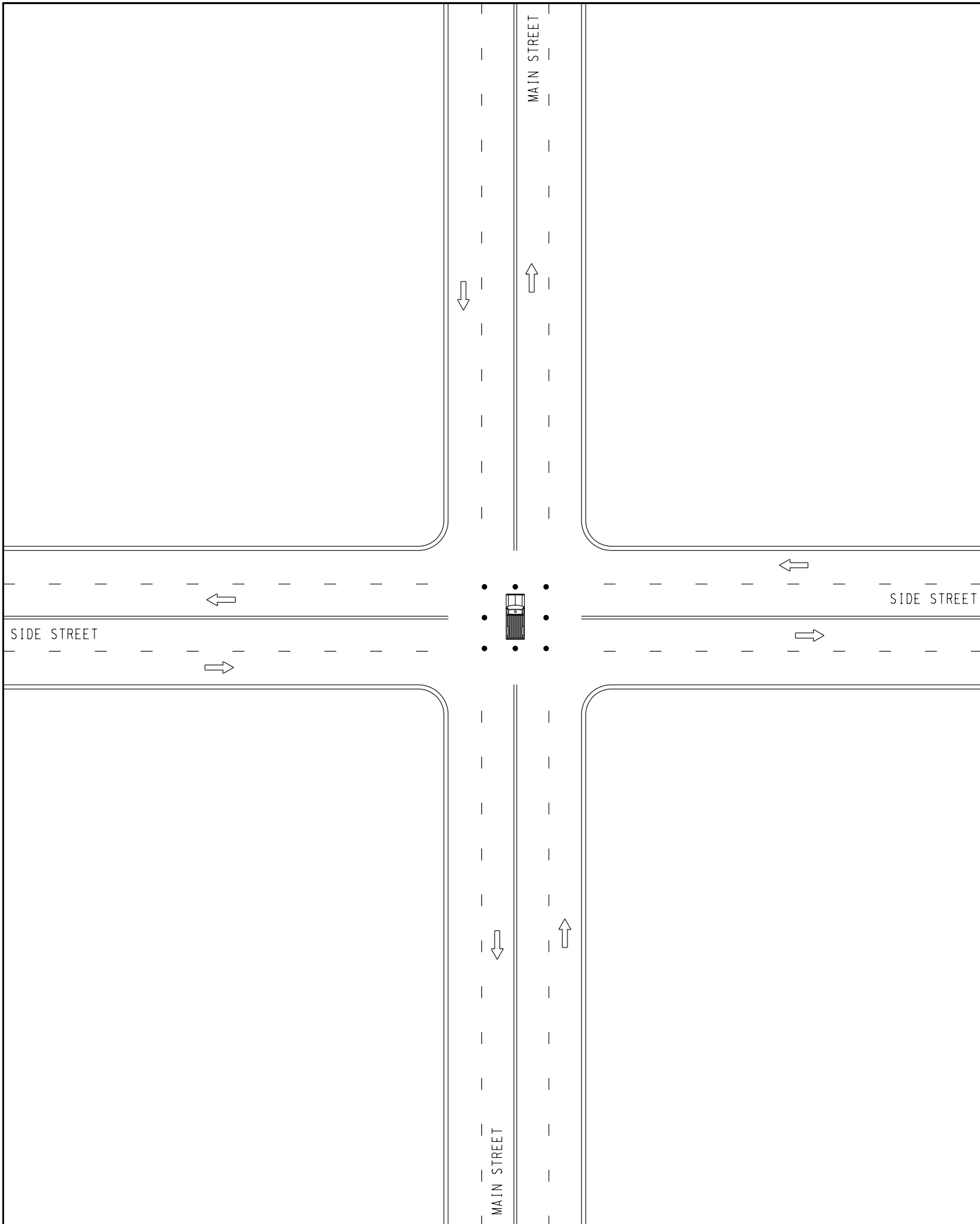
### SIGN SIZES

DIAMOND WARNING	- 48" x 48"
MANDATORY MOVEMENT (R3-5)	- 30" x 36"
STOP (R1-1)	- 36" x 36" MIN.
TURN PROHIBITION (R3-2)	- 24" x 24"


NOT TO SCALE

 TRAFFIC AND SAFETY <b>MAINTAINING TRAFFIC TYPICAL</b>		<b>TYPICAL TEMPORARY TRAFFIC CONTROL FOR TRAFFIC SIGNAL WORK IN INTERSECTION ON A TWO LANE ROADWAY WITH WORK DURATION GREATER THAN ONE HOUR</b>	
DRAWN BY: JK	(SPECIAL DETAIL)	M2800a	SHEET
CHECKED BY: MB:CRB	PLAN DATE:		2 OF 2
FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2800a.dgn REV. 10/17/2011			





**KEY**

- CHANNELIZING DEVICES
- TRAFFIC FLOW
-  WORK VEHICLE WITH FLASHING OR ROTATING LIGHTS

NOT TO SCALE


**MDOT**  
Michigan Department of Transportation  
TRAFFIC AND SAFETY  
MAINTAINING TRAFFIC  
TYPICAL

TYPICAL TEMPORARY TRAFFIC CONTROL  
FOR TRAFFIC SIGNAL WORK IN  
INTERSECTION WITH WORK DURATION  
LESS THAN ONE HOUR

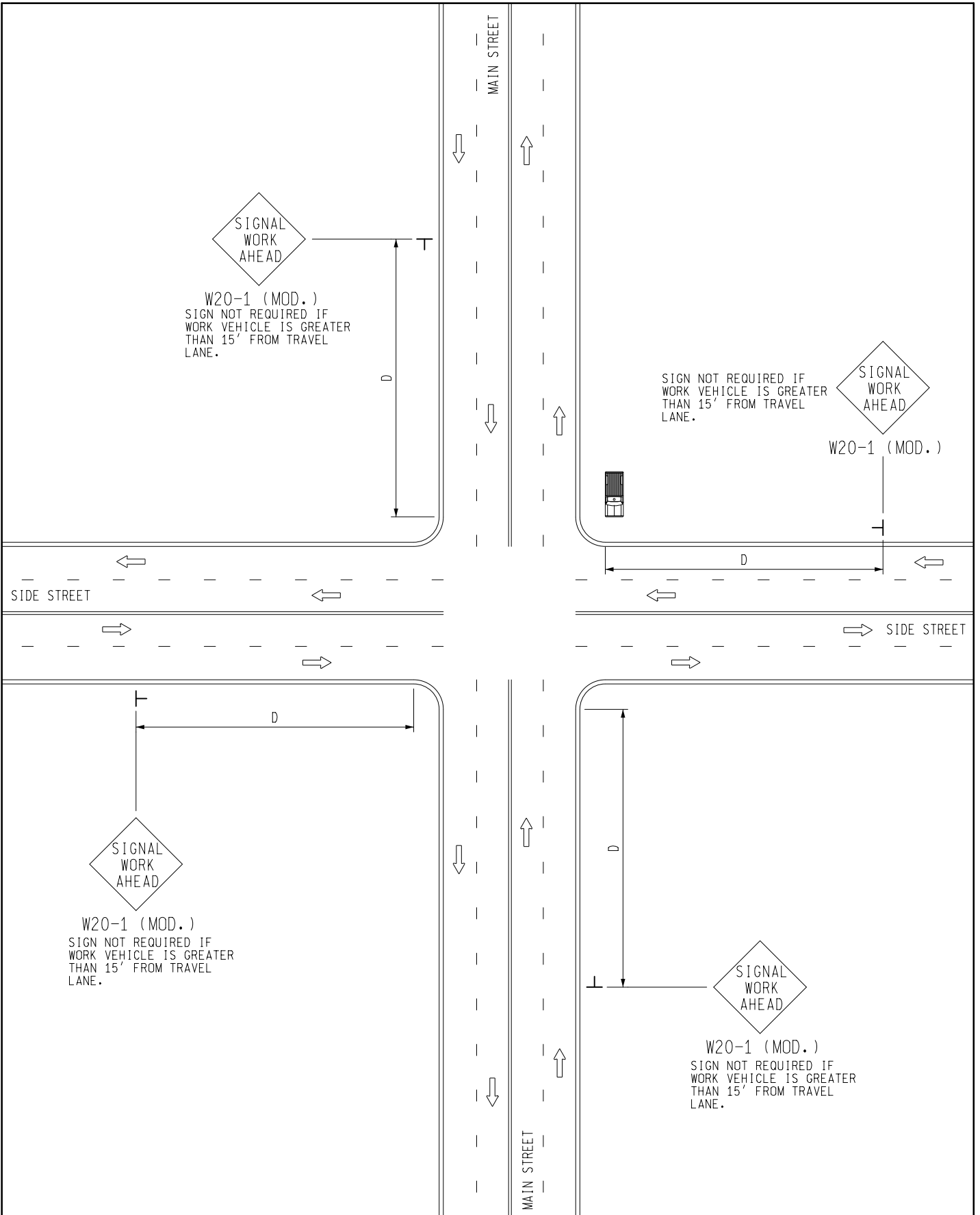
DRAWN BY: JK	(SPECIAL DETAIL)	M2801a	SHEET
CHECKED BY: MB:CRB	PLAN DATE:		1 OF 2
FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2801a.dgn REV. 10/17/2011			

**NOTES:**

- 2. ALL NON-APPLICABLE SIGNING WITHIN THE CONSTRUCTION INFLUENCE AREA (CIA) SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
- 7. ALL TEMPORARY SIGNS, TYPE III BARRICADES, THEIR SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL MEET NCHRP 350 CRASH WORTHY REQUIREMENTS STIPULATED IN THE CURRENT EDITION OF THE MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, THE STANDARD PLANS AND APPLICABLE SPECIAL PROVISIONS. ONLY DESIGNS AND MATERIALS APPROVED BY MDT WILL BE ALLOWED.
- 28" CONES (DAYTIME) OR GRABBER CONES (NIGHTTIME).
- POSITION OF TRUCK MAY BE MOVED TO FACILITATE WORK. TRUCK SHALL BE DELINEATED BY CHANNELIZING DEVICES.
- IF THE AERIAL BUCKET IS LOCATED OVER ACTIVE TRAVEL LANE(S), THE CONTRACTOR MUST HAVE A DESIGNATED PERSON "SPOTTER" ENSURING THAT THE LOWEST POINT OF THE BUCKET DOESN'T TRAVEL BELOW THE MINIMUM 14 FOOT VERTICAL CLEARANCE REQUIREMENTS. THE SPOTTER SHOULD KNOW THE ACTUAL HEIGHT OF THE SIGNAL TO DETERMINE THE MINIMUM WORKING HEIGHT.
- SUFFICIENT VERTICAL DISTANCE FROM ACTIVE TRAFFIC MUST BE MAINTAINED AT ALL TIMES. IF THE WORK OPERATION REQUIRES THE MINIMUM 14 FOOT WORKING HEIGHT TO BE COMPROMISED, THE CONTRACTOR SHALL EITHER UTILIZE AN ALTERNATE SET UP OR PLACE THE INTERSECTION IN A 4-WAY STOP USING APPROPRIATE SIGNING AND USE A TRAFFIC REGULATOR TO CONTROL TRAFFIC THROUGH THE INTERSECTION.

 Michigan Department of Transportation TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL	TYPICAL TEMPORARY TRAFFIC CONTROL FOR TRAFFIC SIGNAL WORK IN INTERSECTION WITH WORK DURATION LESS THAN ONE HOUR		
	DRAWN BY: JK CHECKED BY: MB:CRB	(SPECIAL DETAIL) PLAN DATE:	M2801a
FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2801a.dgn REV. 10/17/2011			

NOT TO SCALE



W20-1 (MOD.)  
SIGN NOT REQUIRED IF  
WORK VEHICLE IS GREATER  
THAN 15' FROM TRAVEL  
LANE.

SIGN NOT REQUIRED IF  
WORK VEHICLE IS GREATER  
THAN 15' FROM TRAVEL  
LANE.

W20-1 (MOD.)

W20-1 (MOD.)  
SIGN NOT REQUIRED IF  
WORK VEHICLE IS GREATER  
THAN 15' FROM TRAVEL  
LANE.

W20-1 (MOD.)  
SIGN NOT REQUIRED IF  
WORK VEHICLE IS GREATER  
THAN 15' FROM TRAVEL  
LANE.

**KEY**



WORK VEHICLE WITH FLASHING  
OR ROTATING LIGHTS



TRAFFIC FLOW

**SIGN = 64 ft x 2 - TYPE B**

NOT TO SCALE

**MDOT**  
Michigan Department of Transportation  
TRAFFIC AND SAFETY  
MAINTAINING TRAFFIC  
TYPICAL

TYPICAL TEMPORARY TRAFFIC CONTROL  
FOR TRAFFIC SIGNAL WORK OUTSIDE  
OF ROADWAY WITH WORK DURATION  
GREATER THAN ONE HOUR

DRAWN BY: JK

(SPECIAL DETAIL)

CHECKED BY: MB:CRB

PLAN DATE:

**M2802a**

SHEET

1 OF 2

FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2802a.dgn REV. 10/17/2011


**NOTES:**

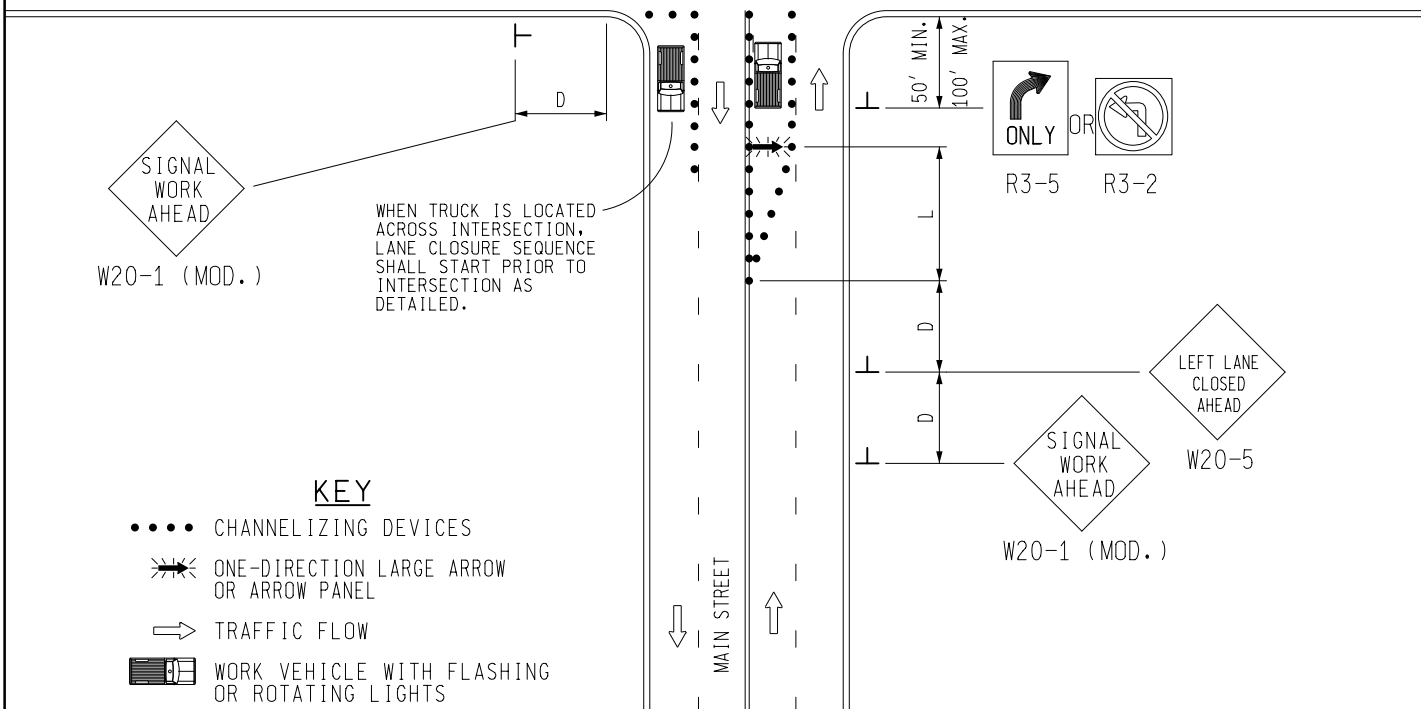
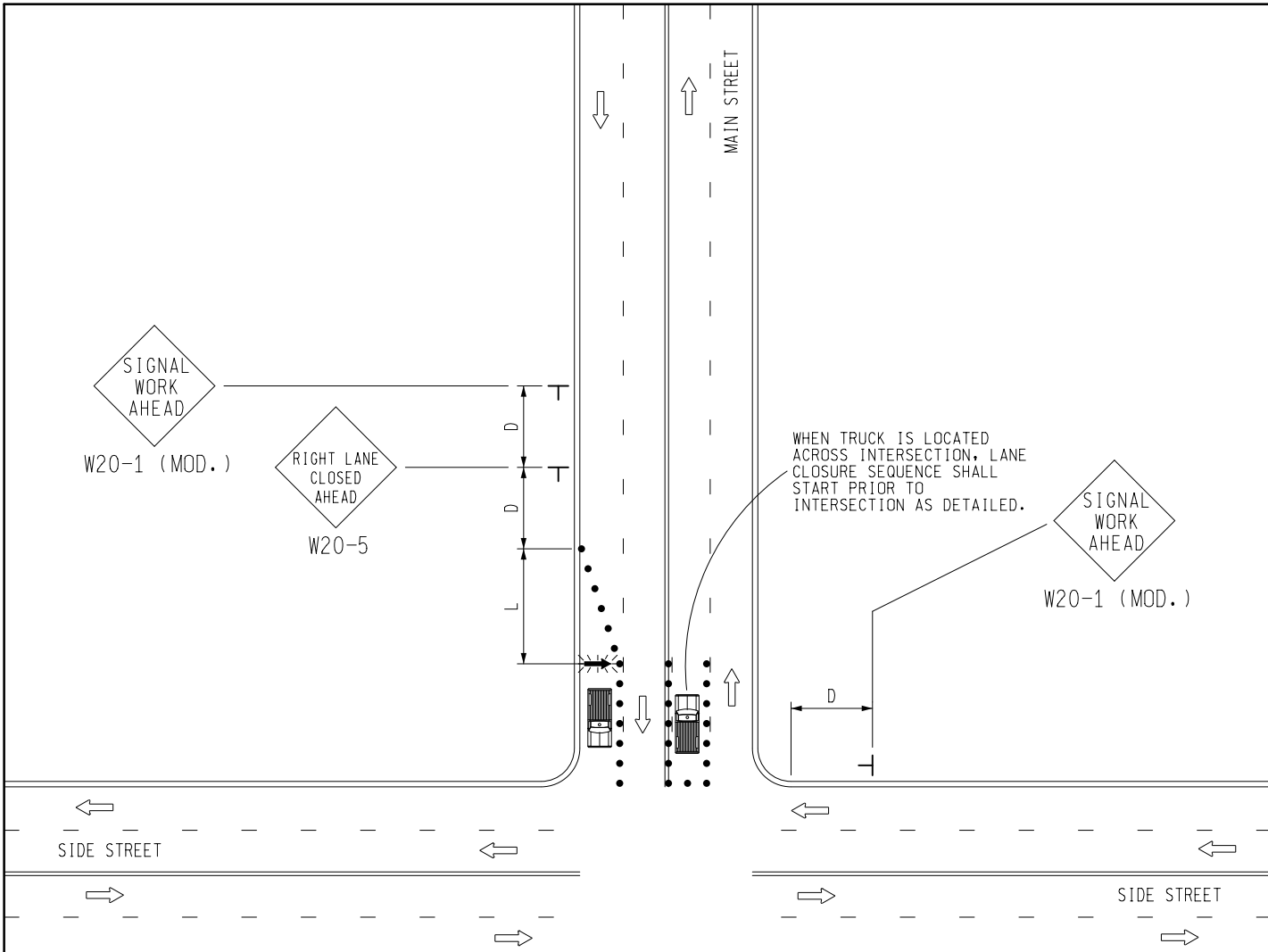
- 1A. SEE M0020a FOR "D" VALUES.
2. ALL NON-APPLICABLE SIGNING WITHIN THE CONSTRUCTION INFLUENCE AREA (CIA) SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
3. DISTANCES BETWEEN SIGNS, THE VALUES FOR WHICH ARE SHOWN IN TABLE D, ARE APPROXIMATE AND MAY NEED ADJUSTING AS DIRECTED BY THE ENGINEER.
7. ALL TEMPORARY SIGNS, TYPE III BARRICADES, THEIR SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL MEET NCHRP 350 CRASH WORTHY REQUIREMENTS STIPULATED IN THE CURRENT EDITION OF THE MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, THE STANDARD PLANS AND APPLICABLE SPECIAL PROVISIONS. ONLY DESIGNS AND MATERIALS APPROVED BY MDT WILL BE ALLOWED.
32. THESE SIGNS SHALL BE LEFT IN PLACE AT THEIR PRESCRIBED LOCATIONS UNTIL ALL TEMPORARY TRAFFIC CONTROL HAS BEEN REMOVED.
35. THESE SIGNS ARE INTENDED TO BE USED WITHIN THE LIMITS OF THE TEMPORARY SEQUENCE SIGNING AS IS SHOWN ON 1 OF 2. THESE SIGNS ARE NOT TO BE INTERMINGLED WITH ANY OTHER TEMPORARY SEQUENCE SIGNING EXCEPT AS SHOWN.
- IF THE AERIAL BUCKET IS LOCATED OVER ACTIVE TRAVEL LANE(S), THE CONTRACTOR MUST HAVE A DESIGNATED PERSON "SPOTTER" ENSURING THAT THE LOWEST POINT OF THE BUCKET DOESN'T TRAVEL BELOW THE MINIMUM 14 FOOT VERTICAL CLEARANCE REQUIREMENTS. THE SPOTTER SHOULD KNOW THE ACTUAL HEIGHT OF THE SIGNAL TO DETERMINE THE MINIMUM WORKING HEIGHT.
- SUFFICIENT VERTICAL DISTANCE FROM ACTIVE TRAFFIC MUST BE MAINTAINED AT ALL TIMES. IF THE WORK OPERATION REQUIRES THE MINIMUM 14 FOOT WORKING HEIGHT TO BE COMPROMISED, THE CONTRACTOR SHALL EITHER UTILIZE AN ALTERNATE SET UP OR PLACE THE INTERSECTION IN A 4 WAY STOP USING APPROPRIATE SIGNING AND USE A TRAFFIC REGULATOR TO CONTROL TRAFFIC THROUGH THE INTERSECTION.
- ALL SIGNS SHOULD BE CONTAINED WITHIN THE SIGNAL INFLUENCE AREA.

**SIGN SIZES**

DIAMOND WARNING - 48" x 48"

NOT TO SCALE

 TRAFFIC AND SAFETY MAINTAINING TRAFFIC TYPICAL	TYPICAL TEMPORARY TRAFFIC CONTROL FOR TRAFFIC SIGNAL WORK OUTSIDE OF ROADWAY WITH WORK DURATION GREATER THAN ONE HOUR	
	DRAWN BY: JK CHECKED BY: MB:CRB	(SPECIAL DETAIL) PLAN DATE:
FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2802a.dgn REV. 10/17/2011		



- KEY**
- CHANNELIZING DEVICES
  - ➔ ONE-DIRECTION LARGE ARROW OR ARROW PANEL
  - ➔ TRAFFIC FLOW
  - WORK VEHICLE WITH FLASHING OR ROTATING LIGHTS

IF USING W1-6's (DAYTIME ONLY) INSTEAD OF ARROW PANELS:  
 SIGN (WITH R3-2) = 116 ft±2 - TYPE B OR  
 SIGN (WITH R3-5) = 119.5 ft±2 - TYPE B  
 IF USING ARROW PANELS INSTEAD OF W1-6's:  
 SIGN (WITH R3-2) = 100 ft±2 - TYPE B OR  
 SIGN (WITH R3-5) = 103.5 ft±2 - TYPE B

**MDOT**  
 Michigan Department of Transportation  
 TRAFFIC AND SAFETY  
 MAINTAINING TRAFFIC  
 TYPICAL

TYPICAL TEMPORARY TRAFFIC CONTROL  
 FOR TRAFFIC SIGNAL WORK IN  
 APPROACH LANE WITH WORK DURATION  
 GREATER THAN ONE HOUR

DRAWN BY: JK	(SPECIAL DETAIL)	M2803a	SHEET 1 OF 2
CHECKED BY: MB:CRB	PLAN DATE:		
FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2803a.dgn REV. 10/17/2011			

NOT TO SCALE


## NOTES:

- 1G. D = DISTANCE BETWEEN TRAFFIC CONTROL DEVICES AND LENGTH OF LONGITUDINAL BUFFERS 1/3 L = MINIMUM LENGTH OF TAPER SEE M0020a FOR "D" AND "L" VALUES
  2. ALL NON-APPLICABLE SIGNING WITHIN THE CONSTRUCTION INFLUENCE AREA (CIA) SHALL BE MODIFIED TO FIT CONDITIONS, COVERED OR REMOVED.
  3. DISTANCES BETWEEN SIGNS, THE VALUES FOR WHICH ARE SHOWN IN TABLE D, ARE APPROXIMATE AND MAY NEED ADJUSTING AS DIRECTED BY THE ENGINEER.
  - 4G. THE MAXIMUM RECOMMENDED DISTANCE(S) BETWEEN CHANNELIZING DEVICES SHOULD BE EQUAL, IN FEET TO 1/2 THE POSTED SPEED IN MILES PER HOUR ON TAPERS AND TO THE POSTED SPEED IN PARALLEL AREA(S).
  7. ALL TEMPORARY SIGNS, TYPE III BARRICADES, THEIR SUPPORT SYSTEMS AND LIGHTING REQUIREMENTS SHALL MEET NCHRP 350 CRASH WORTHY REQUIREMENTS STIPULATED IN THE CURRENT EDITION OF THE MICHIGAN MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, THE STANDARD PLANS AND APPLICABLE SPECIAL PROVISIONS. ONLY DESIGNS AND MATERIALS APPROVED BY MDOT WILL BE ALLOWED.
  26. THE LIGHTED ARROW PANEL SHALL BE LOCATED AT THE BEGINNING OF THE TAPER AS SHOWN. WHEN PHYSICAL LIMITATIONS RESTRICT ITS PLACEMENT AS INDICATED, THEN IT SHALL BE PLACED AS CLOSE TO THE BEGINNING OF THE TAPER AS POSSIBLE.
  32. THESE SIGNS SHALL BE LEFT IN PLACE AT THEIR PRESCRIBED LOCATIONS AND UNTIL ALL TEMPORARY TRAFFIC CONTROL HAS BEEN REMOVED.
  35. THESE SIGNS ARE INTENDED TO BE USED WITHIN THE LIMITS OF THE TEMPORARY SEQUENCE SIGNING AS IS SHOWN ON 1 OF 2. THESE SIGNS ARE NOT TO BE INTERMINGLED WITH ANY OTHER TEMPORARY SEQUENCE SIGNING EXCEPT AS SHOWN.
- SIGNAL IS IN OPERATION.
  - WORK AREA AND TAPERS DELINEATED BY 28" CONES (DAYTIME) OR GRABBER CONES (NIGHTTIME).
  - IF THE AERIAL BUCKET IS LOCATED OVER ACTIVE TRAVEL LANE(S), THE CONTRACTOR MUST HAVE A DESIGNATED PERSON "SPOTTER" ENSURING THAT THE LOWEST POINT OF THE BUCKET DOESN'T TRAVEL BELOW THE MINIMUM 14 FOOT VERTICAL CLEARANCE REQUIREMENTS, THE SPOTTER SHOULD KNOW THE ACTUAL HEIGHT OF THE SIGNAL TO DETERMINE THE MINIMUM WORKING HEIGHT.
  - SUFFICIENT VERTICAL DISTANCE FROM ACTIVE TRAFFIC MUST BE MAINTAINED AT ALL TIMES. IF THE WORK OPERATION REQUIRES THE MINIMUM 14 FOOT WORKING HEIGHT TO BE COMPROMISED, THE CONTRACTOR SHALL EITHER UTILIZE AN ALTERNATE SET UP OR PLACE THE INTERSECTION IN A 4 WAY STOP USING APPROPRIATE SIGNING AND USE A TRAFFIC REGULATOR TO CONTROL TRAFFIC THROUGH THE INTERSECTION.
  - TARGET ARROW W1-6 (DAYTIME) OR ARROWBOARD (NIGHTTIME).
  - ALL SIGNS SHOULD BE CONTAINED WITHIN THE SIGNAL INFLUENCE AREA.

### SIGN SIZES

DIAMOND WARNING	- 48" x 48"
MANDATORY MOVEMENT (R3-5)	- 30" x 36"
ONE-DIRECTION LARGE ARROW (W1-6)	- 48" x 24"
TURN PROHIBITION (R3-2)	- 24" x 24"

NOT TO SCALE

 Michigan Department of Transportation TRAFFIC AND SAFETY <b>MAINTAINING TRAFFIC</b> TYPICAL	<b>TYPICAL TEMPORARY TRAFFIC CONTROL</b> <b>FOR TRAFFIC SIGNAL WORK IN</b> <b>APPROACH LANE WITH WORK DURATION</b> <b>GREATER THAN ONE HOUR</b>
DRAWN BY: JK	(SPECIAL DETAIL)
CHECKED BY: MB:CRB	PLAN DATE:
	<b>M2803a</b>
	SHEET 2 OF 2
FILE: PW:RD/T&S/Typicals/Signs/MT NON FWY/M2803a.dgn REV. 10/17/2011	

## SIGN MATERIAL SELECTION TABLE

SIGN SIZE	SIGN MATERIAL TYPE		
	TYPE I	TYPE II	TYPE III
≤ 36" X 36"		X	X
>36" X 36" ≤ 96" TO WIDE		X	
> 96" WIDE TO 144" WIDE	X	X	
> 144" WIDE	X		

TYPE I            ALUMINUM EXTRUSION  
 TYPE II          PLYWOOD  
 TYPE III         ALUMINUM SHEET

ROUNDING OF CORNERS IS NOT REQUIRED FOR TYPE I OR II SIGNS.  
 VERTICAL JOINTS ARE NOT PERMITTED.  
 HORIZONTAL JOINTS THROUGH SIGN LEGEND OR SYMBOLS ARE NOT PERMITTED.


## POST SIZE REQUIREMENTS TABLE

SIGN AREA (ft <sup>2</sup> )	POST TYPE		
	U-CHANNEL STEEL	SQUARE TUBULAR STEEL	WOOD
≤9	1 - 3 lb/ft*	1 - 2" 12 or 14 GA*	N/A
9 ≤ 20	2 - 3 lb/ft	2 - 2" 12 or 14 GA	1 - 4" X 6"*
> 20 ≤ 30	N/A	N/A	2 - 4" X 6"
> 30 ≤ 60	N/A	N/A	2 - 6" X 8"
> 60 ≤ 84	N/A	N/A	3 - 6" X 8"

\*SIGNS 4 FEET AND GREATER IN WIDTH REQUIRE 2 POSTS.  
 SIGNS GREATER THAN 8 FEET IN WIDTH REQUIRE 2 OR 3 WOOD  
 POSTS DEPENDING ON AREA OF SIGN.  
 A MAXIMUM OF 2 POSTS WITHIN A 7' PATH IS PERMITTED.

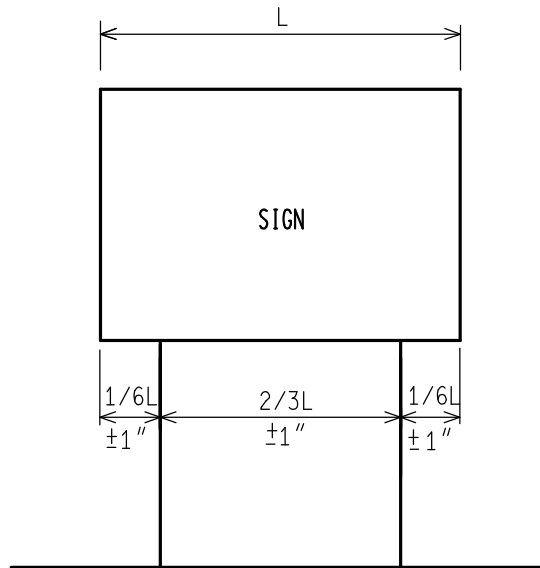
NOT TO SCALE

File:PW/Doc/RD/T&S/Typ/Dev/Sign MainTraf D/WZD-100-A Rev. 8/21/06 ECH

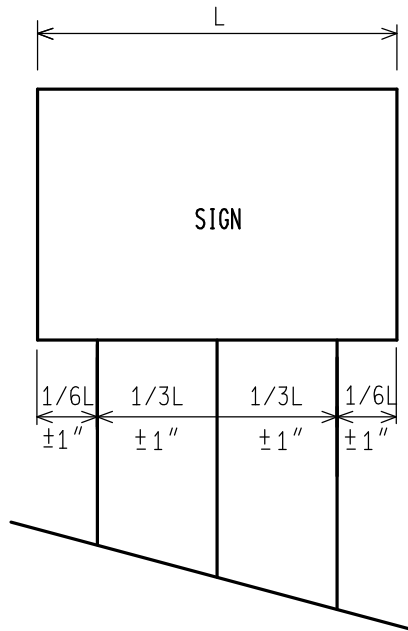
 Michigan Department of Transportation  PREPARED BY TRAFFIC AND SAFETY SUPPORT AREA  DRAWN BY: CON/ECH CHECKED BY: AUG	_____ ENGINEER OF DELIVERY  _____ ENGINEER OF DEVELOPMENT  PENDING _____ FHWA APPROVAL DATE	MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN FOR <b>GROUND DRIVEN SIGN          SUPPORTS FOR TEMP SIGNS</b>		
	8/2006	<b>WZD-100-A</b>	SHEET 1 of 11	
	PLAN DATE			

NOTE: THE ORIGINAL SIGNED COPY IS KEPT ON FILE AT THE MICHIGAN DEPARTMENT OF TRANSPORTATION.

## 2 POST SIGN SUPPORT SPACING



## 3 POST SIGN SUPPORT SPACING



\* FOR ALL 11' AND 12' LONG SIGNS ON 3 WOOD SUPPORTS, SPREAD POSTS SO AS TO HAVE A 8' MIN. TO 9' MAX. DISTANCE BETWEEN OUTSIDE POSTS.

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
FHWA APPROVAL DATE

8/2006  
PLAN DATE

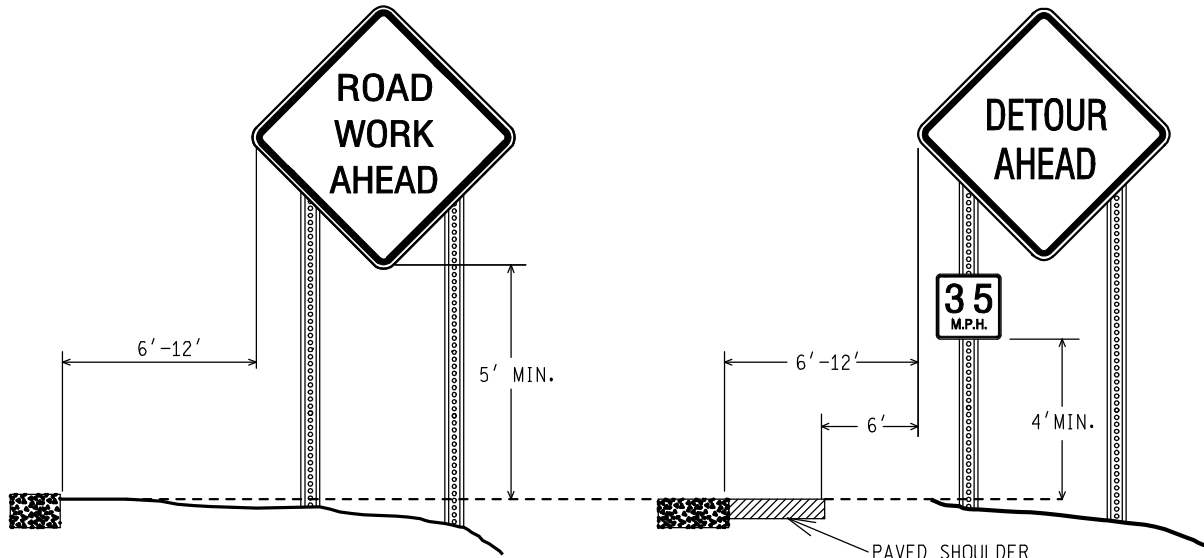
WZD-100-A

SHEET  
2 of 11

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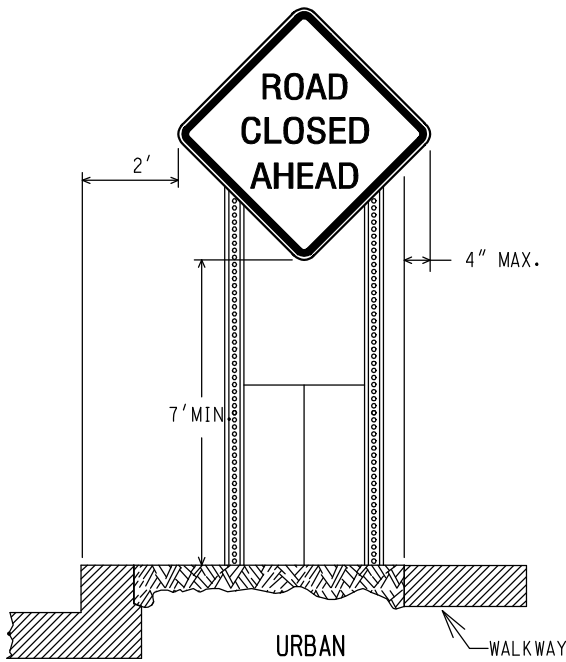
NOTE: THE ORIGINAL SIGNED COPY IS KEPT ON FILE AT THE MICHIGAN DEPARTMENT OF TRANSPORTATION.





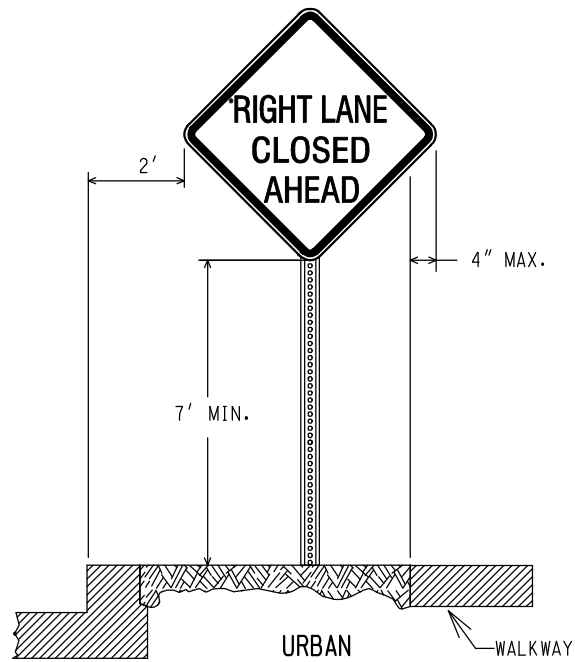
RURAL

RURAL WITH ADVISORY SPEED PLATE



URBAN

WALKWAY



URBAN

WALKWAY

(CURBED AREAS OR WHERE WALKWAYS ARE PRESENT)

(CURBED AREAS OR WHERE WALKWAYS ARE PRESENT)

BOTTOM HEIGHT AND OFFSET

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
FHWA APPROVAL DATE

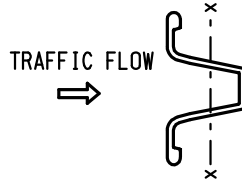
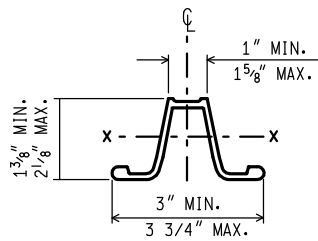
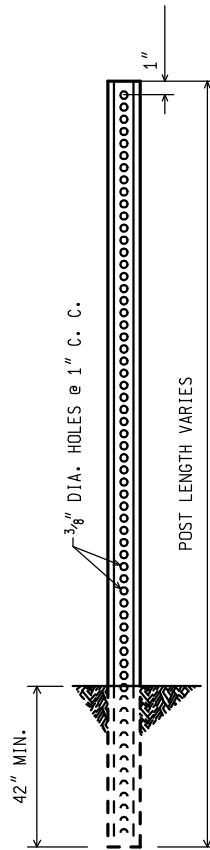
8/2006

PLAN DATE

WZD-100-A

SHEET  
3 of 11

NOTE: THE ORIGINAL SIGNED COPY IS KEPT ON FILE AT THE MICHIGAN DEPARTMENT OF TRANSPORTATION.



WEIGHT = 3 lbs/ft  
 SECT. MOD. X.-X. = 0.31 CUBIC INCHES MIN.

### 3 lb. U - CHANNEL STEEL POST (NO SPLICE)

MOUNT SIGN ON OPEN FACE OF  
 U - CHANNEL STEEL POST

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
 BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
 \_\_\_\_\_  
 FHWA APPROVAL DATE

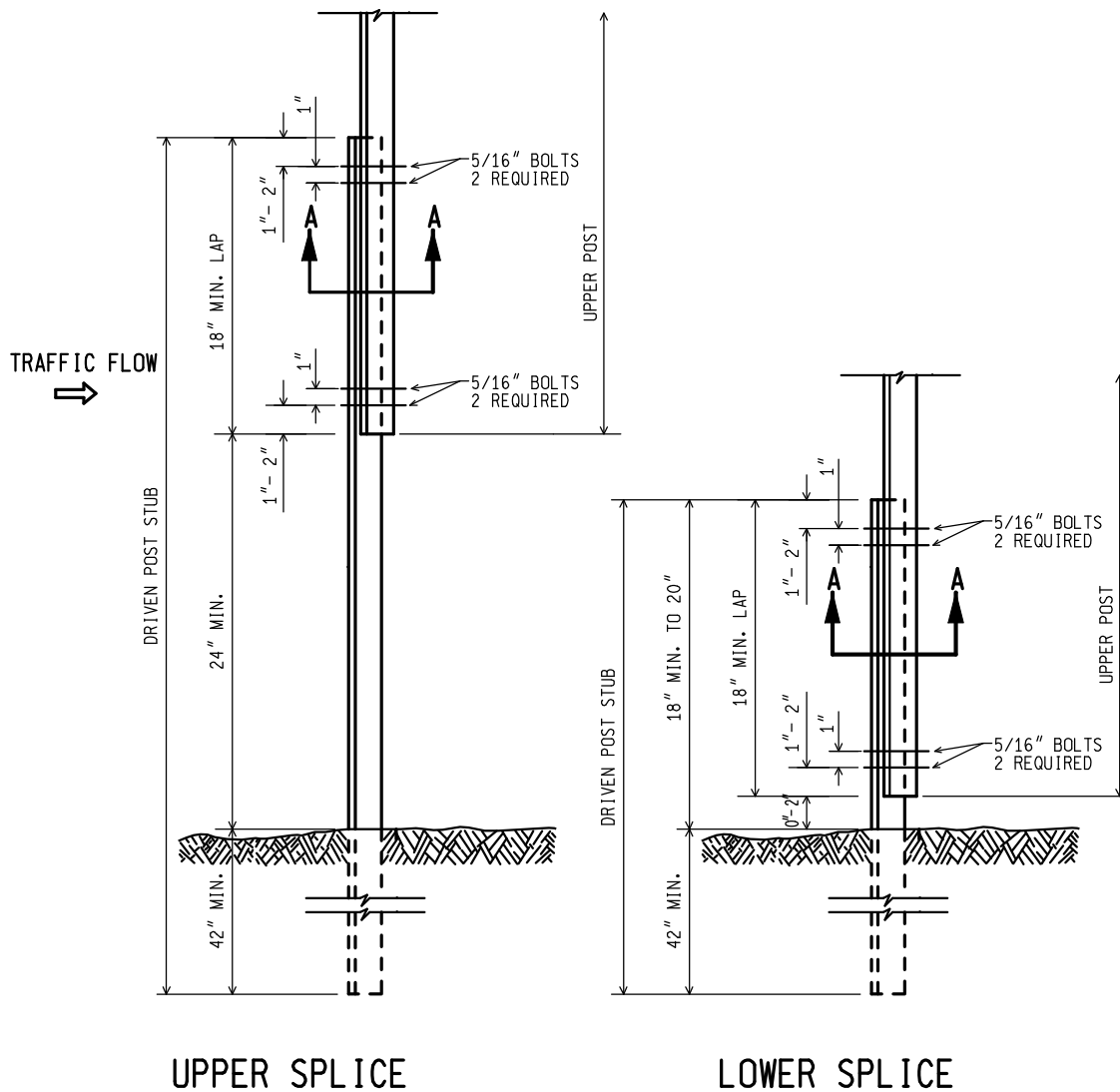
8/2006  
 \_\_\_\_\_  
 PLAN DATE

WZD-100-A

SHEET  
 4 of 11

File:PW/Doc/RD/T&S/Typ/Dev/Sign MainTraf D/WZD-100-A Rev. 8/21/06 ECH

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**3 lb. U - CHANNEL STEEL POST  
(WITH SPLICE)**

MOUNT SIGN ON OPEN FACE OF  
UPPER U - CHANNEL STEEL POST

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
FHWA APPROVAL DATE

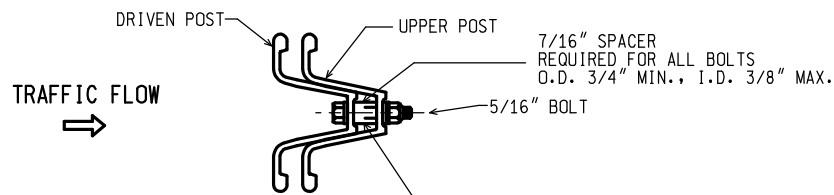
8/2006  
PLAN DATE

WZD-100-A

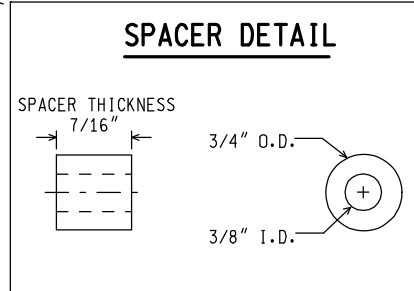
SHEET  
5 of 11

File:PW/Doc/RD/T&S/Typ/Dev/Sign MainTraf D/WZD-100-A Rev. 8/21/06 ECH

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**SECTION A-A**



**NOTES:**

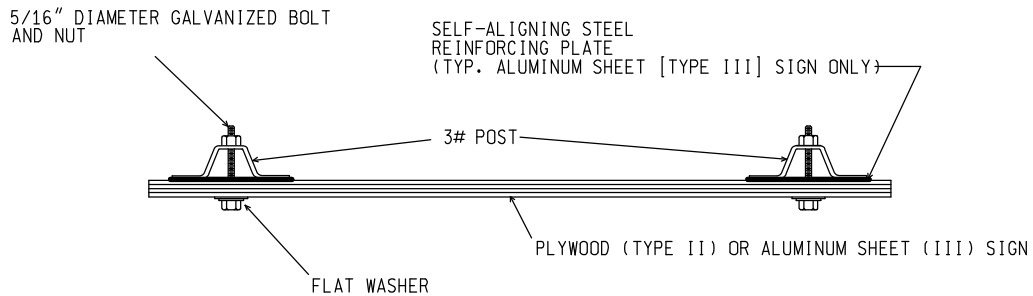
1. THE SPACER THICKNESS SHALL BE 1/16" LESS THAN THE GAP BETWEEN THE POST WHEN POSITIONED IN THE UNBOLTED CONFIGURATION.
2. THE EXTERIOR BOLT (CLOSEST TO LAP), SPACER, WASHER, AND NUT SHALL BE INSTALLED IN A PREPUNCHED HOLE 1" to 2" FROM THE END OF THE LAP.
3. THE INTERIOR BOLT (FARTHEST FROM LAP), SPACER, WASHER, AND NUT SHALL BE INSTALLED IN THE NEXT PREPUNCHED HOLE.
4. THE DRIVEN POST SHALL ALWAYS BE MOUNTED IN FRONT OF THE UPPER POST WITH RESPECT TO THE ADJACENT ONCOMING TRAFFIC, REGARDLESS OF THE DIRECTION THE SIGN IS FACING.
5. THE SPLICE LAP SHALL BE FASTENED BY FOUR-5/16" DIA. GALVANIZED A449 BOLTS (SAE J429 GRADE 5) OR GALVANIZED A325 BOLTS.

**3 lb. U - CHANNEL STEEL POST**  
**(WITH SPLICE)**

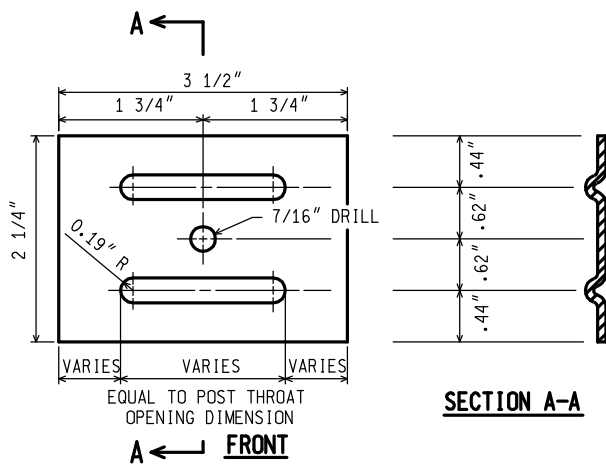
NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN	PENDING FHWA APPROVAL DATE	8/2006 PLAN DATE	<b>WZD-100-A</b>	SHEET 6 of 11
File:PW/Doc/RD/T&S/Typ/Dev/Sign MainTraf D/WZD-100-A Rev. 8/21/06 ECH				

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**SIGN TO 3 lb. POST CONNECTION**



**NOTES: (FOR STEEL SIGN REINF' PLATE)**

1. MATERIAL: 12 GAUGE CARBON STEEL.
2. TOLERANCE ON ALL DIMENSIONS  $\pm 0.0625"$
3. FINISH-AFTER STAMPING AND PUNCHING, GALVANIZE ACCORDING TO CURRENT SPECIFICATIONS FOR ZINC (HOT GALVANIZE) COATINGS ON PRODUCTS FABRICATED FROM PLATES OR STRIPS

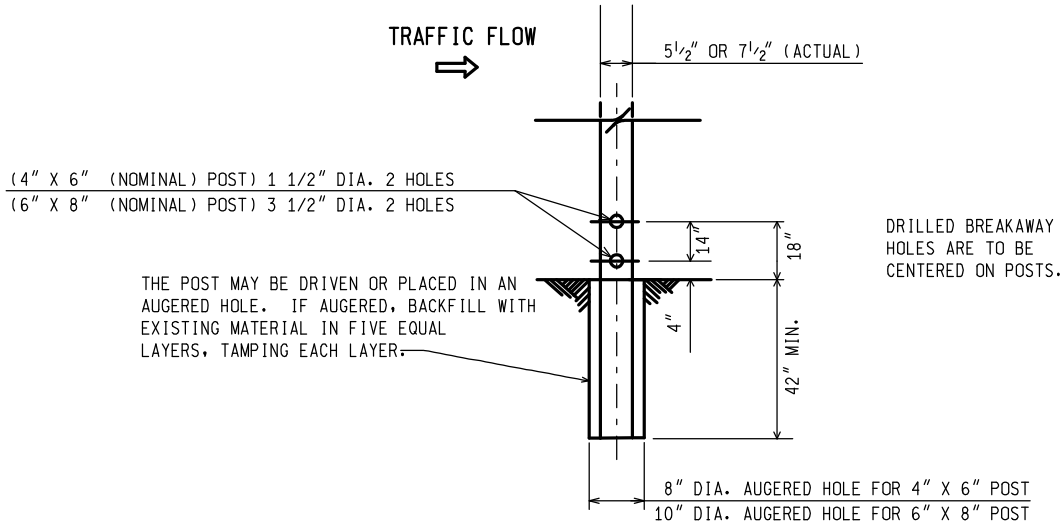
**STEEL SIGN REINFORCING PLATE**  
**REQUIRED FOR TYPE III SIGNS ONLY**

**3 lb. U - CHANNEL STEEL POST SIGN CONNECTION**

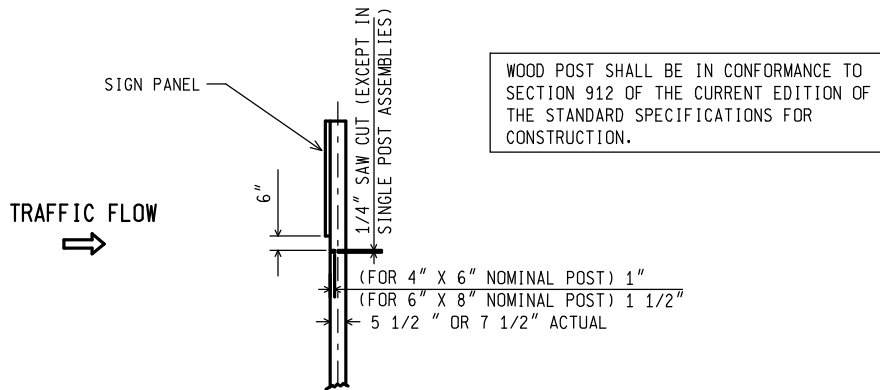
NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN	PENDING FHWA APPROVAL DATE	8/2006 PLAN DATE	WZD-100-A	SHEET 7 of 11
File:PW/Doc/RD/T&S/Typ/Dev/Sign MainTraf D/WZD-100-A Rev. 8/21/06 ECH				

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**WOOD POST BREAKAWAY HOLES/  
 DIRECT EMBEDMENT DETAILS**



**SAW CUT DETAIL  
 (MULTIPLE POST INSTALLATIONS)**

**WOOD POST DETAILS**

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
 BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
 FHWA APPROVAL DATE

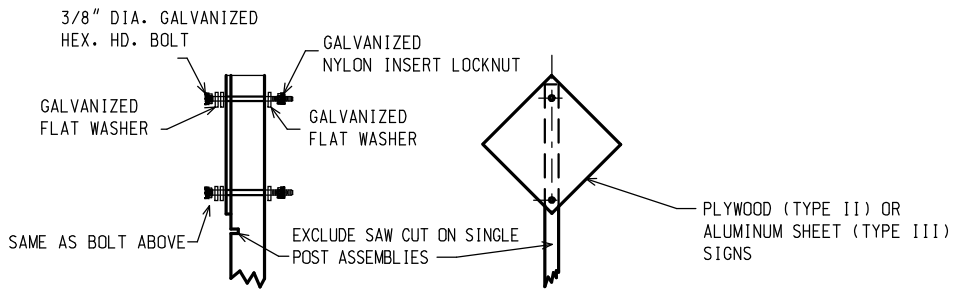
8/2006  
 PLAN DATE

WZD-100-A

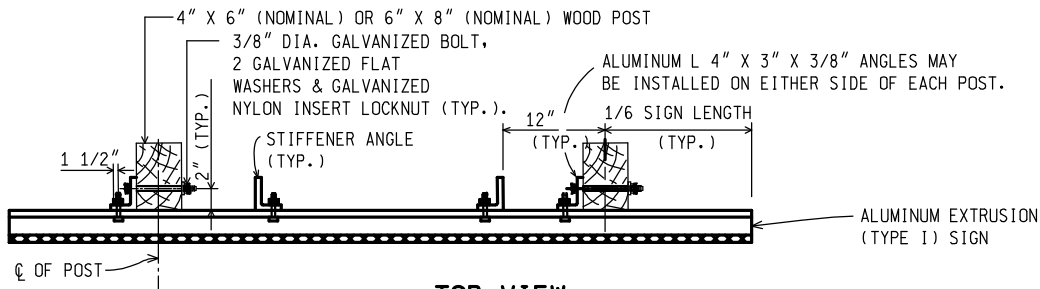
SHEET  
 8 of 11

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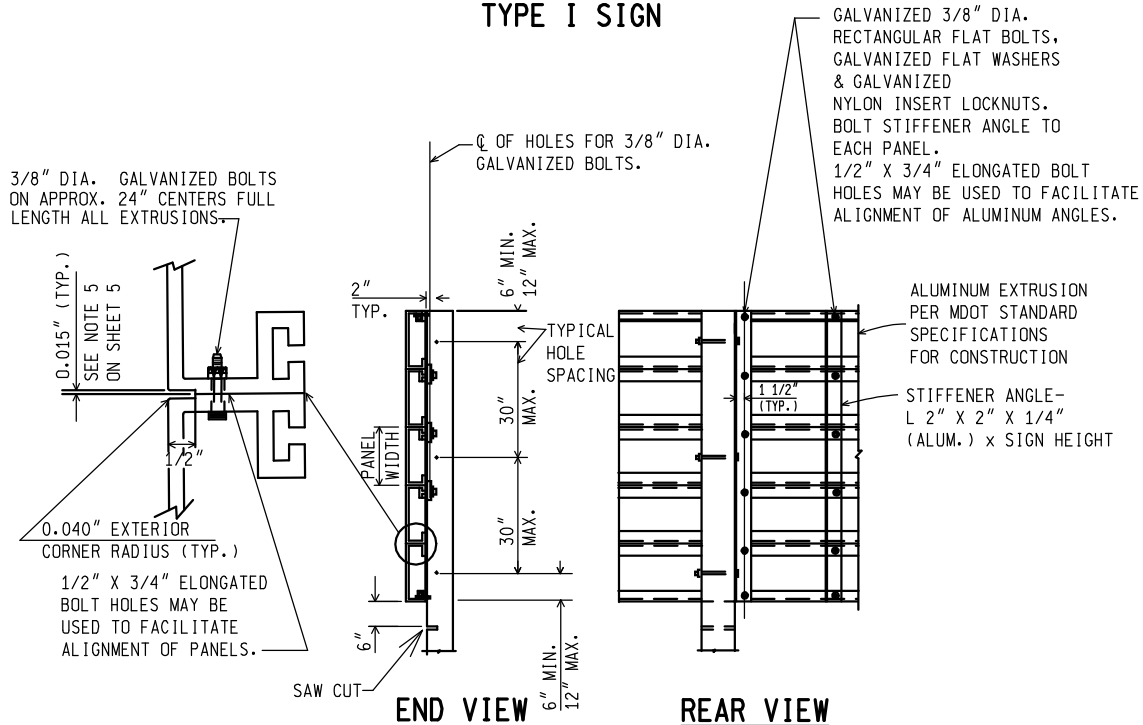
NOTE: THE ORIGINAL SIGNED COPY IS KEPT ON FILE AT THE MICHIGAN DEPARTMENT OF TRANSPORTATION.



**TYPE II AND TYPE III SIGNS**



**TOP VIEW  
 TYPE I SIGN**



**TYPE I SIGN - ERECTION DETAILS**

**WOOD POST CONNECTIONS**

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
 BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
 FHWA APPROVAL DATE

8/2006

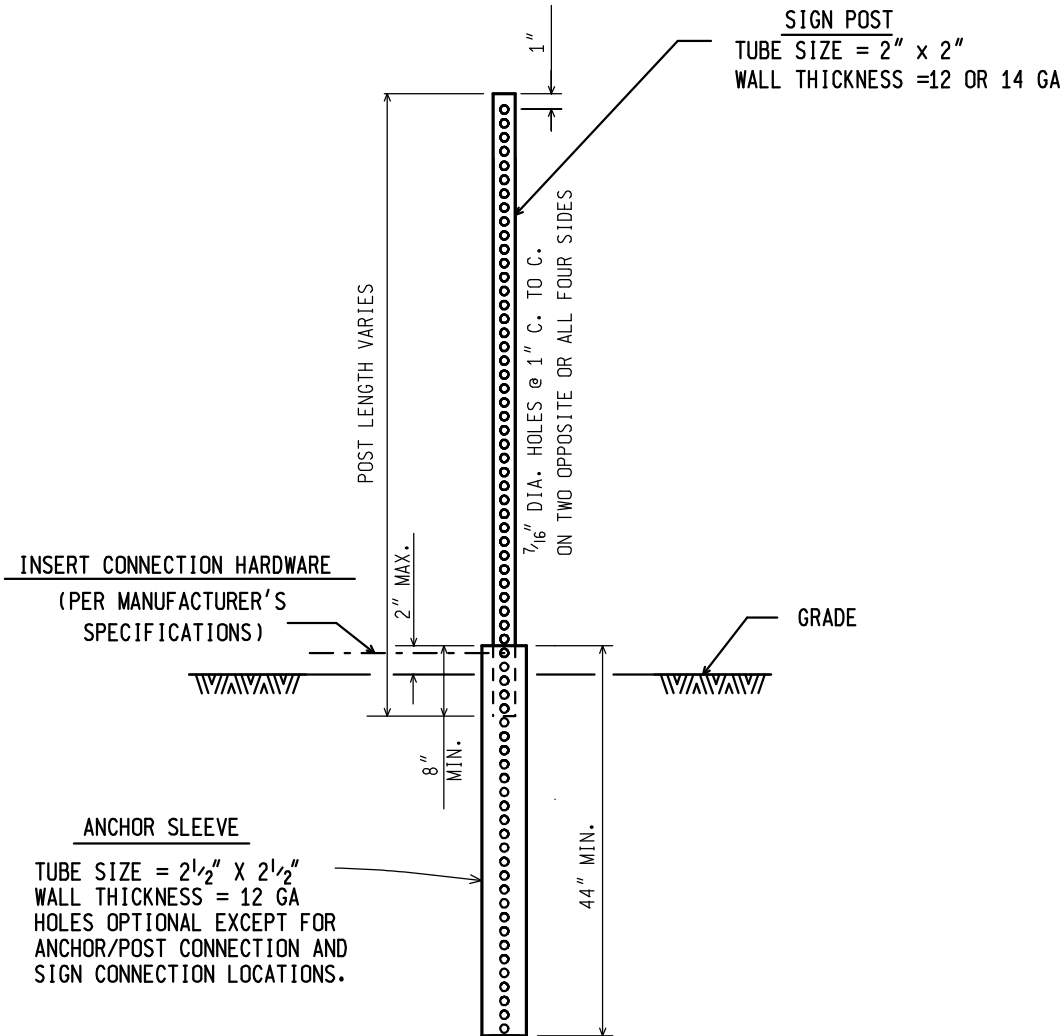
PLAN DATE

WZD-100-A

SHEET  
 9 of 11

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## SQUARE TUBULAR STEEL POST

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
 BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

PENDING  
 FHWA APPROVAL DATE

8/2006

PLAN DATE

WZD-100-A

SHEET  
 10 of 11

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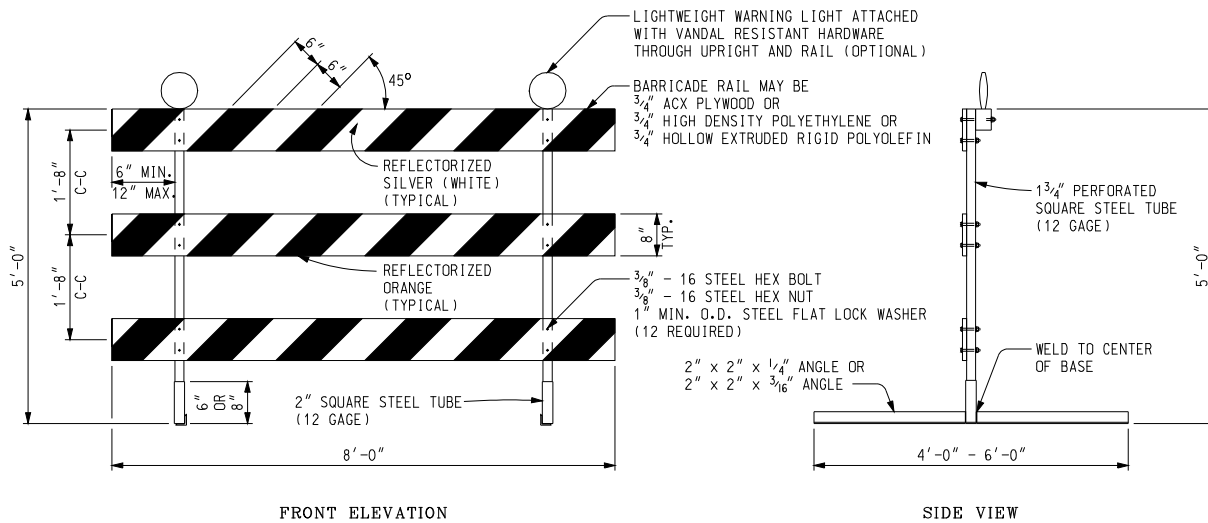
GENERAL NOTES:

1. A MAXIMUM OF TWO POSTS WITHIN A 7 FOOT PATH IS PERMITTED.
2. ALL SIGN POSTS SHALL COMPLY WITH NCHRP 350.
3. ALL POSTS SHALL BE EMBEDDED A MINIMUM OF 42".
4. BRACING OF POST IS NOT PERMITTED.
5. SIGN SHALL BE LEVEL, AND UPRIGHT FOR THE DURATION OF INSTALLATION.
6. ERECT POSTS SO THE SIGN FACE AND SUPPORTS DO NOT VARY FROM PLUMB BY MORE THAN 3/16" IN 3'. PROVIDE A CENTER-TO-CENTER DISTANCE BETWEEN POSTS WITHIN 2 PERCENT OF PLAN DISTANCE.
7. NO MORE THAN ONE SPLICE PER POST, AS SHOWN, WILL BE PERMITTED.
8. POST TYPES SHALL NOT BE MIXED WITHIN A SIGN SUPPORT INSTALLATION.
9. NO VERTICAL JOINTS ARE PERMITTED IN SIGN. NO HORIZONTAL JOINTS THROUGH SIGN LEGEND OR SYMBOLS ARE PERMITTED IN SIGN
10. REMOVE SIGN POSTS AND/OR POST STUBS IN THEIR ENTIRETY WHEN NO LONGER REQUIRED.
11. ALL LABOR, MATERIALS, AND EQUIPMENT, INCLUDING TEMPORARY SUPPORTS REQUIRED TO INSTALL, MAINTAIN, RELOCATE, COVER, AND/OR REMOVE THE TEMPORARY SIGN, INCLUDING SUPPORTS, ARE CONSIDERED TO BE INCLUDED IN THE COST OF THE TEMPORARY SIGN.
12. SAW CUTS IN WOOD POSTS ARE TO BE PARALLEL TO THE BOTTOM OF THE SIGN.
13. POSTS SHALL NOT EXTEND MORE THAN 4" ABOVE TOP OF SIGN.

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN	PENDING FHWA APPROVAL DATE	8/2006 PLAN DATE	WZD-100-A	SHEET 11 of 11
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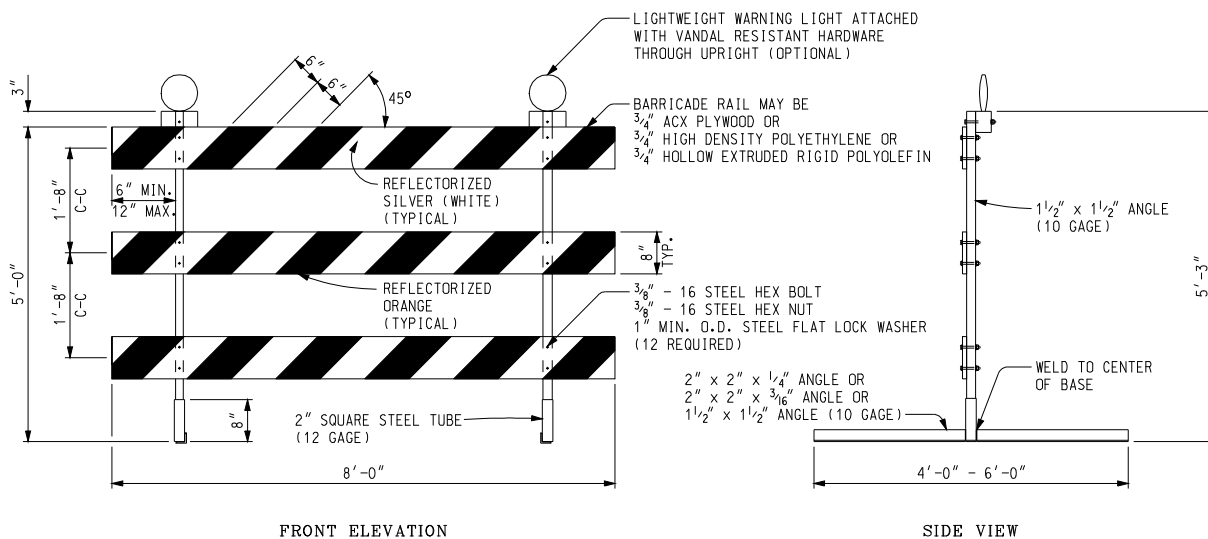
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FRONT ELEVATION

SIDE VIEW

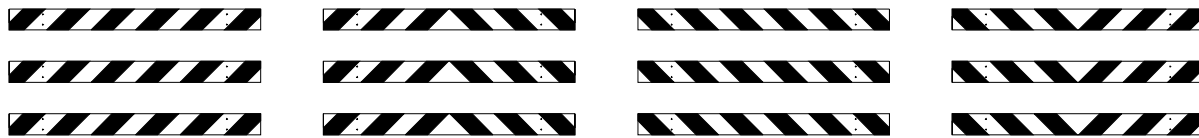
PERFORATED SQUARE STEEL TUBE OPTION



FRONT ELEVATION

SIDE VIEW

ANGLE IRON OPTION



LEFT DIRECTIONAL

BI-DIRECTIONAL

RIGHT DIRECTIONAL

CLOSURES

BARRICADE RAIL SHEETING OPTIONS  
TYPE III BARRICADES

Other Type III Barricades meeting current NCHRP crash worthy criteria can be found on the FHWA Safety website at [http://safety.fhwa.dot.gov/roadway\\_dept/road\\_hardware/wzd.htm](http://safety.fhwa.dot.gov/roadway_dept/road_hardware/wzd.htm)

NOT TO SCALE

File: T&S/Typ/Signs/WorkZones/wzd 125 d

Rev. 09/22/09 PJ



PREPARED BY  
TRAFFIC AND SAFETY

ENGINEER OF DELIVERY

ENGINEER OF DEVELOPMENT

(SPECIAL DETAIL)

FHWA APPROVAL DATE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN FOR

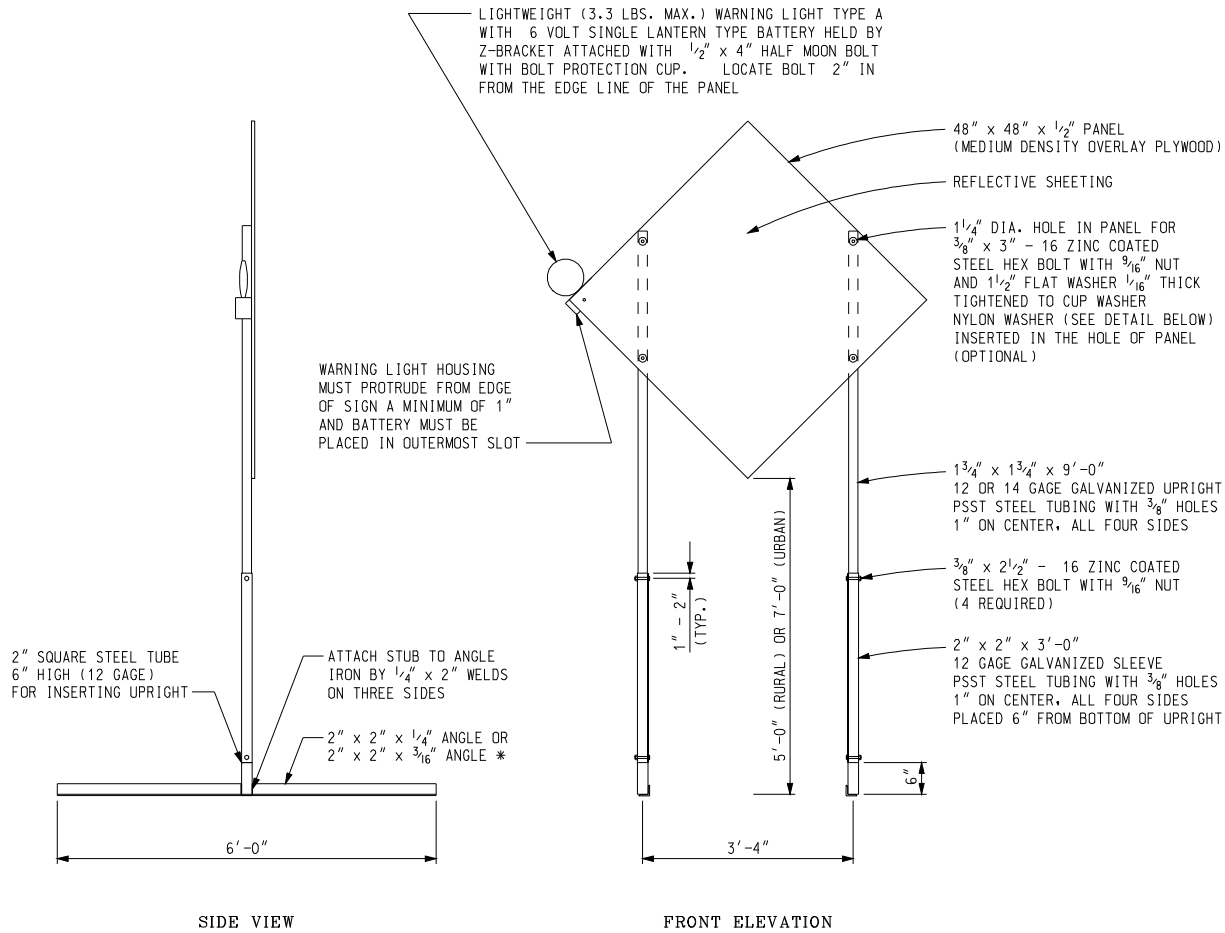
Temporary  
Traffic Control Devices

9/22/09  
PLAN DATE

WZD-125-E

SHEET  
1 of 3

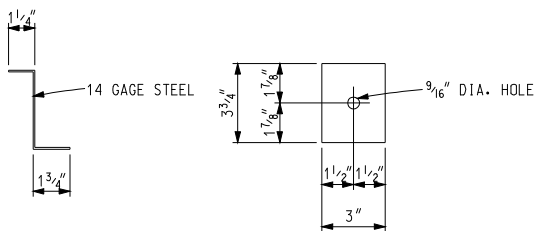
NOTE: THE ORIGINAL SIGNED COPY IS KEPT ON FILE AT THE MICHIGAN DEPARTMENT OF TRANSPORTATION.



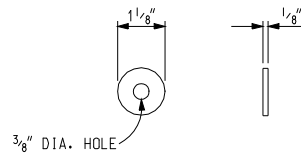
### TEMPORARY SIGN SUPPORT

(WARNING LIGHT PLACED ON SIDE CLOSEST TO TRAFFIC)

- \* SIGN STAND IS BALLASTED WITH FOUR OR MORE 35 LB SANDBAGS. A MINIMUM OF ONE ON EACH END.
- UPRIGHTS SHALL NOT EXTEND ABOVE THE SIGN PANEL.



Z-BRACKET DETAIL



OPTIONAL NYLON WASHER

Other temporary sign supports meeting current NCHRP crash worthy criteria can be found on the FHWA Safety website at [http://safety.fhwa.dot.gov/roadway\\_dept/road\\_hardware/wzd.htm](http://safety.fhwa.dot.gov/roadway_dept/road_hardware/wzd.htm)

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION  
BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN

(SPECIAL DETAIL)  
FHWA APPROVAL DATE

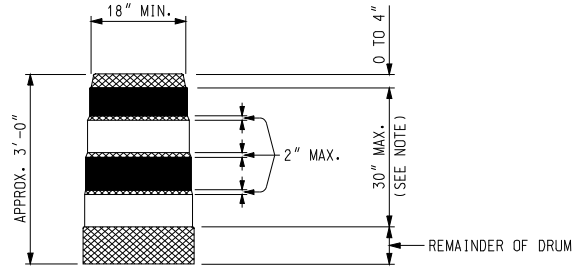
9/22/09  
PLAN DATE

WZD-125-E

SHEET  
2 of 3

- PLASTIC DRUM
- ▲▲▲ PROPOSED TYPE III BARRICADE
- △△△ EXISTING TYPE III BARRICADE

SYMBOLS TO BE USED ON PLANS



- REFLECTORIZED ORANGE
- REFLECTORIZED WHITE
- NON REFLECTORIZED ORANGE

NOTE:  
 DRUMS SHALL HAVE AT LEAST 4 HORIZONTAL REFLECTORIZED STRIPES (2 ORANGE AND 2 WHITE) OF 6" UNIFORM WIDTH, ALTERNATING IN COLOR WITH THE TOPMOST REFLECTORIZED STRIPE BEING ORANGE. NON REFLECTORIZED SPACES BETWEEN THE HORIZONTAL REFLECTORIZED ORANGE AND WHITE STRIPES SHALL BE ORANGE IN COLOR AND EQUAL IN WIDTH.

PLASTIC DRUM

NOTES:

2" PERFORATED SQUARE STEEL TUBES MAY BE USED TO FABRICATE THE HORIZONTAL BASE OF THE TYPE III BARRICADE.

WARNING LIGHTS SHALL BE PLACED ACCORDING TO THE CURRENT STANDARD SPECIFICATIONS FOR CONSTRUCTION AND ALL OTHER PROVISIONS IN THE CONTRACT WHEN THEY ARE USED ON TYPE III BARRICADES.

SEE ROAD STANDARD PLANS R-113-SERIES FOR TEMPORARY CROSSOVERS FOR DIVIDED ROADWAY, AND R-126-SERIES FOR TYPICAL LOCATION AND SPACING OF PLASTIC DRUMS FOR PLACEMENT OF TEMPORARY CONCRETE BARRIER.

SIGNS, BARRICADES, AND PLASTIC DRUMS SHALL BE FACED WITH PRESSURE-SENSITIVE REFLECTIVE SHEETING ACCORDING TO THE CURRENT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

SANDBAGS SHALL BE USED WHEN SUPPLEMENTAL WEIGHTS ARE REQUIRED TO ACHIEVE STABILITY OF THE BARRICADE. THE SANDBAGS SHALL BE PLACED SO THEY WILL NOT COVER OR OBSTRUCT ANY REFLECTIVE PORTION OF THE TRAFFIC CONTROL DEVICE.

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF HIGHWAYS DELIVERY STANDARD PLAN	(SPECIAL DETAIL) FHWA APPROVAL DATE	9/22/09	WZD-125-E	SHEET 3 of 3
File: T&S/Typ/Signs/WorkZones/wzd 125 d	Rev. 09/22/09 PJ	PLAN DATE		

NOTE: THE ORIGINAL SIGNED COPY IS KEPT ON FILE AT THE MICHIGAN DEPARTMENT OF TRANSPORTATION.

ALLEGAN COUNTY  
ROAD COMMISSION

**NOTICE TO BIDDERS  
UTILITY COORDINATION**

WT:JNB

1 of 1

04-29-14

The Contractor shall cooperate and coordinate construction activities with the owners of utilities as stated in Section 104.08 of the Michigan Department of Transportation (MDOT) 2012 Standard Specifications for Construction. In addition, for the protection of underground utilities, the Contractor shall follow the requirements in Section 107.12 of the MDOT 2012 Standard Specifications for Construction. Contractor delay claims, resulting from a utility, will be determined based upon Section 109.05E of the MDOT 2012 Standard Specifications for Construction.

For protection of underground utilities and in conformance with Public Act 174 of 2013, the Contractor shall contact the MISS DIG System, Inc. by phone at 811 or 800-482-7171 or via the web at either [elocate.missdig.org](http://elocate.missdig.org) for single address or [rte.missdig.org](http://rte.missdig.org), a minimum of 3 business days prior to excavating, excluding weekends and holidays. This does not relieve the contractor of the responsibility of notifying utility owners who may not be a part of the "Miss Dig" alert system.

The owners of existing service facilities that are in conflict with the proposed work will move them to locations designated by the Engineer or will remove them entirely from the road Right-of-Way. Owners of Public utilities will not be required by the County to move additional poles or structures in order to facilitate the operation of construction equipment unless it is determined by the Engineer that such poles or structures constitute a hazard to the public or are extraordinarily dangerous to the Contractor's Operations.

The existing utilities shown on the plans represent the best information available as obtained from survey and existing records. This information does not relieve the Contractor of the responsibility of protecting all existing utilities, in case utilities have been constructed or removed since the survey date, or if utilities are encountered in different locations.

All existing utilities shall be located as to both horizontal and vertical position prior to starting any utility construction or other excavation. Cost shall be included in the new utility or excavation pay items.

The Contractor's attention is directed to the requirements for cooperation with others, as covered in Section 104.08 of the MDOT 2012 Standard Specification for Construction.

## NOTICE TO BIDDERS

### **WARRANTY ON TRAFFIC SIGNAL EQUIPMENT**

The Michigan Department of Transportation Special Provision for 24-48 Circuit Digital Type NEMA Type Traffic Controller and Cabinet state that the manufacturer's warranty shall be "transferable to MDOT". In the terms of this contract, the stated manufacturer's warranty shall instead be transferable to the Allegan County Road Commission.

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
TRAFFIC SIGNAL WORK - CONSTRUCTION METHODS

OPR:DJA

1 of 2

C&T:APPR:JAR:DBP:09-09-11  
FHWA:APPR:09-09-11

**a. Description.** This special provision is for electrical construction and/or relocation of traffic signal facilities is to be used in addition to the applicable sections of the standard specifications. In case of conflict use whichever is most restrictive.

**b. Materials.** Furnish new material and equipment, unless specified otherwise, and comply with sections 918 and 921 of the Standard Specifications for Construction. Materials furnished by the Department to the Contractor will be picked up by the Contractor at such site as designated by either MDOT, or the Local Agency representing MDOT, with any associated costs included in pay items as indicated on the plans and will not be paid for separately.

1. General. Provide manufacturer's certifications, in accordance with the specifications, for all wire and cable and other items or as directed by the Engineer. Do not install any wire or cable before it has been approved by the Engineer. Include statement "Materials are in accordance with the Specifications" on their material order, especially on wire and cable.

Reuse only the best of the existing material and equipment where the contract calls for reuse of existing material and equipment as directed by the Engineer. The Department will have the right to furnish the Contractor with a new part if any are found defective prior to dismantling. Any part or parts damaged by the Contractor subsequent to starting the removal are a liability of the Contractor.

Furnish the Engineer an as-built record of all underground or overhead work installed within 5 days after completion of each section of the underground conduit, cable or overhead line work. This record must include the size and length of cable and duct lines, location of the lines, handholes and manholes, and location and size of support poles. Tag and stamp all wires and cables using a brass tag indicating the source and use of the cable.

Connect the ground wire to the ground rod with a UL rated copper or bronze ground clamp.

**c. Construction.** All work must comply with sections 819 and 820 of the Standard Specifications for Construction, the applicable "typical" signal construction details, this special provision, and requirements of the *National Electrical Code (NEC)*, *National Electrical Safety Code (NESC)*, and the Michigan Department of Licensing and Regulatory Affairs (LARA). Contact the Michigan Department of Licensing and Regulatory Affairs (LARA) for electric service inspection and be responsible for payment of all applicable fees.

1. Maintain all existing street lighting, traffic signal, primary, transmission, communication cables, etc. circuits in an operational condition, unless otherwise noted on the plans or as directed by the Engineer.

2. In addition to sections 104.07 and 812.03 of the Standard Specifications for Construction, the following applies to Contractor maintenance of permanent or temporary traffic signal installations which are being worked on by the Contractor:

A. The Contractor is responsible for maintaining any portion of a traffic signal which has been worked on by the Contractor until final acceptance of that specific location.

B. If MDOT forces are required to work on an emergency traffic signal malfunction that is determined to have been caused by the work of a Contractor, the cost of the work will be the responsibility of the Contractor.

C. If vandalism occurs to equipment that is not energized, the Contractor is responsible for replacement.

3. Utility Coordination. Notify the System Operating Division of the local utility 72 hours in advance of any work on underground or overhead transmission or distribution circuits. If possible, the System Operating Division will shutdown and red tag the line by 8 a.m. for the day requested. Notify the System Operating Division when the work is complete.

Provide coordination and make arrangements, as described above, to work on traffic signal circuits.

Schedule, coordinate, install, and pay for work provided by the local utility company(s), as indicated on the plans or as directed by the Engineer. The Engineer will not authorize payment for delay caused by the Contractor's failure to properly schedule and coordinate any utility work.

4. Agency Coordination. Secure all necessary permits covering the operations, including permits from the Public Authorities having jurisdiction over the streets, or other Public Properties in which the work is located, and the improvements therein. Obtain the amount of any charges for payment, including fees or inspection charges required by such authorities, and include the cost of these fees in the bid prices.

The local traffic authority may impose restrictions regarding particular times of certain days of the week wherein the Contractor cannot perform work and may, in fact, be required to clear the area of work obstacles or construction equipment. The Contractor must take note of this and there will be no extra payment to perform the work with possible restrictions imposed. The Engineer will not authorize extra payment if the Contractor chooses to perform work during overtime status.

5. Construction must be performed by persons who are experienced and qualified for the work required. On-site licensed (Journeyman electrician) supervision is required for the electrical system installation (including placement of traffic loops, conduits, and/or cables in dirt, foundations, and handholes) and must be present at all times when electrical construction is in progress. Ensure the ratio of electrical journeymen or master electricians to registered apprentice electricians is on the basis of one electrical journeyman or master electrician to one registered apprentice electrician in accordance with Michigan Law section 338.883e. This ratio is to be enforced on a jobsite basis. For traffic signal work a single jobsite is defined as a single intersection or single electronic traffic control device.



MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
**24 - 48 CIRCUIT DIGITAL NEMA TYPE TRAFFIC CONTROLLER AND CABINET**

OPR:DJA

1 of 41

C&T:APPR:DBP:04-20-12  
FHWA:APPR:04-23-12

**a. Description.** This work consists of completing one or more of the following work types at locations shown on the plans:

1. Furnishing, delivering, and installing a controller and cabinet, digital type for locations where the controller does not need to function as the master for a closed loop system.
2. Furnishing, delivering, and installing a controller and cabinet, digital type, master for locations where the controller functions as the master for a closed loop system.

This work includes furnishing and delivering the controller and cabinet to the maintaining agency for controller timing and cabinet setup. This work includes transporting the cabinet from the maintaining agency to the job site for installation. This work includes installation of the traffic signal controller unit (CU), cabinet, and accessories required to provide the traffic signal control operations as shown on the plans, in accordance with the MMUTCD and this special provision. As applicable this work includes mounting brackets and hardware, conduit risers, wiring, connectors, grounding, rewiring of existing signal heads, and all appurtenant materials required to ensure a complete installation.

**b. Material.** Provide materials that meet sections 918 and 921 of the Standard Specifications for Construction and this special provision.

1. Controller Unit (CU).

A. Provide a CU that is capable of running:

- (1) Fully actuated (4 to 16 phase).
- (2) 24-36 circuit solid state pretimed.
- (3) Fully actuated (4 to 16 phase) closed loop master.
- (4) Solid state pretimed closed loop master.
- (5) A full complement of operational, programming and diagnostic capabilities.
- (6) A menu structured traffic oriented/English language operator interface providing comprehensive traffic control, analytical and management capabilities.

B. Environmental Standards. The CU must perform all of its functions within the environment as defined by *NEMA Standards Publication TS-2*. The CU must meet or exceed

the applicable sections and clauses of *NEMA Standards Publication TS-2*, Section 2, with respect to each of the following functions:

Operating Voltage	Transients, Power Service
Operating Frequency	Transients, Input-Output Terminals
Power Interruption	Non-destruct Transient Immunity
Temperature and Humidity	Vibration and Shock

C. Provide a CU that meets the following physical, interface and functional requirements of solid state controller shelf mounted unit and complies with the current *NEMA Standards Publication TS-2* - Type 2, A2 and P2, with MS A, B, and C connectors.

(1) Processor. The control processor unit (CPU) must be a bit type, running at 25 megahertz (Mhz) and provided with a Microware OS-9 operation system with runtime license. The CPU must be installed on a separate printed circuit board for ease of maintenance and upgrading.

D. Memory. Provide a minimum of 8 MB of FLASH memory organized as a disk drive. Traffic application and intersection data must reside in FLASH memory. The FLASH memory must retain data without power, capacitor, or battery backup, and remain permanent until changed by user data entry or a new download.

Provide a minimum of 4 MB of dynamic random-access memory (DRAM) to be used to execute the traffic application software. DRAM must be capable of being reloaded from FLASH upon power restoration since it does not retain memory during power failures.

Provide 1 MB of static random-access memory (SRAM), for use as a scratchpad for temporary data storage, backed by a capacitor during power failures for a minimum of 30 days.

E. Power Supply. Provide the CU with a modular power supply.

Provide the power supply with +5 volts direct current (VDC) for the CU electronics and +24 VDC to power devices in the control cabinet. Protect both these power supplies by 5 millimeter 2 amp slow blow glass cartridge fuses accessible from the front panel.

Include added safety circuitry to the power supply to measure line voltage and output voltage, as well as generate power fail interrupts, power up reset, and a 120 Hz signal for a time base.

Provide the power supply with a line frequency reference signal generated by a crystal oscillator that must synchronize to the 60-Hz volt alternating current (VAC) incoming power line at 120 and 300 degrees. A continuous square wave signal must be +5 VDC amplitude, 8.333 ms half-cycle pulse duration and  $50 \pm 1$  percent duty-cycle. The line frequency reference must compensate for missing pulses and line noise during normal operation and continue through 500 ms power interruptions.

F. Physical Standards. *NEMA Standards Publication TS-2* applies and is supplemented as follows:

(1) Dimensions. The dimensions of the CU enclosure must conform to the following maximum limits:

Height = 7 inches      Width = 16 inches      Depth = 9½ inches

(2) Design. Form the CU housing of polycarbonate except the back panel, rear mounting tab, and power supply mounting plate must be aluminum. The housing must have a built-in carrying handle and be provided with two adjustable front mounting feet.

(3) Expansion. There must be seven slots with card guides for standard 3U size Versa Module Europe expansion modules. The controller must also be provided with two slots with card guides for standard joint NEMA/AASHTO/ITE/Advanced Transportation Controller (ATC) modems.

Include two expansion slots in the CU that may be used to house standard 2070 ATC modules such as series modems.

G. Interface Standards. Provide a CU with an input-output interface meeting the following requirements.

(1) Ethernet Port. There must be a built-in base-T Ethernet with RJ-45 connector on the controller front panel. There must be a unique, built-in Internet protocol (IP) address for each controller.

(2) Infrared Port. Provide a CU with a built-in infrared (IR) wireless port compatible with Microsoft™ Windows for Pocket personal computer (PC) infrared RAW mode. The IR port must work like the NEMA Port 2, but without the need for a cable.

(3) NEMA Port 1 SDLC. Provide a CU with a 15-pin "D" connector to communicate to hardware devices within the cabinet.

(4) NEMA Port 2. Provide a CU with a 25-pin connector compliant with the EIA-232 communications standard that serves 2 functions.

Port 2 must provide hardwired data communications to devices nearby such as laptop PCs, personal digital assistants (PDA's), phone modems, or printers. Communications baud rates must be user selectable baud rates of up to 38400 bits per second (bps).

Port 2 must also provide signals that implement the C50 function of the Joint NEMA/AASHTO/ITE Specification of the ATC and must be present on the secondary transmit and receive pins described in the EIA-232 specification for a 25-pin connector. The C50 section of this port is to be used to upload/download updated/new/alternate versions of the traffic applications software.

(5) NEMA Port 3. Provide a CU with an internal NEMA Port 3 communications port. This port must provide systems communications to on-street masters or central office computers. This port must be addressable with user selectable baud rates of up to 38400 bps.

The CU must come equipped, when called for on the plans, with a modular internal Frequency Shift Keying (FSK) two wire port 3 modem that is accessed on the controller front panel by way of an 9-pin "D" connector, and by way of the 37-pin "D" connector. The communications must be half duplex, time division multiplexed, 1200 BPS, asynchronous, bit serial. Output

power is 0 dBm  $\pm$ 15 percent into a 600 ohm load. Receiver sensitivity is a minimum of -34 dBm. The FSK modem must have an anti-streaming option that will turn the modem transmitter off if the modem consistently transmits for greater than 7 seconds. The FSK modem must interface with existing FSK systems in use by the MDOT.

The CU must also be provided with a module that contains an additional 9-Pin RS-232 port and a 25-Pin RS-232 port. The module must provide an LED display for the TXD, RXD, RTS and CTS commands. The module must also provide a data key receptacle to program and read serial data keys. The data key must be provided with enough capacity to store data use by the software application. The data key must be removable and can be transferred to another controller. The data key must be designed for harsh environments with large contacts that are wiped by the rotation of the key within the receptacle. The data key must conform to Data Key™ "Key Link" serial data protocol. The data key receptacle must be attached to NEMA Port 2. One data key must be provided with each CU.

An optional Port 3 fiber optic modem must be provided when called for on the plans.

(6) C60 Connector. Provide a built-in C60 connector for use with a removable keyboard and display, PC, or PDA. The C60 protocol must conform to the joint NEMA/AASHTO/ITE ATC standard.

(7) Keyboard and Display.

(a) Programming. Programming the CU variables must be via a front panel keyboard and display. For ease of front panel programming, the controller must utilize English language menus.

The CU must prevent the alteration of keyboard set unit variables prior to the user having entered a specific code. This "Access" code must also be user programmable via the keyboard.

All variables must be displayed for visual verification concurrent with entry.

(b) Programming Security. The CU must maintain user programmable variables in non-volatile memory to assure continued safe and efficient CU operation in the event of power loss.

(c) Keyboard and Display. The keyboard and display must be contained in one unit that can be removed from the front of the CU without the use of any tools. An extension cord must be integral to the keyboard and display. The connector for the extension cord on the front of the controller must be compatible with C60 connector. The keyboard functions and terminal emulation must be per joint NEMA/AASHTO/ITE ATC standards. The liquid crystal display (LCD) must display 8 lines of 40 characters and must use a light-emitting diode for backlighting. The LCD must provide a keypad contrast adjustment. No contrast knob is allowed.

Programming of the CU variable must be via the keyboard and display. For ease of front panel programming, the controller must utilize English language menus. The CU must prevent alteration of keyboard set unit variables prior to the user having entered a specific code. The "Access" code must also be user programmable via the keyboard. All variables must be displayed for visual verification concurrent with entry.

The CU must maintain user programmable variables in non-volatile memory to assure continued safe and efficient operation in the event of power loss.

(8) A, B, C Connectors. Provide a CU with the A, B, and C connectors with inputs and outputs as defined by *NEMA Standard Publication TS-2 - Type 2, A2 and P2*. A number of the input definitions must be programmable in the CU to differ from NEMA specifications. Example: the phase omit, hold, and ped omit inputs can be redefined to provide an additional 24 vehicle detector inputs. A number of the output definitions must be programmable in the CU to differ from NEMA specifications. Example: the phase on, next, and check outputs can be redefined to provide an additional eight sets of green, yellow, red outputs.

(9) D Connector. There must be a 37-pin connector D on the front of the unit to provide for additional input/output functions and for systems communications. These functions must be manufacturer specified. A number of the input and output definitions must be programmable in the CU. This connector must provide the ability of the controller to be used in a systems environment.

H. Actuated Control. *NEMA Standards Publication TS-2, Section 3* applies and are supplemented as follows:

(1) Per Phase. Provide a CU with the following functional capability on a per phase basis:

(a) Conditional Service. Conditional service must provide an optional method for phase selection and apply to vehicle phases only. If two concurrent phases are timing and a call exists on the other side of the barrier and one of the phases is prepared to terminate due to gap out or max time out, the ring containing the timed out phase must revert to a preceding vehicle phase if:

(i) A call exists on a preceding actuated vehicle phase. (Non-Actuated Phases must not be conditionally re-serviced).

(ii) The gaped/maxed phase is programmed for conditional service.

(iii) There is sufficient time remaining before max time of the other phase has elapsed.

(b) Special Detector Functions. Provide the following special vehicle detector functions:

(i) Detector Control. There must be 64 vehicle detector assignments, 8 pedestrian detectors, and 8 special detectors. Each detector must be programmable for a standard vehicle detector input, pedestrian detector input, one call, stop bar A or stop bar B, Adaptive Protected Permissive Left Turn, Adaptive Protected Permissive Thru, and an AND code that only allows a call to be entered if calls are active on all detectors so programmed. In addition, each detector must be capable of being programmed to extend, delay, or switch.

(c) Extended Pedestrian Clearance. Provide a CU design with an alternate mode of operation for the Pedestrian `Don't Walk' Output to extend the flashing period (Ped Clearance) for each phase so programmed, so a portion (equal to the sum of the Yellow

Change and/or Red Clearance time settings) may appear concurrently with the vehicle change intervals.

(d) Pedestrian Overlaps. It must be possible to program phase ped outputs such that the ped outputs are active with two separate phases.

(e) Pedestrian Extend and Delay. It must be possible to delay or advance the start of the walk display relative to the same phase green by up to 99.9 seconds in 0.1 second increments.

(f) Actuated Rest in Walk. Provide a CU design with an alternate mode pedestrian dwell for actuated phases. The actuated phase must rest in Walk when so programmed and there is no serviceable conflicting call at the end of the Walk timing.

(g) Automatic Pedestrian Clearance. Provide a CU design with an alternate mode of operation to enable timing of the pedestrian clearance interval when Manual Control Enable is active. When programmed, this feature will prevent the pedestrian clearance interval being terminated by the interval advance input.

(h) Last Car Passage. Last car passage provides an alternate method of operation to control green termination with volume density operation.

(2) Per Unit. Provide a CU with the following functional capability on a per unit basis:

(a) Simultaneous Gap Out. Green timing termination in multiple ring controller configurations must provide for simultaneous termination. Simultaneous termination, when timing phases concurrently with the next serviceable call on a phase that conflicts with more than one of the phases timing (about to cross a barrier), insures that all phases which will terminate must simultaneously reach a point of being committed to terminate before green timing termination must begin (i.e., Gap-Out, Max-Out and/or Force-Off).

(b) Dual Entry. Dual entry is a mode of operation (in a multiple ring CU) in which one phase in each ring must be in service, where possible subject to compatibility, at all times. If a call does not exist in a ring when it is committed to cross a barrier, a phase must be selected in that ring to be activated by the CU based on this programming.

(c) Variable Sequence. Provide a CU with controls for 16 Vehicle Phases, 16 Pedestrian Phases, and 4 Timing Rings with each phase being able to be assigned to any ring with the user definition of Ring, Phase Next, and Concurrent Phases.

(d) Overlaps. Provide a CU with controls for 16 Overlaps with each phase being able to be assigned to any overlap with the user definition of Trailing Green, Yellow, and Red Timing when needed.

(e) Detectors. Provide a CU with controls for 80 Detectors with each detector being able to be assigned as phase vehicle or pedestrian detector with Delay, Extend, and Switch capability, and assigned as System, Speed Trap, and Count detector function.

(f) Signal Driver Outputs. Provide a CU capable to assign the Type 2 CU Signal Driver Outputs to any pin set (i.e., Overlap E outputs to Ped 1 output pins) or use Phase On,

Phase Next, and Phase Check for signal driver outputs via alternate ABC connector I/O modes.

(g) Special Function Mapping Routines.

(i) Adaptive Maximum Routines. Provide a CU with, via Time Base Control (TBC), up to three separate Step values to cause the running maximum to increase or decrease smoothly based on current traffic conditions. Separate Dynamic Maximum Parameters must be available for each Step value. The Dynamic Maximum Value can be either larger or smaller than the normal maximum limit.

(ii) Adaptive Protected/Permissive Routines. Provide a CU with routines which measure the volume of left-turn vehicle traffic and available gap windows in the conflicting through-vehicle traffic to determine whether the Left Turn should operate protected or permissive.

(iii) Adaptive Variable Passage Time and Maximum Routine. Provide a CU with routines that have up to three separate values to increase or decrease the default passage time enabled via TBC.

(iv) Coord Adaptive Split. Provide a CU with a routine to allow the utilization of unused coord split time to be allocated to a split that is being forced during coordination.

(v) Permissive Red Flash Routine. Provide a CU with a routine to allow an in-cycle red flash during the through green phase(s), enabled via TBC.

(vi) Provide a Flashing Yellow Arrow (FYA) routine that is programmable in the CU. This routine must be used to provide for operation of a 4 section FYA left turn signal per National Cooperative Highway Research Program (NCHRP) project 3-54. Data entries in the CU must define when the signal face displays the protected (green arrow) and the permissive (flashing yellow arrow). It must be possible to logically AND a minimum of two phases as the control defining the permissive display.

(h) Alternate Sequences. Provide a CU with the capability of 15 alternates to the standard sequence. The alternate sequences may also be selected by the Alternate Sequence external interface inputs or the coordinator as a function of the pattern (Dial/Split/Offset) in effect or as defined by the Start Up menu selection.

(3) Priority of Input Functions. The priority of input functions must be in the following order:

(a) Power-Up.

(b) External Start.

(c) Phase Omit. Lower priority inputs must.

(d) Pedestrian Omit. Condition those of higher.

(e) Interval Advance. Priority as defined.

- (f) Stop Time. Elsewhere in this special provision.
- (g) Remote Flash.
- (h) Manual Control Enable.
- (i) Ring Force Off.
- (j) Phase Hold.
- (k) Pedestrian Recycle.

I. Concurrent Real Time Displays. Provide a CU that displays a dynamic current real time status of six active timers and status per ring for any combination of two of the four rings simultaneously. Real time displays must be provided for ring timer status, coordination, telemetry, preemption, detectors, intersection status, communications, connector input and output status, and TBC. As a minimum, the real time displays must provide concurrent active status for the following conditions:

(1) Ring timer status for 16 phases for any 2 of the 4 rings, minimum green, added initial, walk, ped clear, time before reduction, cars before reduction, time to reduce, effective gap in effect, MAX 1 or 2, passage time, gap out, max. out, force off, last car passage, walk hold or rest, green rest, yellow clearance, red clearance, red rest and red revert state. Phase status indicators for 16 phases concurrently displayed with the ring status indicators must be phase on or rest, vehicle call, non-actuated vehicle recall, minimum vehicle recall, maximum vehicle recall, soft vehicle recall, pedestrian call, pedestrian non-actuated recall, pedestrian recall, phase hold, omit and pedestrian omit. Additionally, the program and pattern in effect, cycle countdown, preemption program in effect, and stop time in effect must also be concurrently displayed. In addition, vehicle and detector calls may be placed through front panel entry while in the active ring timer display.

(2) Coordination active timers must simultaneously display, for up to four rings, the active phase(s) and/or force off active, current cycle length in seconds, offset in seconds, correction mode in effect, local cycle countdown, system cycle count up, offset in last cycle zero, correction of current cycle, time base interconnect, system, backup, manual control, or standby in effect or control.

(3) The telemetry status must simultaneously display the on line-off line status, active or non active carrier frequency, receiving or transmitting data and the validity of data received and/or transmitted for two ports.

(4) The preemption status must concurrently display the real time status for preemption in control, preemption call (preemption or low priority call), timing of (ped or minimum green, ped or vehicle clearance, track greens and clearance, dwell green), delay before preemption, and duration of preemption.

(5) The detector status display must simultaneously indicate the current status of up to 16 detectors. It must indicate the status of both special and phase detectors and whether they are on line or failed. The display must indicate, as a minimum, whether the failure was due to max presence, no activity or erratic count.



(6) The intersection display must simultaneously indicate the active status of 16 phases and the red, yellow, green, walk, don't walk and overlap status of each phase and whether the vehicle and/or pedestrian detectors have a call or recall. Vehicle and pedestrian calls may be placed through front panel entry while in the active intersection display.

(7) The TBC must simultaneously display the current month, day, year, time (hour, minute, second) and whether it is standard or daylight savings time; the day and week program in effect, the dial, split, and offset in effect, phase function mapping for 16 phases, 8 phase functions, the status of 3 auxiliary and diagnostic outputs, and the status of the dimming function. It must be possible to enable the auxiliary, special functions, and phase function options through front panel entry while in the TBC active status display.

J. Coordination. Provide a CU with internal coordination operating as a special program. There must be 16 Timing Plans (one for each Dial/Split combination) with 3 offsets in each. Each Timing Plan must provide a separate Cycle Timing, Phase Split Timing, and Phase Modes.

(1) Operation Modes. There must be six operational modes which may be selected for continual operation or to operate only with a specific pattern (Dial/Split/Offset). Operational modes must be as follows:

(a) Permissive mode provides non-actuated coord phase vehicle and pedestrian modes with permissive windows opened phase-by-phase to the non-coord phases.

(b) Yield Mode provides non-actuated coord phase vehicle and pedestrian modes with a single permissive window for all non-coord phases.

(c) Permissive Yield Mode provides for actuated coord phase vehicle and pedestrian modes with permissive windows opened phase-by-phase to the non-coord phases. Additionally, the coord phase vehicle can extend its green time at the beginning of the first permissive window.

(d) Permissive Omit Mode provides operation similar to Permissive Yield except the coord phase, once terminated, is prevented from occurring prior to the end of the last permissive.

(e) Sequential Omit Mode provides operation similar to Permissive Yield except the permissive is a phase-by-phase sliding window (only one phase in a ring will be allowed service at any time).

(f) Full Actuated Mode provides operation similar to Permissive Yield except any phase can be serviced and re-serviced in the standard sequence following the first permissive and through the last permissive.

(2) Offset Correction Modes. There must be a number of offset correction modes used to determine the method in which the coordinator will bring the running cycle in sync with the background cycle. These correction modes must include as a minimum:

(a) Dwell, correction will take place within one cycle.

(b) Max Dwell, maximum amount of correction per cycle user programmable.

(c) Shortway, cycle will be either shortened or lengthened by a maximum of 20 percent when correcting and will automatically take into consideration phase minimum times.

(d) Shortway+, same as Shortway except cycle will only be lengthened when correcting.

(e) Shortway 2, same as Shortway except the amount of correction will be proportional to the running split times.

(3) Maximum Modes. There must be three Maximum Modes to determine whether Maximum 1, Maximum 2, or Maximum Inhibit will be effective when coordination is in control.

(4) Force Modes. There must be two Force Modes to determine whether the non-coord phase force will be based on a position in the background cycle or on the Timing Plan Phase Split Time.

(5) Offset Position Modes. There must be two Offset Position Modes to determine whether the Offset is calculated based on the Start or End of the first coord phase Green.

(6) Local Traffic Responsive Override. There must be a Local Traffic Responsive Override to enable selection of patterns based on computed volume plus occupancy of selected detectors.

(7) Virtual Split Routine. There must be a Virtual Split Routine on all operational modes that provides for actuated coord phase vehicle and pedestrian modes. This control provides for a period of time for each cycle that is distributed to the Coord Phase(s) or non-coord phases, based on Coord Phase vehicle traffic activity.

(a) Coord Adaptive Split. When coord adaptive split is selected, the running pattern must automatically seek the most advantageous split possible for all non-coordinated phases. If a phase is forced, it is a candidate for an increase in its split. If a phase is gapped out, it is a candidate for a decrease in its split. Time will never be subtracted from a phase split except to give it to another phase. Time will only be added to a phase split if such addition does not cause the cycle length to change.

(8) Phase Times. The coordinator must provide an adjustable time for each phase for each of the 16 programs. The phase time must be adjustable from 1 to 99 seconds. For the coord phase(s) this must become the minimum phase time and for the actuated phases it must become the maximum phase times. Green time for a phase is the phase time minus the phase vehicle clearance (yellow and red) times. The phase time begins when the respective phase is ON except for the coord phase(s) whose phase times may not begin until the local time zero.

(9) Phase Modes.

(a) Coord Phase(s). The coordinator must provide for selecting in each of the 16 programs which phase(s) is/are to be the coord phase(s). The coord phase(s) must operate as non-actuated when coordinated. When no phases have been selected as the coord phases(s), the controller must run Free. When operating in multiple ring controller configurations, a phase in each ring must be selected as the coord phase unless compatibility does not exist within that ring to the coord phase in Ring 1.

(b) Dual Coord Phase(s). The coordinator must provide for selecting in each of the 16 timing programs secondary coord phase(s) in each ring. The secondary coord phases must operate as non-actuated when coordinated.

The secondary coord phases must maintain a fixed position in the pattern cycle in relationship to the coord phase. It may begin early but must not terminate later than the allocated times would imply.

(c) Actuated Phase(s). The coordinator must provide for operation modifiers to be selected for each actuated phases in each of the 16 timing programs. The five modifiers must be:

- (i) Minimum Vehicle Recall.
- (ii) Maximum Vehicle Recall.
- (iii) Pedestrian Recall.
- (iv) Maximum Vehicle Recall and Pedestrian Recall.
- (v) Phase Omit.

(d) Alternate Sequences. The coordinator must provide a means to select one of the alternate sequences or the standard sequence as a function of the pattern (Dial/Split/Offset) in effect.

When the coordinator is running a pattern, the external interface inputs must not override the pattern sequence.

(e) Permissive Periods. The coordinator must provide two types of permissive periods. The permissive period must control the time period during which the coordinator releases the coord phase(s), allowing the CU to begin servicing calls on the non-coord phases.

(i) The first type of permissive operation must consist of a standard vehicle permissive. The length of the period must be determined by the phase time and the minimum time (minimum time = Minimum Green or Maximum Initial + Vehicle Yellow and Red Clear).

Minimum time must be based on the longer of Minimum Green or Maximum Initial when the Seconds/Actuation setting is greater than zero, otherwise minimum time must be based on Minimum Green. The minimum time must be internally set to 5 seconds in cases where the timings are programmed for less.

(ii) The second type of permissive operation must consist of a separate pedestrian permissive concurrent with the vehicle permissive. The length of this period must be determined by the phase time and Walk + Ped Clear + Phase Yellow + Red Clear.

In no case will the pedestrian permissive period be longer than the vehicle permissive period. When a phase is selected as next during the pedestrian permissive period, the

pedestrian movement may start with the beginning of the associated vehicle movement (phase green) regardless of when the pedestrian call is received.

When the CU yields during any permissive period, the coordinator must allow the CU to service all the subsequent phase(s) in normal order before returning to the coord phase(s) and it must not yield on subsequent permissive periods in the same cycle.

(iii) Sync Monitor. The coordinator must monitor the Offset command request for validity of the imposed sync reference.

The coordinator must discontinue offset correction when the length of time between sync pulses exceed the cycle in effect by 5 seconds and until the next sync pulse is received.

The coordinator must cause the CU to revert to Free mode when:

- 1) No sync pulse is received for three consecutive cycles.
- 2) No offset line is active for 15 seconds.
- 3) More than one offset line is active for 15 seconds.

The Sync Monitor "Free" mode may be replaced by a TBC event. See the "On-Line" definition in the Time Base section.

(iv) Manual Control. The coordinator must be capable of being set to manually operate in any pattern (Dial/Split/Offset) by an entry through the front panel. A manual selection of pattern overrides the pattern interface commands.

A manual sync of the pattern must be controlled by an entry through the front panel.

(v) Free. The coordinator must be capable of Free mode of operation. During this mode all coordinator control of the CU operation must be removed.

The coordinator must be capable of being set to the Free mode defined under Sync Monitor and by an entry through the front panel.

The coordinator must recognize input requests that conflict with the internal coordination operation and automatically revert to Free mode when the inputs are active. The inputs that conflict with internal coordination are:

- 1) Manual Control Enable    Free
- 2) Stop Time (Either Ring)    Free
- 3) Remote Flash            Free
- 4) Preemption (Any)        Free

(vi) Master Line Drivers. Eight outputs for master type interconnect interface drivers must be available. The master line driver outputs echo the active program. All outputs

must be constantly "on" when active except offset which is "off" for 3 seconds once each cycle beginning at the zero point of the cycle.

K. Preemption. Provide a CU with Internal Preemption operating as a special program. The preemption program must accept commands from six high priority preempt inputs and six low priority inputs.

The preemption must be capable of cycling while in dwell. It must be capable of being linked to another preempt. It must provide for two modes of priority inputs, one for preempt (railroad, emergency vehicle) and one for low priority (bus or transit vehicles).

Preemption sequences must be programmable, as a minimum, for minimum green/walk, delay and duration, lock/non-lock memory, dwell, selective ped clearance, selective yellow, selective red, track green, track ped clear, track yellow, track red, return ped clear, return yellow, return red, exit phases, flash override, lockout, exit calls and max recalls.

L. Time Base Coordination. The internal TBC must be a special program operating within the CU. A minimum of 250 different TBC events must be capable of being programmed over a 99 year time frame on a Time-Of-Day, Day-Of-Week, and Month Day-Of-Year basis.

TBC events must be entered through the CU front panel or transferred from another like CU. TBC settings and activity must be monitored on the CU display.

The TBC program must output dial, split and offset commands to the coordination program. It must be possible to perform functions not necessarily traffic related within the TBC program by programming and using the three auxiliary outputs.

(1) Clock Calendar. The TBC must be provided with a line frequency driven clock and backed up by a super capacitor crystal controlled clock. During normal operation, the line frequency driven clock must control all timings and re-sync the crystal controlled clock to the line frequency clock once per minute. When power is removed and reapplied, the crystal controlled clock must provide the current time to the line frequency clock.

The TBC must provide a 99 year calendar for automatically determining the current day of week, day of month, month of year and year based on the data set as a starting point. The calendar must provide automatic compensation for leap years.

(2) Time of Day Clock. A Time of Day Clock (TOD) that displays hours, minutes, seconds, month, year and automatic daylight savings time adjustment must be provided. The TOD must be implemented in the CPU via electronic circuitry, operating system software, Global Positioning System (GPS), or a combination. The GPS interface must require simple data entries in the CU to implement and must not require cycling power off/on to enable or disable the GPS function.

(3) Backup Power. A super-capacitor must provide backup power during loss of service voltage. The super-capacitor must have a minimum of 15-farad nominal size. No batteries of any type must be allowed.

(4) Daylight Savings Time. The TBC must provide for Daylight Savings Time to be programmed to occur automatically as defined by law in Michigan, to occur automatically at any user selected date, or not to occur.

When programmed to occur automatically at a user selected date, time must advance 1 hour on the date programmed at 02:00:00 a.m. and decrement 1 hour on the date programmed at 02:00:00 a.m.

Daylight Savings Time must only be capable of being implemented once per year.

(5) Program Day. A program day must be the list of traffic and/or auxiliary events to occur in a 24-hour period. The TBC program must provide for 99 program days to be defined.

It must be possible to equate program days which may require the same event listing to effectively multiply the event capacity.

It must be possible to copy an entire program day event listing to another program day to establish a data base for editing to create a similar but different program day event listing.

(6) Special Days. The exceptions to the normal day-of-week event listings must utilize Time-Of-Year Special program days. Time-Of-Year Special program days 01 through 49 must be utilized for special day programs which occur on the same date (month and month day) every year. Program days 50 through 99 must be utilized for special days which occur on one date (year, month, and month day).

(7) Alternate Week. The TBC events must be implemented from a weekly schedule of program days on a day-of-week (except for special days) basis.

The normal day-of-week (Sunday through Saturday) event listing must utilize program days 01 through 07 with Sunday being program day 01.

The Time-Of-Year event structure must provide a means of substituting 10 alternate weekly schedules for the normal weekly schedule.

(8) Event Capacity. A minimum of 250 traffic and/or auxiliary events must be capable of being programmed. A minimum of 180 special days must be capable of being programmed. The capacity of either of the above may be inversely affected by the number of entries in any one.

(a) A traffic event must consist of a coordination pattern (Dial #, Split #, and Offset #) flash or free mode, Phase Function Mapping and the time of occurrence (hour, minute, and program day).

(b) An auxiliary event must consist of the condition of three Auxiliary outputs, Dimming control, detector diagnostics, special function outputs, and the time of occurrence (hour, minute, and program day).

(c) A time-of-year event must consist of a special day or alternate week plus date of occurrence (year, month, and month day).

(9) Traffic Programs. In addition to dial, split and offset commands, the TBC program must provide the following as traffic events:

(a) Flashing (Voltage Monitor inactive).

(b) Free.

(c) Phase Function Mapping by phase for 16 phases.

(i) Phase function mapping must include: Max 2, phase omit, pedestrian omit, minimum vehicle recall, max vehicle recall, pedestrian recall, detector switching omit, detector switching now, detector switching also (switch and assigned detector input simultaneously) and overlap omits.

(ii) Phase Function Mapping features are Free Mode modifiers and must not be part of an event which selects a pattern (Dial/Split/Offset) or Flash.

(10) Auxiliary Events. There must be three auxiliary outputs available. Each output must be non-cyclic, each totally independent of any other output. The outputs must not be affected by any other input including the On-Line input. The auxiliary outputs may begin and/or end concurrently with another program.

(11) Detector Diagnostics. There must be three detector functions available. One must set the value of the detector diagnostic to be selected (four parameters can be set for each detector) and one to initiate or stop the detector log report. The third function is reserved for future use.

(12) Dimming. There must be a dimming function that allows signals so programmed to dim their outputs.

(13) Special Function Mapping. There must be eight special function mapping outputs available. There must be eight special functions, three alternate passage and maximum times, three adaptive maximum settings, an Adaptive Protected/Permissive feature, an In Cycle Flashing Red feature, four sign control outputs, three diamond intersection control outputs, four queuing controls, and coord adaptive split. It must be possible to map more than one function to the same logical control.

(14) Input and Program Priorities. The coordination programs must be capable of being selected based on manual (keyboard) inputs, TBC events and interconnect inputs. Program select priority must be:

(a) Manual Inputs.

(b) System Interface.

(c) TBC Events.

(d) Interconnect Inputs.

When the TBC On-Line input is active, the TBC events have no priority and program selection must be based on manual inputs or interconnect inputs.

When the On-Line input is active, the coordination routine reverts to TBC control based on sync monitor failure.

M. Miscellaneous.

(1) Flash.

(a) Start-Up Flash. The CU must have provisions whereby an adjustable timed period/state (Start-Up Flash) must occur prior to the Initialization routine.

The time range for Start-Up Flash must be 0 to 99 seconds in increments of 1 second.

When power is restored following a defined power interruption or Watchdog restart, the Start-Up Flash state must become operational. No input, other than alternating current (AC) Power, must prevent this state from the completion and/or exit to the Initialization routine.

(b) Remote Flash. Activation of this input must cause vehicle and pedestrian calls to be placed on all phases. The CU must assure the completion of the Minimum Green or Walk plus Red Clearance time on the current phase(s) and must proceed immediately, thereafter, to the vehicle clearance intervals followed by the phase(s) programmed as the Entry Phase(s).

After the Entry Phase(s) Minimum Green or Walk plus Red Clearance, the CU must proceed to the vehicle clearance intervals.

Upon completion of the vehicle Red Clearance interval, the CU must initiate flashing operation (Voltage Monitor output inactive). The CU must maintain this condition, Voltage Monitor inactive and Red Dwell as long as the Test A (Remote Flash) input is active. When the input becomes inactive, the CU must move immediately to the beginning of the phase(s) programmed as the Exit Phase(s), with a Green/Walk display, calls on all phase vehicle and pedestrian, and must cease flashing operation (Voltage Monitor output active).

N. Pretimed Control. When selected, these specifications cover the minimum acceptable operating requirements for a pretimed fixed cycle traffic signal CU of solid-state microprocessor type, per *NEMA Standards Publication TS-2, P2*. The CU must be designed for operation on 120 volt, 60 hertz, single phase A.C. electrical systems.

(1) The pretimed CU must be an interval oriented device. The conditions of the output circuits (load switch drivers) must be programmable as to condition in each of the Signal Plan intervals. The interval sequence, interval timing, and output circuit condition are used to control the order in which traffic movements are assigned the right-of-way at the intersection and the time allocated to each. The CU must be capable of operating as a master controller, isolated controller, or secondary controller without changes or additions.

(2) The CU must accept Timing Plan (Dial/Split) and Offset commands from traditional interconnect systems, the internal systems interface, and/or from a companion Time Base program.

O. Functional Operation.

(1) General. Provide a CU with the following operational features:

(a) A minimum of four Dials (cycles).



- (b) Four Splits per Dial (cycle).
  - (c) Three Offsets per Dial/Split combination.
  - (d) A minimum of 32 intervals per Dial/Split.
  - (e) A minimum of 24 signal circuits but capable of 36 circuits.
  - (f) Four Signal Plans, each with alternate path programming and inputs from four vehicle and four ped detectors.
  - (g) Up to six complete and separate Preemption Programs and six Low Priority routines.
  - (h) Sync out for use as system master.
  - (i) Operation on standard 120 volt, 60 Hz, AC pretimed interconnect inputs without external interface.
- (2) Dial (Cycle).
- (a) A minimum of four cycles must provide 30-999 seconds minimum in 1 second increments. The cycle time of each Timing Plan must be the sum of the interval times of the longest path in the signal plan.
  - (b) The Dial (Cycle) must be selected by application of 120 volt, 60 Hz, AC to the input connector and also be able to be manually selected from the keyboard.
  - (c) A visual indication of the Dial currently in effect and a dynamic display of the cycle seconds must be provided.
  - (d) Transfer from one Dial to another must occur at the end of the interval in effect at the time of request for transfer, unless that interval is programmed to prohibit transfer.
- (3) Offset.
- (a) Three Offsets must be provided for each Dial/Split combination.
  - (b) Each Offset for each Dial/Split must be individually programmable from 0-999 seconds in 1 second increments. The programmed Offset must define the number of seconds by which the beginning of interval #1, local time zero, must follow the system sync pulse.
  - (c) Offset must be selected by TBC or via "D" Connector input and be manually synchronized from the keyboard.
  - (d) A visual indication of the offset currently in effect must be provided.
  - (e) Offset adjustment must be programmable to use shortway or dwell transfer procedures. If shortway method is programmed, the CU must seek a new offset in the shortest direction by adding or subtracting with the rate of offset change never exceeding 18.75 percent points per cycle. Shortway Add Only - must only add up to 18.87 percent. If

dwelling (maximum or variable) is called for, the CU must dwell in the programmed interval for a maximum (0-999 seconds in 1 second increments) or until a sync pulse is received while the CU is dwelling. Following the timing of a full offset dwell interval, the absence of a synchronization pulse prior to the beginning of the next dwell interval must cause the CU to ignore the dwell time and run free (non-interconnected) until the receipt of a valid synchronization pulse.

(4) Split.

(a) Four Splits must be provided for each Dial (cycle). Splits must be capable of being programmed independently of any signal plan and also must be capable of being "tied" to the corresponding signal plan.

(b) Each Split for each Timing Plan must consist of a programmed number of intervals, a minimum of 32 and must be individually programmed. The same number of intervals must not be necessary for all splits.

(c) Split must be selected by application of 120 volt, 60 Hz, AC to the input connector and also be able to be manually selected from the keyboard.

(d) A visual indication of the split currently in effect is provided.

(e) Transfer from one split to another must occur, upon command, at the end of the interval in effect at the time of request for transfer, unless that interval is programmed to prohibit transfer.

(5) Interval.

(a) A minimum of 32 intervals must be provided for each combination of Dial and Split.

(b) The timing for each interval must be programmable between 0-999.9 in 0.1 second increments for each of the four Splits in each of the four Dials.

(c) It must be possible to copy the timing values for any Dial and Split into any other Dial and Split in one operation.

(d) When less than 32 intervals are required, it must be possible to specify and program only the number used. Programming zero times for unused intervals must not be required.

(e) The following interval related intersection configuration data must be programmed in non-volatile EEPROM memory for each interval of each signal plan:

(i) Each interval must be capable of being named as an actuation interval through input 1 and/or through input 2. If a valid call is not placed on this interval, the allotted time must be automatically added to a designated default interval. Each interval must also have the capability of being a RESET interval of input 1 and/or input 2.

(ii) Each interval must be programmed as either fixed or variable for purposes of shortway offset changes. Each interval must be programmed as either self-timing or non-self-timing when Manual Control Enable or System Control is asserted. Operation of

Interval Advance input must immediately terminate non-self-timing intervals, but must have no effect on self-timing intervals.

(iii) Minimum time for the intervals. The range must be 0-99.9 seconds in 0.1 second increments. Minimum interval time must not be violated by programmed time. The CU will time no less than the minimum and indicate an error in programming.

(iv) Each interval must be able to be programmed to control the display shown on up to 12 load switches. The status of each load switch must be one of the following: RED, GREEN, YELLOW, FL-RED, FL-GREEN, FL-YELLOW, RED GREEN, or DARK.

(v) Each interval must be capable of specifying the signal plans (if any) to which transfer would be safely allowed.

(vi) Each signal plan must provide for a selection of three alternate signal sequences, plus a default sequence, based upon a detector 1, detector 2 or detector 1 plus 2 input. An alternate set of detectors (detector 3 and detector 4) may be used if required for the proposed sequence. This must provide a means of selecting one of the interval sequences in response to a detector input without the necessity of changing signal plans. Different interval paths, within a signal plan, may be followed during a given cycle, depending upon an external detector(s) input.

(f) Driver and Remote Flash control must be provided to allow:

(i) Driver control as either vehicle or pedestrian so that the intersection display status and preemption operation are correct.

(ii) Remote flash control to allow the CU to flash certain load switches when remote flash is called for. It must be possible to flash either Red or Yellow and alternate if desired.

(6) Displays. Provide a CU with a simultaneous dynamic display of the following operational status:

(a) Dial, offset, signal plan, split, preempt, and interval in effect.

(b) Time remaining in the cycle.

(c) Offset correction method in effect.

(d) It must be possible to display data previously programmed through the keyboard. The parameter called for and its current programmed value must be displayed. The CU must continue in uninterrupted cyclic operation during any interrogation of currently programmed values. After entry of the proper access code, it must be possible to change any front panel programmable values.

(e) Concurrent Real Time Displays. The CU must display a dynamic current real time status of interval, interval time, and signal plan. Concurrent real time displays must be provided for, coordination timing, telemetry, preemption, detectors, intersection status and TBC. As a minimum, the real time displays must provide concurrent active status for the following conditions:

(i) Coordination active timers must simultaneously display, for interval timing cycle timing, offset active, current cycle length in seconds, offset in seconds, correction mode in effect, local cycle countdown, system cycle count up, offset in last cycle zero, correction of current cycle, time base interconnect, system, backup, manual control or standby in effect or control and interval minimum time set.

(ii) The telemetry status must simultaneously display the on line-off line status, active or non active carrier frequency, receiving or transmitting data and the validity of data received and/or transmitted for two ports.

(iii) The preemption status must concurrently display the real time status of a minimum of six preemptions for preemption in control, preemption call (preemption or low priority call), timing of (ped or min. green, ped or vehicle clearance, track greens and clearance, dwell green), delay before preemption, and duration of preemption.

(iv) The detector status display must simultaneously indicate the current status of up to 12 detectors. It must indicate the status of both special and group detectors and whether they are on line or failed. The display must indicate whether the failure was due to max presence, no activity or erratic count.

(v) The intersection display must simultaneously indicate the active status of 12 load drivers and the red, yellow, green, and walk, and don't walk status of each driver and whether the vehicle and/or pedestrian detectors have a call or recall.

(vi) The TBC must simultaneously display the current month, day, year, time (hour, minute, second) and whether it is standard or daylight savings time; the day and week program in effect, the dial, split, and offset in effect, the status of three auxiliary and diagnostic outputs and the status of the dimming function.

#### (7) Signal Circuits.

(a) Provide a CU with a minimum of 36 signal circuits. The number implemented must be as required to provide the specified signal sequence.

(b) The ON/OFF FLASH and COLOR state of each implemented signal circuit during each interval for each signal plan must be programmed in EEPROM.

(c) The flash rate of any signal circuit programmed to FLASH must be 60 times per minute with a 50 percent duty cycle.

#### (8) Signal Plans.

(a) Provide a CU capable of implementing four different signal plans.

(b) All signal plans need not have the same number of intervals.

(c) Signal plan must be selected via program entry or manually from the keyboard.

(d) Each of the four vehicle detector input must be capable of being programmed to operate in (1) NON-LOCK mode, (2) LOCK mode and (3) RECALL mode.

(i) Detector Delay/Extension. The following special vehicle detector functions must be provided for each of the four group detectors:

1) Delay. The group vehicle detector actuation (input recognition) must be capable of being delayed, by an adjustable (00-999 seconds), when not in the actuated interval associated with the detector. Once the actuation has been present for the delay time it must be continued for as long as it is present.

2) Extend. The group vehicle detector actuation (input duration) must be capable of being extended from the point of termination by an adjustable time (0-99.9 seconds).

3) The special vehicle detector functions must be capable of being used in any combination. The sequence is that an actuation must be extended first and delayed second.

(e) The CU must operate in accordance with the programmed values for the selected dial, offset and split for the signal plan in effect. Signal Plan EEPROM programming must affect the ON/OFF/FLASH and COLOR condition of the load drivers for each interval.

(f) During any CU cycle, it must be possible to operate in any 1, 2, 3, or all 4 signal plans independent of split.

(g) A visual indication of the signal plan currently in effect must be provided.

(9) Preemption.

(a) Provide a CU with preemption capable of containing a minimum of six complete and separate sequences.

(b) It must be possible to program the ON/OFF FLASH and COLOR condition of all implemented signal circuits independently for each preempt interval.

(c) It must be possible to program preempt operation to proceed sequentially through the preempt intervals and hold at the end of a specified interval.

(d) It must be possible to specify the interval(s) in the preempt plan during which normal cyclic operation resumes.

(e) It must be possible to program a delay between the time the preempt input is asserted and implementation of the preempt plan. The range of this delay must be 0-999 seconds in 1 second increments.

(f) It must be possible to program the preempt input to operate as a LOCK or NON-LOCK input. When programmed NON-LOCK, termination of the preempt input during the delay before preemption must not initiate preempt operation.

(g) A visual display must be provided of the condition of the preempt inputs and the preempt plan interval in effect.

(10) Master-Secondary.

- (a) Provide a CU with a sync output for 3 seconds of the cycle length.
- (b) Any CU must be able to operate as a master controller or as a secondary without requiring any changes in the unit itself.
- (c) When used as a master controller, it must not be necessary to program the CU's offsets to 0.

P. Diagnostics. Provide a CU with a resident series of diagnostic capabilities describing its own internal state. It must not require internal access or changes to the CU to initiate diagnostic programs.

- (1) Automatic Diagnostics. The CU must perform diagnostics enabling operator verification of proper operation.

The "automatic" diagnostics must be performed without an operator request. The diagnostics evaluation must be displayed on the CU front panel display.

- (a) Processor Monitor. The CU must contain provisions to monitor the operation of the microprocessor. The monitor must receive signals, at least, once every 100 milliseconds from the microprocessor.

- (b) When the signal is not received for 200 milliseconds  $\pm 20$  percent, the processor monitor must initiate flashing operation (Voltage Monitor output inactive). When flashing is initiated as a result of the processor monitor, it must illuminate a front panel indication labeled "Watchdog." The monitor must be deactivated when there is a power failure and become active when restored.

- (c) The monitor must attempt an automatic restart of the microprocessor to the power up Start Flash timing condition. The CU must operate as though power had been removed long enough for a full restart and reapplied. The front panel Watchdog indicator must remain illuminated until the CU front panel has been manually addressed.

- (2) Operator Initiated Diagnostics. The CU must perform diagnostics enabling operator verification of properly operating inputs, outputs, keyboard and display.

The "operator initiated" diagnostics must be performed only after an operator request through the CU front panel. The technique used must be relatively simple and suspend normal traffic operation during the test and the CU must be plugged into Suitcase-Sized *NEMA Standards Publication TS-2* Controller Test Set. The diagnostics evaluation must be displayed on the CU front panel display and/or indicators on the suitcase tester as an operator interface.

- (a) Inputs. The CU must provide test routines to enable operator verification that input functions are proper. This test must determine whether the input buffers are operating correctly.

- (b) Outputs. The CU must provide test routines to enable operator verification that output functions are proper. This test must determine whether the output drivers are operating correctly.

Each output must be actuated in a fixed sequence. The user must observe the output sequence and determine correct operation.

(c) Display. The CU must provide test routines to enable operator verification that display functions are proper. This test must determine whether front panel drivers and decoders are operating properly. All the indicators must be activated. The user must observe the front panel display and determine correct operation.

(d) Keyboard. The CU must provide test routines to enable operator verification that keyboard functions are proper. This test must determine whether the keyboard is operating correctly. The operator must test each of the CU keys. The numeric display must indicate the key pressed. The user must observe the front panel display and determine correct operation.

#### Q. Traffic Analysis Functions.

(1) Alarm Monitoring/Events Logging. Provide a CU that monitors and logs the status of the following functions for subsequent uploading to an on-street or central office master:

Cycle Fault	Voltage Monitor	Preempt
Coord Fault	Conflict Flash	Local Free
Coord Failure	Local Flash	Special Status
Cycle Failure	Remote Flash	Power On/Off

(2) Local Alarms Report. A Local Alarms Report must be generated with the capacity for up to 120 alarm events, including date and time of occurrence. Once logged, the alarms must remain until the report capacity is exceeded at which time the oldest alarm must be deleted and the new one added. This report must be output to the front panel display, to the printer port, and to the 25 pin RS-232 port.

#### (3) System Detectors.

(a) Detector Data. Provide a CU that has the ability to receive input data from up to eight special (system) detectors in addition to the normal actuated CU phase detectors as system detectors.

The CU must process all system detector data, consisting of volume and occupancy, and must be capable of transmitting the results of this processing to either the on-street or central office master monitor. As a minimum the following parameters must be determined:

Raw volume count, raw occupancy  
 Average occupancy percent  
 Average volume percent  
 Volume + occupancy percent

(b) Detector Report. The CU must generate a System Detector Report based on an operator determined logging interval and sample period. The report must include raw volume and occupancy along with averaged volume and occupancy percent for the sample period. This report must have the capacity to store up to 96 sample periods. A sample

period data set must remain until the report capacity is exceeded at which time the oldest sample period data set will be replaced by the new data set.

The CU must provide a volume count report. Means must be provided to enable the use and vehicle, special or pedestrian detector inputs as count detector inputs for the volume count report. The detector volume count report must have the capacity to store up to 72 count periods. Note: the detector volume count report parameters and output will not be capable of being entered or viewed via the front panel of the CU. It must be downloaded and viewed via a PC and the manufacturer's software.

(c) Detector Diagnostics. Each detector, both phase and special system must be tested by a diagnostics routine for conformance to specified parameters. The detector diagnostics must monitor activity on each detector for constant calls, absence of calls, and erratic output. These parameters must be user programmable.

A detector must be classified as 'on-line' when the results of the monitoring and diagnostic procedures determine that data from the detector is within the allowable range.

Detectors which have failed the diagnostics and those subsequently operating within diagnostic parameters must be automatically logged in a Detector Failure Report, including date and time of occurrence. This report must have the capacity to store up to 60 diagnostic events and the event must remain until the report capacity is exceeded.

(4) Measures of Effectiveness (MOE's) must be accumulated and reported to enable the evaluation of coordination pattern parameters based on actual data collected during the periods the pattern is in control. MOE calculations must be made once each sequence cycle for Volume, Stops, Delay and Utilization for each phase in the CU and then averaged over the duration of the pattern. A MOE Report must be provided and must have the capacity to store up to 24 patterns of MOE's. The pattern MOE's set must remain until the report capacity is exceeded at which time the oldest pattern set must be deleted and the new MOE pattern added.

(a) Volume must represent the average number of actuations during the sequence cycle, for each phase, over the duration of the pattern.

(b) The Stops measurement must represent the average number of vehicles which must stop at an intersection during the cycle, for each phase, over the duration of the pattern.

(c) Delay must represent the average time, in seconds, that vehicles are stopped during the sequence cycle, for each phase, over the duration of the pattern.

(d) The Utilization measurement must represent the average seconds of green time used by each phase during the sequence cycle for the duration of the pattern.

(5) Speed Traps. Provide a CU with speed monitoring capability in the form of a Speed Trap function. The CU must provide for up to two independent Speed Traps with operator selectable detector spacing of either 11 or 22 feet, dependent upon the application. Provision must be made in the CU to monitor the speed in miles per hour (MPH).

A nominal speed range must be settable for each pattern, with the percent of vehicles higher, within and lower than this nominal speed ranged logged for reporting.



A Speed Report must be provided and must have the capacity to store up to 24 patterns of Speed data. The pattern Speed data must remain until the report capacity is exceeded at which time the oldest pattern speed data must be deleted and the new data added.

(6) Reports. In addition to the above-described reports, the CU must provide a Communications Report which will allow the user to view a list of communications failures along with date and time of occurrence. This report must have a minimum capacity of storing up to 60 events (faults). The fault event, including date and time of occurrence, must remain until the report capacity is exceeded at which time the oldest fault will be deleted and the new fault event added.

In regard to communications, indication must be provided on the front panel of the CU to denote when a carrier signal is being received, valid data is being received and when the unit is transmitting.

R. Quality. The CU must meet the *NEMA Standards Publication TS-2* requirements, as applicable, and must have been tested and certified by an independent test laboratory. An independent test laboratory is defined as one that has no relationship to the controller manufacturer, except as a supplier of services. The Contractor must supply the Engineer with documents certifying conformance to the requirements.

S. Compliance. The supplier is required to complete, sign, and attach a Specification Compliance Sheet with respect to the equipment bid. Appropriate supporting documentation including one complete set of instructions for installation and maintenance of the CU, manufacturer’s literature, and wiring diagrams must be provided. Failure to provide this documentation will result in evaluation of equipment based on information already on file.

2. Cabinet.

A. Scope. This subsection provides the minimum acceptable requirements for a series of cabinets that differ in size, to house the CU and related devices. Provide the base mounted size 6 cabinet unless the plans indicate otherwise.

B. Outline Dimensions. Outline dimensions must be as shown in Table 1. These dimensions are outside dimensions exclusive of hinges, handles, overhang(s), vent housing, and adapters. Cabinet heights are measured to the lowest point of the top surface of the cabinet. The combined overhangs of the four sides of the cabinet must not exceed 4 inches.

**Table 1: Minimum Outline Dimensions**

<u>Size</u>	<u>Height</u> (inches)	<u>Width</u> (inches)	<u>Depth</u> (inches)
M30	51	30	16
M36	51	36	16
6	56	44	25.5

C. Cabinet types and mountings.

(1) Base Mounted (Size 6). The size 6 cabinet must be constructed so that it can be mounted on a 30 inch by 48 inch foundation. Anchor bolt mounting provisions for four bolts on 40¾ inch centers (side-to-side) and on 18½ inch centers (front-to-back). One Base

Adaptor that is 15 inches in height with the same dimensions and bolt pattern as the cabinet must be included. Provide eight nuts and eight washers with each size 6 cabinet.

(2) Pole Mounted/Base Mounted (M30). Cabinets intended for side of pole mounting must be provided with any necessary adapter, exclusive steel banding, to permit mounting to a 4½ inch or larger diameter pole. The adapter must accommodate lag bolts up to 3/8 inch and steel banding up to 1 inch wide. Mounting points must be provided at or near the top and bottom of the cabinet. The adapter must have provisions for two holes spaced horizontally, which will have a center-to-center distance of 3½ inches. Cabinets must be furnished without conduit holes. In addition, the cabinet must be provided with a removable bottom to enable it to be pole or base mounted.

(3) Base Mounted (M36). The M36 cabinet must be constructed so that it can be mounted on a 24 inch by 42 inch foundation. Anchor bolt mounting provisions must be dimensioned for two bolts on 18 inch centers (side to side).

(4) Anchor Bolts. Anchor bolts for base mounted cabinets must be 3/4 inch diameter by 42 inches long which includes a 90 degree bend with a 3 inch leg meeting the requirements of subsection 908.14.D of the Standard Specifications for Construction, except as noted herein. The end opposite the leg must be threaded for at least 3 inches with a 3/4 inch Unified Coarse Thread (UNC) - 10 thread. Anchor bolts must be steel with a hot-dipped galvanized or zinc plate surface.

D. Materials. The traffic control cabinet must be constructed of aluminum alloy. The aluminum material must be a minimum of 1/8 inch alloy sheet, ASTM B 209, 5052-H32 or equivalent.

E. Finish and Surface Preparation.

(1) The surface of the cabinet must be suitably prepared prior to painting, to avoid paint peeling.

(2) Interior surface must be painted white.

(3) The exterior of the controller cabinet and all mounting attachments must be finished with a durable and weather-resistant protective coating having a total dry film thickness of not less than 1.5 mils. The final coat must be aluminum in color, must give complete hiding, and must be at least 0.75 mil in thickness.

(4) If the painted surface is scratched or damaged, the affected area must be repainted.

F. Top Surface Construction. The cabinet must be manufactured so as to prevent the accumulation of water on its top surface.

G. Doors.

(1) Main Cabinet Door. The cabinet must have a main door which permits access to all equipment within the cabinet. Doors must be hinged on the right side of the cabinet as viewed from the outside facing the cabinet door opening. They must have a handle made of one piece construction and swing away from the locking mechanism.

(2) Hinges. All cabinet doors must incorporate a piano type hinge utilizing stainless steel hinge pins.

(3) Door Stop. The cabinet door must be provided with a door stop which holds the door open as a minimum at 90 degrees and 180 degrees ( $\pm 20$  degrees).

(4) Latches and Locking Mechanism.

(a) All cabinets must incorporate a main door lock, Corbin No. 15481RS or Pelco (Type II) SM-1025 or equivalent, constructed of nonferrous or stainless materials, which must operate with a Traffic Industry conventional #2 key, Corbin No. 1R6380 or Pelco (Type II) SM-0198-2 or equivalent. A minimum of two keys must be included for the main door of each cabinet.

(b) Provide cabinet door(s) with a three-point latch. The top and bottom must have rollers to secure the door in a closed position.

(c) When in the locked position, the lock must prevent the movement of the three-point latching mechanism.

(d) Provide the cabinets with a means of externally padlocking the latching mechanism. A minimum of 3/8 inch diameter lock shackle must be accommodated.

(5) Door Opening. The main door opening of all cabinets must be at least 80 percent of the area of the side which the door closes, exclusive of the area of plenums.

(6) Switch Compartment.

(a) Mount a hinged switch compartment door to the outside of the main cabinet door. The door must permit access to a switch panel but must not allow access to exposed electrical terminals or other equipment within the cabinet.

(b) In order to allow for the switch controls and storing of the manual control cord, the switch compartment with the door closed must have minimum internal dimensions of 3½ inches high, 7½ inches wide, and 2 inches deep. Additionally, the volume must not be less than 70 cubic inches.

(c) Equip switch compartment doors with a lock, which can be operated by a police key, Corbin Type Blank 04266 or Pelco type SM-0200 long keys, or equivalent. A minimum of two keys must be included for the switch compartment of each cabinet.

(7) Plastic Doors. When called for on the plans, doors for the M30, M36 and Size 6 must be vacuum formed from gray ultra violet (UV) inhibited 3/8 inch GPX 3800 Acrylonitrile Butadiene Styrene (ABS) plastic. Exterior surfaces of the door must be laminated during the extrusion process with a 0.010 inch minimum thickness Pearl Gray Korad acrylic film for additional protection against ultraviolet degradation.

The doors must have vacuum formed louvers for the cabinet ventilation system. The interior panel must be vacuum formed from 1/4 inch GPX 3800 gray ABS plastic and molded with ribs for rigidity and stability of the door and be provided with channels opposite the louvers for holding the cabinet's air filter. The door must have a 3/8 inch wide door flange around the

perimeter of the door that will properly fit the cabinet and gasket to provide a moisture proof seal.

The exterior of the door must have a hair cell pattern with an overlay of the gray Korad. The interior and inside panel must have a smooth finish without the overlay of gray Korad. All fasteners must be stainless steel. A three point locking mechanism must be provided. A heavy gauge continuous hinge must have a 3/16 inch non-removable pin and attached to the cabinet with carriage bolts for vandal resistance. The door stop must accommodate the standard cabinet door stop rod in the cabinet. A switch compartment door is not required on the plastic doors.

There must be no wiring attached to the plastic door. Switches and other circuits normally attached to the aluminum doors must be mounted on a panel located between the shelves when the plans call for a plastic door on the cabinet.

H. Shelves. Provide a cabinet with two shelves for supporting the control equipment. The shelves must be at least 10 inches in depth.

All cabinets must have a provision for positioning shelves to within 12 inches of the bottom of the cabinet and to within 6 inches of the top of the cabinet in increments not more than 1/2 inch.

I. Cabinet Risers. The M30 (when specified as base mount), M36, and the Size 6 must be provided with a 15 inch high cabinet riser. The riser must match the mounting base of the cabinet and be provided with anchor bolt holes on the top and bottom of the risers. The risers must come in two parts for ease of assembly.

J. Ventilation System. All cabinets must incorporate a ventilation system so as to provide for the circulation of external air through the enclosure to remove excess heat, fumes, or vapors. When forced ventilation is required, each cabinet must be equipped with an electric fan with a capacity of at least 100 cubic feet of air per minute.

(1) Fan. The fan on all aluminum door cabinets must be installed so that it operates in the filtered incoming air stream so as not to create a negative pressure within the cabinet relative to its outside environment. All fans must be equipped with a guard which inhibits a user from making contact with the blades of the fan.

(2) Fan Controls. All cabinets equipped with a fan must have a device to control the operation of the fan. The device switch-on point must be manually adjustable at least in the range from 80 degrees F to 120 degrees F.

The device must have a differential between its switch-on point and its switch-off point. This differential must not be greater than 25 degrees F. The device must be located in the inside of the top of the cabinet not lower than 6 inches from the top of the cabinet.

(3) Filter. The cabinet must be equipped with a device to filter the incoming air. The cabinets must be provided with louvered vents in the main door with a replaceable air filter having a width of 16 inches, a height of 12 inches, and a thickness of 1 inch.

K. Terminal Facility.

(1) Scope. This section provides the minimum acceptable requirements for terminal facilities to interconnect the related devices within a traffic control cabinet.

(2) Mechanical Construction. The terminal facility must conform to the following mechanical requirements.

(a) Terminal Identification. Permanently identify all terminals in accordance with the cabinet wiring diagram. Where through-panel terminal blocks are used, both sides of the panel must have the terminals properly identified with the terminal position number.

Permanently attach identification as close as possible to the terminal strip and do not affix to any part which is easily removable from the terminal block panel.

Each input or output terminated on a terminal block must be identified on the front of the panel by position number and function terminology (e.g., Ph 1 Red, Ph 2 Hold, etc.). The same identification must be used consistently on the cabinet wiring diagram.

(b) Component Identification. Permanently identify all components which make up the basic terminal facility in accordance with the cabinet wiring diagram. The following components are considered part of the basic terminal facility:

- (i) Load Switch Sockets.
- (ii) Flash Transfer Relay Sockets.
- (iii) Flasher Socket.
- (iv) Main and Auxiliary Circuit Breakers.
- (v) Radio Interference Suppressor and Surge Protector.
- (vi) Solid State Signal Power Relay.
- (vii) Power Terminal Bus Bars.

Where through-panel components are used, both sides of the panel must have the components properly identified by relative symbols (e.g., FRI, LS1, etc.).

Permanently attach identification as close to the component as possible and do not affix to any part which is easily removable from the panel.

Each component must be identified on the front of the panel by symbol and function terminology (e.g., LF1 Filter, BR1 Signal Bus, etc.).

(c) Load Switch and Flasher Support. Design and construct load switch and flasher bases as to receive all such devices which may be manufactured to the maximum size requirements permitted under the *NEMA Standards Publication TS-2*.

Provide all support(s) so that, as a minimum, it is supporting the flasher and load switch of the maximum size at some point(s) between 3 inches and 7 inches from the panel.

At least 90 percent of the area beneath the load switch or flasher must be open to allow for the free flow of air across the load switches or flasher. Provide at least 1 inch unobstructed open area within 1 inch above or below the units.

(d) Load Switch, Flasher, and Flasher Transfer Positions. Provide wired load switch, flasher, and flash transfer relay sockets in the quantities listed below:

<u>Configuration</u>	<u>Load Switch</u>	<u>Flasher</u>	<u>Flash Transfer</u>
A2	8	1	4
A5	12	1	6
A16	16	1	6

The flasher socket must be wired for a Type 3 solid state flasher conforming to Section 8 of *NEMA Standards Publication TS-2*. Flashing of even numbered load switch output indications must be placed on one circuit and flashing for odd numbered load switch output indications must be placed on the other circuit. It must be possible to flash either the amber or red indication on any load switch outputs. It must be possible to easily change the flash indication from the front side of the panel using simple tools without the need to unsolder or re-solder connections.

The load switch sockets must be wired for triple-signal load switches conforming to Section 5 of *NEMA Standards Publication TS-2* for Type 2 CUs. All load switch driver outputs coming out of the CU must be on separate terminal points from the respective inputs to the load switches. These separate termination points must be bussed for normal operation. All load switch outputs must be on separate points from the respective inputs to the malfunction management unit (MMU) inputs. These separate points must be bussed for normal operation.

Load switch sockets for the A2 configuration must be oriented in a single row of eight. Socket positions one thru four must be for phases one thru four vehicles, respectively. Socket positions five thru eight must be for phases one thru four pedestrians, respectively.

Load switch sockets for the A5 configuration must be oriented in a single row of 12. Socket positions one thru eight must be for phases one thru eight vehicles, respectively. Socket positions 9 thru 12 must be for phases 2, 4, 6, and 8 pedestrians, respectively.

Load switch sockets for the A16 configuration must be oriented in two rows of eight positions each. The top row must be socket positions one thru eight and must be for phases one thru eight vehicle respectively. The lower row must include socket positions 9, 10, 11, and 12 for overlaps A thru D, respectively, and must each be located below socket positions 1, 3, 5, and 7 respectively. Socket positions 13, 14, 15, and 16 in the lower row must be below and to the right of socket position 8, and must be for pedestrian phases 2, 4, 6, and 8 respectively.

(e) Terminal Blocks. Terminal blocks must have mechanical characteristics to properly support the wiring connected without warping the terminal block. All materials including screws and threaded portions used in terminals and terminal blocks must be stainless steel.

(i) Field Terminal Blocks. Field terminal blocks for all inputs and outputs for a fully expanded CU must be included. These blocks must be either single terminal type with through-panel connection on the rear side of the mounting panel or double binder head screw terminals. Either type of terminal block used must be of the correct ampacity for the application. Minimum acceptable ratings are 30 amperes, 300 V, with 10 - 32 binder head screws.

(ii) Control Terminal Blocks. Control terminal blocks for inputs and outputs of the CU, MMU, flash transfer relays, load switches, etc., must be included. These blocks must be either single terminal type with through-panel connections or double binder head screw terminals. Either type of terminal block used must be of the correct ampacity for the application. Minimum acceptable ratings are 15 amperes, 250 V, with 6-32 x 1/4 inch pan or binder screws.

The control terminal block wiring must provide groupings of functions based on probable interconnect (bussing) for normal operation rather than based on the source of the wiring (e.g., CU, MMU, etc.).

(iii) Detector Terminal Blocks. Detector terminal blocks for loop and push button inputs must be included. These blocks must be either single terminal type with through-panel connections or double binder head screw terminals. Either terminal block must be of the correct ampacity for the application. Minimum acceptable ratings are 20 amps, 250 V with 8 - 32 pan or binder screws.

(f) Controller Unit (CU) and Malfunction Management Unit (MMU) Harnesses. The CU and MMU harnesses must be neatly arranged and provided with the flexibility for the connectors to reach at least 40 inches from the top of the terminal block panel which must be mounted directly below the CU shelf. The harness connectors must not have any sharp edges and the stress relief attachment screws must not extend greater than 1/4 inch beyond the stress relief.

Provide terminal positions, completely wired and neatly arranged, providing access to all inputs and outputs listed in the CU specification. As a minimum, all *NEMA Standards Publication TS-2* functions of the CU for the configuration selected must be terminated except those designated by *NEMA* as spares, reserved, no connection, and manufacturer's use need not be installed in the harness.

Provide terminal positions, completely wired and neatly arranged, providing access to inputs and outputs in the MMU. All MMU input must be terminated. Provisions must be made to terminate any unused red monitoring inputs. Type select and port one disable inputs must be terminated.

The MMU harness must be configured for a 16 channel MMU operating in the type 12 mode. The MMU harness must be configured as follows:

<b>Table 3: MMU Harness Configuration</b>		
<u>Configuration</u>	<u>Load Switch</u>	<u>MMU</u>
A2	8	12 Channel
A5	12	12 Channel
A16	16	12 Channel

(g) Power Distribution. The following equipment must be supplied as part of the power distribution panel:

- (i) Main Circuit Breaker.
- (ii) Six Auxiliary Circuit Breakers.
- (iii) Solid State Signal Power Relay.
- (iv) Primary and Secondary Surge Protector.
- (v) AC-Common Bus Bar.
- (vi) Safety Ground Bus Bar.
- (vii) AC+ Power (Filtered) Bus Bar.
- (viii) AC+ Power (Unfiltered) Bus Bar.

(h) Practices. Design and construct the basic facility to be made of a minimum number of separate assemblies to reduce maintenance and handling time for knockdown and retrofit applications.

(3) Electrical Requirements. The terminal facility must conform to the following electrical requirements:

(a) Power Distribution. The terminal facility must operate properly when supplied with single-phase AC power [95-135 V, 57-63 Hertz (Hz)]. All breakers and grounding devices must be wired in accordance with the NEC and the Michigan Electrical Code.

(i) Circuit Breakers. Provisions must be made for mounting and wiring up to nine circuit breakers in the terminal facility. A quantity of seven circuit breakers must be provided with ampacities as noted below:

<b>Table 4: Circuit Breaker Ampacity (in Amps)</b>							
<u>Configuration</u>	<u>Main</u>	<u>Veh LS</u>	<u>Ped LS</u>	<u>Flasher</u>	<u>Misc</u>	<u>Ch Reds</u>	<u>Illum Sign</u>
A2	30	10	10	10	10	10	20
A5	30	10	10	10	10	10	20
A16	30	10	10	10	10	10	20

The main circuit breaker must be wired to protect the entire facility and must be identified as the "MAIN" breaker. The vehicle load switch breaker and the pedestrian load switch breaker must be fed by the load side of the solid state bus relay and must provide power to the vehicle and pedestrian load switches, respectively. The flasher breaker must have the flasher connected to its load side. The miscellaneous breaker must have the cabinet fan, light, and door mounted duplex receptacle connected to its load side. The channel reds breaker must have the inputs to the MMU for the reds of unused channels and cabinet control relay coils connected to its load side. The illum sign breaker must be available to powering auxiliary devices such as illuminated signs. The circuit breakers



must be capable of manual operation with markings to indicate rating and whether it is in the open or closed position. Square D series QOB circuit breakers must be used and mounted on QON3B triple position breaker blocks.

A four pole fuse holder with screw terminals for connecting individual illuminated sign loads must be provided and wired to the load side of illum sign breaker.

(ii) Cabinet Surge Protection. The power panel must have devices to provide both primary and secondary surge protection devices. All cabinet surge protection devices must be terminated to a single terminal block for ease of replacement.

Connect the primary surge protection device (SPD) to the load side of the main circuit breaker. Connect the primary SPD in parallel to the load and have a surge capacity of 160 kA per phase or greater. The let through voltage measured 6 inches outside the unit must not exceed 430V = 3kA 8/20 u/s pulse and 650V = 10kA 8/20 u/s pulse. Modes protected must be Line to Ground, Line to Neutral, Line to Line and Neutral to Ground. The SPD must provide Green LED indications that protection is operational and Red LED indications that a fault has occurred. In addition, an audible alarm must sound indicating a fault has occurred. There must be a set of normally open and normally closed contacts available for remote monitoring of the SPD. The SPD must be no larger than 9.3 inches W by 3 inches H by 4.93 inches D. Mount the SPD on the lower right hand side of the cabinet and easily accessible for replacement.

Connect the secondary SPD to the load side of the main circuit breaker and its output will be used to supply AC power to the CU, MMU, and cabinet electronics power strip. The surge current capacity must be 50 kA or greater, with the unit connected in series to the load. The secondary SPD must be a 5 stage hybrid design with integrated filter with series load current of 12 amps. The let through voltage measured 6 inches outside the unit must not exceed 260 V = 2kA 8/20 u/s pulse and 300 V = 3kA 8/20 u/s pulse. Modes protected must be Line to Ground, Line to Neutral, and Neutral to Ground.

Install a gas tube device on the load side of the main circuit breaker. It must be possible to replace this device without interrupting power to the rest of the terminal facility.

(iii) Solid State Signal Power Relay. The terminal facility must include a SPST-NO signal power relay wired to provide power from the main circuit breaker and RFI filter to the AC signal power bus bar and load switches. The solid state relay must be energized to provide power to the signal bus and have ampacity of 75 amps. It must provide zero voltage switching from 47 - 63Hz. The Signal Power Relay must be mounted on a panel on the lower right side of the controller cabinet and easily accessible for replacement.

(iv) AC-Common Bus Bar. The AC-common (Neutral) must be terminated on a solid metallic multi-terminal bus bar that will accept 4 - 16 American Wire Gage (AWG) copper conductors. Insulate this bus bar from the cabinet. Run separate wires from this bus bar to each unit or group of similar units in the terminal facility which requires AC-common connection. Ensure only one conductor is allowed in each termination position. Provide a minimum of 24 open termination positions for field wiring common return connections.

(v) Safety Ground Bus Bar. The safety (Earth/Chassis) ground must be terminated on a solid metallic multi-terminal bus bar that will accept 4 - 16 AWG copper conductors. Connect this bus bar to the cabinet. Ensure only one conductor is allowed in each

termination position. Provide a minimum of 24 open termination positions for field wiring ground connections.

Run separate wires from this bus bar to each unit or group of similar units in the terminal facility which requires safety ground connection.

(b) Conductors. Use #22 AWG, or larger, with a minimum of 19 strands, for all conductors in the terminal facility. Conductors terminated on the AC-Common Bus Bar and Safety Ground Bus bar must be tinned and a minimum size of #16 AWG. Conductors must conform to Military Specification MIL-W-16878, Type B or D. Provide insulation with a minimum thickness of 10 mils and nylon jacketed polyvinyl chloride or irradiated cross-link polyvinyl chloride. Conductors #8 AWG must be UL Type THHN.

Use conductors in the terminal facility wiring which conform to the following color-code requirements:

- (i) Identify the AC-common conductor of a circuit with a continuous white color.
- (ii) Identify the safety (Earth/Chassis) ground conductor of a circuit with a continuous green color or a continuous white color with one or more green stripes.
- (iii) Identify the AC+ power conductor of a circuit with a continuous black color.
- (iv) Identify the low level DC (+24 or less) conductor of a circuit with a continuous blue color.
- (v) Identify other conductors, not conforming to one of the above, with any continuous color not defined above.

(c) Wiring (Power Distribution within the Facility). Ensure all terminal facility wiring is neat, firm, and routed, where practical, to minimize crosstalk and electrical interference. Printed circuit boards are prohibited.

Ensure all terminal facility conductors are of sufficient size to carry the maximum current of the circuit or circuits they are provided for. Size them based on the ampacity ratings as follows:

<b>Table 5: Terminal Facility Conductor Size</b>	
<u>AWG Wire Size</u>	<u>Ampacity Rating</u>
#22	5 Amps
#16	10 Amps
#14	15 Amps
#12	20 Amps
#10	30 Amps
# 8	50 Amps
# 6	70 Amps

The ampacity ratings are calculated based on the current required to raise the temperature of a single insulated conductor in free air (86 degrees F ambient) to the limit of the insulation

and applying a bundle de-rating factor of 0.5 for wires #22 AWG through #10 AWG and a de-rating factor of 0.7 for wires #8 AWG and #6 AWG.

Ensure the conductor feeding power from the main circuit breaker to the auxiliary breakers, solid state signal power relay, primary and secondary SPD terminal blocks, and AC+ signal power bus bar has an ampacity of 40 amps.

Ensure the conductor feeding power to the flasher socket has a minimum ampacity of 30 amperes.

Ensure the conductor feeding power from the AC+ signal power bus bar to each load switch socket has an ampacity of 10 amperes and is capable of being easily programmed to supply the load switch from another point or interrupt AC+ signal power to an individual load switch for special applications.

Ensure the conductors feeding power from the load switch to the field signal terminals has an ampacity of 10 amperes.

Ensure the conductors feeding power from the flasher socket to the flash transfer relay sockets, which feed flashing power to same, has an ampacity of 15 amperes. The remaining wires to and from the flash transfer relay socket, which are in the circuit between the load switch socket and the field signal terminals, are covered in the previous paragraph.

(d) Control Circuits.

(i) Flash Transfer Control. Ensure the control circuit to the flash transfer relay sockets provides flashing operation when the MMU or optional auxiliary equipment call for flash (e.g., switch compartment panel flash switch and maintenance panel). Ensure the flash transfer control also conforms to the following:

Wire the flash transfer relay socket so the coil of the relay(s) must be de-energized for flashing operation. Locate the flash transfer relay sockets in close proximity to the load switches, flasher, and field signal terminals.

(ii) Malfunction Management Unit (MMU) Control. Wire the MMU to provide flashing operation when the fault relay de-energizes or if the MMU is disconnected. Ensure it also provides "Stop Time" to the CU when the fault relay de-energizes. Wire the MMU to provide an "External Start" signal to the CU upon the application of AC power to the MMU following a power interruption or upon initial turn-on.

(iii) Detector Rack. Ensure all cabinets have a 20 channel detector rack that meets *NEMA Standards Publication TS-2*, Section 5 specifications. Ensure the detector rack can accommodate 16 channels of vehicle detection and an additional 4 channels of pedestrian detection push button isolation. Ensure all cabinets include one Buss Interface Unit (BIU) that meets the requirements of Section 8 of the *NEMA Standards Publication TS-2*. Locate the BIU in the first (furthest to the left) slot in the detector rack. Locate the 16 channels of vehicle detection immediately to the right of the BIU. Locate the four channels of pedestrian detection in the last (furthest to the right) slot positions. Ensure each terminal facility includes one 6 foot Port 1 communications cable to connect from the detector rack BIU to the CU. Ensure each cabinet includes one power supply for the detector rack that meets the *NEMA Standards Publication TS-2* for power supplies.

(4) Field Wire Terminal Locations. Ensure the terminal facility provides Field Wire Terminals located to conform to the following requirements:

(a) AC Service Hookup. Ensure incoming AC power service terminates on the right side of the cabinet on the power distribution panel. Ensure the incoming AC power service terminates in compression fittings capable of accepting a #4 AWG or #6 AWG conductor for AC+ and AC- and accepting a #8 AWG conductor for safety (Earth/Chassis) ground. Ensure the AC+ line terminates directly to the main circuit breaker. Ensure the AC- and safety ground lines terminates directly to their respective bus bars. Ensure the service hookup meets NEC code, and MDLARA electrical codes.

(b) Signal Hookup. Ensure signal wires terminate on terminal blocks on the back of the cabinet at least 3 inches but not over 6 inches from the bottom of the cabinet. Locate the field terminal block for signal circuits a minimum of 4 inches below the load switches and angled up 30 to 45 degrees from vertical for ease of access. Ensure signal terminals are directly accessible from the front of the cabinet. Provide one terminal for each load switch output. Ensure each field terminal includes a SLUM-35 or equivalent pressure connector that will allow multiple field conductors to be attached to a single output terminal. Ensure it is possible to terminate a minimum of 16 #14 AWG or 5 #10 AWG neutral leads on the signal common bus.

(c) Detector Panel. Ensure vehicle loop and pedestrian pushbutton inputs terminate on terminal blocks on the left side of the cabinet at least 3 inches from the bottom of the cabinet. Provide a minimum of three terminals for each vehicle detector and four terminals for each pedestrian detector. Ensure the terminal block meets the specifications of the detector terminal blocks. Wire the detector panel to the detector rack providing 20 channels total and includes the power supply.

(5) Auxiliary Equipment.

(a) Ensure the terminal facility includes provisions for the following equipment in a panel accessible from a switch compartment door on the front of the cabinet.

(i) Signal On-Off Switch. Install and wire a signals on-off switch.

The switch and wiring must energize or de-energize the solid state signal power relay. Do not route the AC signal power through this switch. Label the switch "Signal-Off". When in the "Off" position, all signal field terminal must be de-energized and the Red Enable input to the MMU must be inactive.

(ii) Flash Normal Switch. Include a flash-normal switch.

When in the flash position, the flash transfer relays and solid state signal power relay must be de-energized, and power must be removed from the MMU and CU, resulting in flash being displayed to traffic. Do not route either the AC signal power or the flashing power through this switch. Label the switch "flash-normal".

Ensure that when the switch is returned to the "Normal" position, the signal returns to the initialization phase and begin cycling.

Ensure the operation of the signal-off switch overrides this switch. That is, when in the "Off" position, the signal-off switch prevents flashing operation as called for by the flash control circuits.

(iii) Manual Control Cord and Switch. Install and wire a manual control cord and auto-hand switch in the switch compartment panel of the cabinet.

Ensure the switch and wiring energizes the "manual control enable" input to the CU and connects the Manual Control Cord to the "interval advance" input to the CU. This will provide the control of "green" intervals by the manual control cord with the CU timing the remaining intervals, when the auto-hand switch is in the "hand" position. The switch must be labeled "auto-hand".

(b) Maintenance Panel Options.

(i) Detector Test Switches. Ensure a detector test push-button switch for each vehicle and pedestrian detector circuit is provided in a panel on the inside of the front cabinet door. The A2 configuration requires eight test push-buttons for phases one thru four vehicle and pedestrian inputs. The A5 and A16 configurations require 12 test push-buttons for phases 1 thru 8 vehicle inputs and phases 2, 4, 6, and 8 pedestrian inputs.

The switch and wiring must place an actuation for the respective vehicle or pedestrian phase when pushed. The switch(s) must be labeled "call switch" and the phase # as well as whether it is vehicle or pedestrian (e.g., Ph 1 Veh, Ph 1 Ped, etc.).

(ii) Stop Time Switch. Ensure a stop time switch is provided in a panel on the inside of the front cabinet door. The switch and wiring must provide three modes of operation which are:

- 1) Normal. "Stop time" to the CU is provided as required by the MMU.
- 2) Run. "Stop time" is prevented from being applied to the CU from other devices.
- 3) Stop. "Stop time" is applied to the CU.

Label this switch "stop-run-normal".

(iii) Flash-Normal Switch. Ensure a flash-normal switch is provided in a panel on the inside of the front cabinet door.

Ensure the switch and wiring provides flashing operation as defined for switch compartment panel flash-normal switch except that it does not terminate power to the CU. Ensure that this flash-normal switch operates as a CU power switch by removing a control terminal link. Label this switch "flash-normal".

(iv) Duplex Receptacle. Ensure a duplex receptacle of a three-wire ground fault interrupter (GFI) type is provided in a panel on the inside of the front cabinet door.

(c) Miscellaneous Options.

(i) Cabinet Light. Ensure two incandescent light sockets, with switches, are installed in the cabinet.

Provide a door switch to activate the light(s) when the door is opened. The door switch must be wired in parallel with a thermostat that will turn the lights on also. The thermostat must be manually adjustable at least in the range of 30 degrees F to 50 degrees F.

Wire the switches and lights to the Misc circuit breaker.

Install one light socket in the upper right wall of the control cabinet and the second socket must be mounted on the left wall of the cabinet immediately below the lower shelf.

(ii) Outlet Strips. Install a multiple outlet strip on the upper right side of the cabinet. Wire the outlet strip to the load side of the secondary SPD and is intended to power accessory cabinet electronic devices.

(6) Prints, Functional Data, and Parts List. The manufacturer must supply each of the following items with each cabinet:

(a) Two complete set of schematic and wiring diagrams of the cabinet and terminal facilities. One set of schematic and wiring diagrams is to be put in the installed cabinet, and one set is to be furnished to the maintaining agency.

(b) Cabinet mounting diagram.

(c) Complete parts list of cabinet and accessories.

Each of these items must apply directly to the cabinet with which it is applied.

### 3. Accessories.

A. Scope. This subsection provides the minimum acceptable requirements for plug-in accessories for the traffic controller assembly within a traffic control cabinet.

B. Malfunction Management Unit (MMU). This subsection defines the minimum requirements for a shelf-mountable, 16 channel, MMU. Ensure the MMU meets all applicable sections of the *NEMA Standards Publication TS-2*. Where differences occur, this special provision will govern.

Ensure the following monitoring functions are provided, in addition to those required by the NEMA standard:

(1) Dual Indication Monitoring. Ensure the MMU is capable of detecting simultaneous input combinations of active Green (or Walk), Yellow and Red inputs on the same channel. Ensure the channels enabled for Dual Indication monitoring are user determined. Ensure Dual Indication monitor is disabled when the Red Enable input is not active.

(2) Field Check Monitoring. Ensure when the field signal inputs states sensed by the MMU do not correspond with the data provided by the CU in the type #0 message for 10 consecutive messages, the MMU enters the fault mode and indicates the Field Check Fail fault.

(3) Recurrent Pulse Monitoring. Ensure the MMU detects Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs.

(4) Ensure when the MMU detects a conflict flash indication that it provides an output to the "D" connector indicating an MMU/Conflict Flash Status input.

(5) Ensure the MMU can monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement outlined by the National Cooperative Highway Research Program (NCHRP) Research Project 3-54 on Protected/Permissive signal displays with Flashing Yellow Arrows. Ensure the MMU provides the same fault coverage for the FYA approaches as it does for conventional movements including Conflict, Red Fail, Dual Indications, and Minimum Clearance monitoring.

Ensure the MMU can provide alternate configuration options as follows:

(a) RYG Only Red Fail Option. This function excludes the Walk input from the Red Fail Fault algorithm when operating the Type 12 mode.

(b) LED Signal Threshold Adjust. This function provides the capability to sense field inputs with an alternate set of voltage thresholds to better determine the state of LED signal indications. Conflict and Dual Indication thresholds for Green/Yellow/Red inputs are set for: No Detect is less than 15 Vrms, Detect is greater than 25 Vrms. Red Fail thresholds for Green/Yellow/Red are set for: No Detect is less than 50 Vrms, Detect is greater than 70 Vrms.

(c) CVM Log Disable Option. Ensure the MMU can provide a means to disable the logging of CVM faults events.

(d) Ensure a 4 line by 20 character LCD display is provided to report MMU Status, time and date, and menu navigation. Ensure a separate Red, Yellow, Green LCD indicator, display is provided for the input status of signal inputs. Ensure that individual icons be provided to indicate channels involved in a fault.

(e) Ensure a mode is provided to display the RMS voltage of each field signal input and each cabinet control signal voltage, and the frequency of the AC Line, the ambient temperature measured at the MMU.

(f) Ensure when the MMU is in the fault mode, a display screen is provided to identify all field signal inputs with Field Check status, and all field signal inputs with Recurrent Pulse status.

(g) Ensure additional display functions include a configuration display of settings and all MMU configuration parameters; logs of Previous Fault, AC Line, and MMU reset logs; Clock set.

(h) Ensure the program card supplied with the MMU provides non-volatile memory that contains the configuration parameters for the enhanced features of the MMU, such that transferring the program card to a different MMU completely configures that MMU. Ensure the non-volatile memory device used on the program card does not utilize any Input/Output (I/O) pins designated as "Reserved" by *NEMA Standards Publication TS-2*.

(i) Ensure a minimum of five logs are provided that graphically display all field signal states and Red Enable for up to 30 seconds prior to the current fault trigger event. Ensure the resolution of the display is at least 50 milliseconds. Ensure these signal sequence logs are accessible from the front panel RS-232 port with software available from the manufacture.

C. Flasher. Ensure a NEMA two-circuit, 15 Amp per circuit, flasher is provided for installation in the cabinet. Ensure each flashing circuit contains zero-voltage switching, a 25 ampere power triac, a snubber and a light emitting diode across the AC circuitry, directly indicating the AC load that is activated. The flasher must conform to a Type 3 per Section 8 of the *NEMA Standards Publication TS-2*. Ensure the flasher is fabricated such that internal components are completely enclosed by the chassis.

D. Flash Transfer Relay. Ensure two flash transfer relays for the A2 configuration and six for the A5 and A16 configurations are provided for installation in the cabinet. Ensure the flash transfer relays conform to the following requirements:

(1) Mechanical Requirements. Ensure the relay is enclosed in a transparent plastic case which protects the relay from dust, moisture, and other contamination. Ensure the case can protect the user from contact with live parts and be sufficiently rugged to permit insertion and removal of the relay from its mating socket.

(2) Connector. Mount the relay on an eight-pin spade plus base and wire the socket and relay/base as follows:

Pin 1 - Coil

Pin 3 - #1 Closed

Pin 5 - #1 Common

Pin 7 - #1 Open

Pin 2 - Coil

Pin 4 - #2 Closed

Pin 6 - #2 Common

Pin 8 - #2 Open

(3) Contacts. Ensure the relay is provided with four single-pole, double-throw (form C) contact sets. Ensure each contact is rated to switch a 20 ampere tungsten load for a minimum of 30,000 operations. Provide contact material that minimizes welding.

(4) Coil Rating. Ensure the relay coil is rated for continuous duty from 95 to 135 VAC. This rating must be valid at 158 degrees F ambient temperature outside the relay case. Ensure the relay coil can measure less than 10 volt amperes at 120 VAC. Ensure the relay picks up by 95 VAC and drops out by 50 VAC, and makes the transfer within 50 milliseconds. Ensure the magnetic circuit in the relay reverses concurrently with the 60 Hz AC input voltage.

E. Load Switches. Use solid-state load switching assemblies for opening and closing signal light circuits and are jack-mounted external to the CU. Ensure each load switch provides three independent switching circuits. Ensure each of the three circuits contains a zero-voltage switching optical coupler electrically isolating the DC input circuitry from the AC output circuitry, a 25 ampere power triac and light emitting diode (LED) indicators on both the DC input circuitry and the AC output circuitry. Provide eight load switch assemblies (24 circuits) for the A2 configuration unit. Provide twelve load switch assemblies (36 circuits) for the A5 configuration unit. Provide sixteen load switch assemblies (48 circuits) for the A16 configuration unit.



4. Packing and Marking. Unless otherwise specified in the contract, each CU must be packed separately in a manner that precludes injury or defacement to the CU during transportation to the point of destination. Mark each carton legibly with the CU description, purchase order number, and vendor's name.

5. Warranty. Provide materials with a manufacturer's warranty, transferable to the MDOT, that the supplied materials are free from all defects in materials and workmanship. Furnish the warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to acceptance.

**c. Construction.** Complete this work in accordance with sections 819 and 820 of the Standard Specifications for Construction, as shown on the plans and as directed by the Engineer.

**d. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the pay items below and in accordance with the following:

The Engineer may process a partial payment for units delivered to MDOT signals shop or other approved location after initial inspection and acceptance provided the contractor provides either a paid invoice/proof of payment or a receipt for delivery. If payment is based on the delivery invoice, the Contractor must provide a copy of the paid invoice/proof of payment to the supplier within 10 calendar days of the prime Contractor receiving payment for the materials. Partial payments for delivered materials/units meeting all project specifications will be limited to the smaller of the actual invoice amount or 96 percent of the contract unit price. Final payment will be processed after final acceptance of the individual traffic signal installation:

<b>Pay Item</b>	<b>Pay Unit</b>
Controller and Cabinet, Digital Type .....	Each
Controller and Cabinet, Digital Type, Master .....	Each

**1. Controller and Cabinet, Digital Type** includes:

A. All labor, equipment, and materials required to install the traffic signal CU, cabinet, and accessories required to provide the traffic signal control operation as shown on the plans, in accordance with the MMUTCD, and this special provision.

B. Furnishing and delivering the controller and cabinet to the maintaining agency for controller timing and cabinet setup.

C. Transporting the cabinet from the maintaining agency to the job site for installation.

**2. Controller and Cabinet, Digital Type, Master** includes:

A. All labor, equipment, and materials required to install the traffic signal CU, cabinet, and accessories required to provide the traffic signal control operation as a master for a closed loop system as shown on the plans, in accordance with the MMUTCD, and this special provision.

B. Furnishing and delivering the controller and cabinet to the maintaining agency for controller timing and cabinet setup.

- C. Transporting the cabinet from the maintaining agency to the job site for installation.