

Maricopa Association of Governments Building Code Amendments and Standards Manual BCAS #18	
Title: Model Plans for Electric Vehicle Installations at Residential Occupancies	
Originally Reviewed by MAG Building Codes Committee: 3/20/19	
Updated by MAG Building Codes Committee: 4/17/19	

At the March 20, 2019, Building Codes Committee meeting, the committee reviewed and discussed draft model plans developed by the Salt River Project for in installation of electric vehicle chargers at residential units.

At the April 17, 2019, meeting, the committee voted to recommend approval of the final version of the plans and make them available to any member agency that wants to use and distribute them as needed.

EQUIPMENT REQUIREMENT TABLE						
CHARGER SIZE, IN AMPERES	MAXIMUM DEMAND LOAD	MAXIMUM BREAKER SIZE	MINIMUM WIRE SIZE	MINIMUM NEUTRAL WHERE REQUIRED	MINIMUM EQUIPMENT GROUND	REQUIRED RECEPTACLE
UP TO 16A	20 AMPERES	20	#12 AWG CU	#12 AWG CU	#12 AWG CU	20 AMPERE
17A TO 20A	25 AMPERES	25	#10 AWG CU	#10 AWG CU	#10 AWG CU	25 AMPERE
21A TO 24A	30 AMPERES	30	#10 AWG CU	#10 AWG CU	#10 AWG CU	30 AMPERE
25A TO 32A	40 AMPERES	40	#8 AWG CU	#8 AWG CU	#10 AWG CU	40 AMPERE
33A TO 40 A	50 AMPERES	50	#6 AWG CU	#6 AWG CU	#10 AWG CU	50 AMPERE

- TABLE NOTES**
- ALL CONDUCTOR SIZES ARE BASED UPON COPPER NM OR NMB CABLE. SE CABLE IS PERMITTED.
 - CONDUCTOR AMPACITY IS BASED UPON 60 DEGREE CELSIUS WIRE AND TERMINATIONS.
 - CONDUCTOR SIZES ARE BASED UPON A MAXIMUM OF 3 CURRENT CARRYING CONDUCTORS IN A CABLE OR RACEWAY.
 - CONDUCTOR SIZE BASED UPON A MAXIMUM AMBIENT TEMPERATURE OF 140 DEGREES FARENHEIGHT.
WHERE CONDUCTORS ARE INSTALLED IN AN ATTIC, THE CIRCUIT CONDUCTORS SHALL BE INCREASED A MINIMUM OF ONE WIRE GAUGE SIZE. THIS DOES NOT APPLY TO THE EQUIPMENT GROUND WIRE PER 2017 NEC SECTION 250.122.
 - CHARGERS ARE TO BE DIRECTLY CONNECTED (HARD WIRED) ONLY. THE USE OF CORDS IS NOT PERMITTED.
 - MANUFACTURER'S LISTING REQUIREMENTS SUPERCEED THIS TABLE WHERE THEY ARE MORE RESTRICTIVE.

MINIMUM CONDUCTOR LENGTH TABLE		
CONDUCTOR SIZE	MINIMUM CONDUCTOR LENGTH	AVAILABLE FAULT CURRENT
#12 AWG CU	12	4779
#10 AWG CU	19	4798
#8 AWG CU	29	4945
#6 AWG CU	45	4962

AVAILABLE FAULT CURRENT IS BASED UPON A UTILITY CONTRIBUTION OF 21,118 AMPERES AND REFLECTS THE MINIMUM LENGTH OF COPPER CONDUCTOR SHOWN IN NON-MAGNETIC CABLE OR RACEWAY.

SCOPE OF WORK

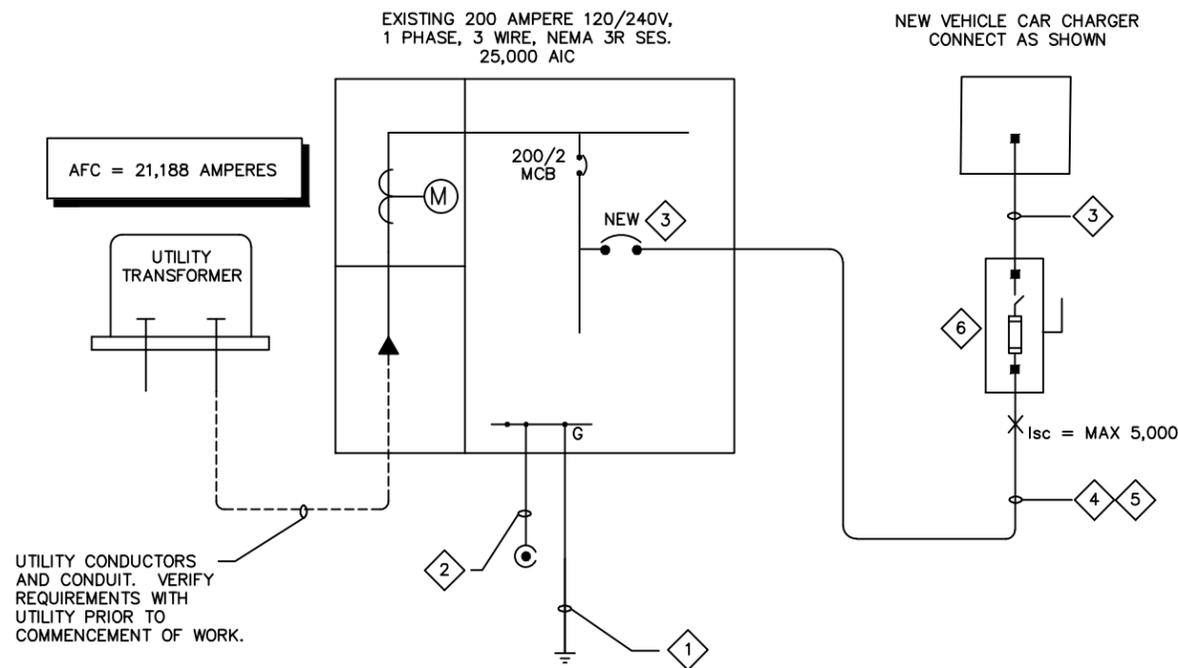
THE SCOPE OF WORK FOR THIS PROJECT IS LIMITED TO THE INSTALLATION OF AN ELECTRIC VEHICLE CAR CHARGER. SEE ATTACHED EQUIPMENT SPECIFICATIONS FOR ADDITIONAL INFORMATION.

NOTE

THE VEHICLE CHARGING EQUIPMENT SHALL COMPLY WITH THE OpenADR STANDARDS



PROPERTY ADDRESS



ONE-LINE DIAGRAM
NTS

KEYED NOTES

- #4 CONCRETE ENCASED ELECTRODE (UFER). IF UFER IS NOT AVAILABLE, PROVIDE 2 - 8 FOOT GROUND RODS A MINIMUM 6 FEET APART.
- EXISTING WATER BOND AND/OR GAS BOND. PROVIDE MINIMUM #4 WATER BOND IF NOT PRESENT. FOR GAS BOND, THE EQUIPMENT GROUND THAT SERVES THE GAS EQUIPMENT IS PERMITTED TO BE USED FOR THE BONDING OF THE METALLIC GAS PIPING SYSTEM PER NEC SECTION 250.104(B)(1).
- NEW CIRCUIT BREAKER, SIZE BASED UPON THE EQUIPMENT REQUIREMENT TABLE THIS SHEET. NOTE: THE NEW CIRCUIT BREAKER SHALL BE MANUFACTURED BY THE SAME MANUFACTURER AS THE PANEL WHICH IT IS TO BE INSTALLED IN. NO EXCEPTIONS.
- CONDUCTOR SIZE AS SHOWN IN THE EQUIPMENT REQUIREMENT TABLE SHOWN ON THIS SHEET.
- SEE MINIMUM CONDUCTOR LENGTH TABLE ON THIS SHEET. WHERE THE CONDUCTOR LENGTH IS LESS THAN SHOWN, A FUSIBLE DISCONNECT SHALL BE PROVIDED WITH CLASS RK-1 OR CLASS T FUSES. NO EXCEPTIONS.
- 250 VOLT, SINGLE PHASE FUSIBLE DISCONNECT IS ONLY REQUIRED WHERE THE MINIMUM CONDUCTOR LENGTH SHOWN ON THE EQUIPMENT REQUIREMENT TABLE IS NOT PROVIDED. FUSE SIZE IS TO BE THE SAME AS THE CIRCUIT BREAKER SIZE SHOWN IN THE EQUIPMENT REQUIREMENT TABLE OR THE MANUFACTURER'S RECOMMENDED SIZE, WHICHEVER IS MORE RESTRICTIVE. THE FUSE LET THROUGH WILL LIMIT THE AVAILABLE FAULT CURRENT TO LESS THAN 5,000 AMPERES.

DO NOT USE - FOR REGULATORY APPROVAL ONLY

ONE LINES

E-1

FAULT CURRENT CALCULATIONS

ONE-LINE GENERAL NOTES

FAULT '12 AWG CU'

L = 12
 I = 21,188
 C = 617
 E (L-L) = 240
 N = 1

$$f = \frac{2 \times L \times I}{N \times C \times E(L-L)}$$

f = 3.434

$$m = \frac{1}{1 + f}$$

m = 0.226

Isc = I x m

Isc = 4,779 AMPS

FAULT '10 AWG CU'

L = 19
 I = 21,188
 C = 982
 E (L-L) = 240
 N = 1

$$f = \frac{2 \times L \times I}{N \times C \times E(L-L)}$$

f = 3.416

$$m = \frac{1}{1 + f}$$

m = 0.226

Isc = I x m

Isc = 4,798 AMPS

FAULT '8 AWG CU'

L = 29
 I = 21,188
 C = 1,559
 E (L-L) = 240
 N = 1

$$f = \frac{2 \times L \times I}{N \times C \times E(L-L)}$$

f = 3,284

$$m = \frac{1}{1 + f}$$

m = 0.233

Isc = I x m

Isc = 4,945 AMPS

FAULT '6 AWG CU'

L = 45
 I = 21,188
 C = 2,430
 E (L-L) = 240
 N = 1

$$f = \frac{2 \times L \times I}{N \times C \times E(L-L)}$$

f = 3.270

$$m = \frac{1}{1 + f}$$

m = 0.234

Isc = I x m

Isc = 4,962 AMPS

WHERE:
 L = LENGTH IN FEET
 I = UTILITY CONTRIBUTED FAULT CURRENT, IN AMPERES
 C = CONSTANT PER 'BUSSMAN' SPD MANUAL
 E = VOLTAGE
 N = NUMBER OF CONDUCTORS, PER PHASE

NOTE: ALL RACEWAYS ARE NON-MAGNETIC UNLESS NOTED OTHERWISE.

ELECTRICAL CONTRACTOR SHALL INSTALL RACEWAYS AND CONDUCTORS WITH THE MINIMUM LENGTH ("L") SHOWN, NO EXCEPTIONS.

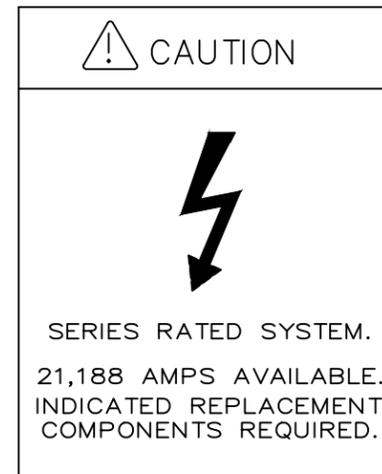
1. THE GENERAL/ELECTRICAL CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS TO FULLY FAMILIARIZE THEMSELVES WITH ALL EXISTING CONDITIONS PRIOR TO BID. NO ADDITIONAL CONSIDERATIONS WILL BE ALLOWED AFTER THE BID.
2. THE ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL EXISTING SWITCH, FUSE, CONDUCTOR, CIRCUIT BREAKER SIZES, ETC., FOR CODE COMPLIANCE. NOTIFY ENGINEER OF ANY AND ALL DISCREPANCIES PRIOR TO HIS BID.
3. GFP MUST BE ON-SITE TESTED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. ELECTRICAL CONTRACTOR SHALL PROVIDE COPY OF MANUFACTURER'S INSTRUCTIONS AND TEST RESULTS TO AUTHORITY HAVING JURISDICTION.
4. ALL NEW OR MODIFIED ELECTRICAL EQUIPMENT RATED @ 1000 AMPS OR MORE SHALL BE TESTED IN CONFORMANCE WITH UL STANDARD 869 OR 891 FOR INSULATION BREAKDOWN PRIOR TO BEING ENERGIZED. THIS TEST SHALL BE PERFORMED BY A TESTING FACILITY APPROVED BY THE BUILDING OFFICIAL. (SEE SECTION 4.6 OF ELECTRICAL SYSTEM SPECIFICATIONS)
5. SERVICE ENTRANCE SECTION SHALL BE MARKED IN ACCORDANCE WITH NEC ARTICLE 110.16 FOR FLASH PROTECTION HAZARDS. (REFERENCE NFPA 70E-2000 AND ANSI Z535.4-1998)

SERVICE EQUIPMENT RATING INFORMATION

1. THIS ELECTRICAL SYSTEM SHALL BE A U.L. LISTED SERIES RATED _____ FUSE ■ CIRCUIT BREAKER - CIRCUIT BREAKER COMBINATION.
2. PUBLISHED AVAILABLE FAULT CURRENT FROM SERVING UTILITY = 21,188 AMPERES.
3. MOTOR F.L.A. CONTRIBUTION DOES NOT EXCEED 1% OF THE INTERRUPT RATING OF DOWN STREAM A.I.C. SERIES RATED DEVICE.
 WORST CASE DOWN STREAM A.I.C. RATING = 10,000 AMPERES.
 WORST CASE TOTAL MOTOR FULL LOAD AMPS. < 99 AMPS.
4. NO DESIGN CHANGES MAY BE MADE TO THIS SYSTEM WITHOUT APPROVAL OF THE AUTHORITY HAVING JURISDICTION. THIS SYSTEM SHALL BE INSTALLED EXACTLY AS INDICATED ON THESE PLANS.
5. PROVIDE LABEL FOR EACH SERIES/FULLY RATED PANELBOARD AS INDICATED BELOW IN ACCORDANCE WITH NEC #110.22
6. PANELS, BUSSBARS, CONTACTORS, TERMINATIONS AND ALL INTERNAL COMPONENTS OF ALL SWITCHBOARDS, PANELBOARDS AND LOAD CENTERS SHALL BE FULLY BRACED FOR THE AVAILABLE FAULT CURRENT AVAILABLE AT THE TERMINALS OF THE EQUIPMENT. SERIES RATINGS SPECIFIED, PER THESE DOCUMENTS, APPLY SOLELY TO THE OVERCURRENT DEVICES INSTALLED THEREIN UNLESS NOTED OTHERWISE.

PERMISSIBLE SUBSTITUTION OF A FULLY RATED CIRCUIT BREAKER SYSTEM IS ALLOWABLE PROVIDED THE PANELBOARD AND CIRCUIT BREAKER AIC RATING IS GREATER THAN AVAILABLE FAULT CURRENT AS INDICATED THIS SHEET AND LABELED AS A "FULLY RATED SYSTEM".

THIS PROPOSED ADDITION/ALTERATION WILL NOT CAUSE THE EXISTING SYSTEM TO BECOME UNSAFE OR CREATE AN UNHEALTHY OR OVERLOADED CONDITION.



PANEL 'SES'

PROPERTY ADDRESS

CALCULATIONS

E-2

**RESIDENTIAL LOAD CALCULATION
USING THE OPTIONAL METHOD PER NEC 220.82**

BCAS #18

LIGHTING CALCULATION (LOAD 1):

LIVEABLE SQUARE FOOTAGE OF THE HOME:

NOTE (x)	LIGHTING LOAD	VA (EA)	TOTAL VA
	HOME SQUARE FOOTAGE MULTIPLIED BY 3 VA PER SQUARE FOOT:		
	FIXED LIGHTING LOADS		
(1)	BATHROOMS		
(1)	KITCHEN		
(1)	EXTERIOR		
(1)	RECESSED LTG		
(1)	GARAGE		
(1)(3)	CEILING FANS (60 WATTS EACH)		
(1)(3)	CEILING FANS WITH LIGHT KIT (240 WATTS EACH)		
(1)(3)	OTHER		

TOTAL LIGHTING LOAD:

NOTE (x)	APPLIANCE OR CIRCUIT	NUMBER OF UNITS (7)	VA (EA)	TOTAL VA
(2)(7)	SMALL APPLIANCE CIRCUITS		1,500	
(3)(7)	DISHWASHER		1,500	
(3)(7)	DISPOSAL		760	
(3)(7)	MICROWAVE		1,500	
(4)(7)	OVEN/RANGE		8,000	
(7)	LAUNDRY CIRCUIT		1,500	
(4)(7)	CLOTHS DRYER		5,000	
(7)	WATER HEATER		4,500	
(4)(7)	COOKTOP			
(3)(5)	WARMING DRAWER			
(3)(5)	SPA TUB			
(6)	DEDICATED REFRIDERATOR CIRCUIT			
(6)	DEDICATED FREEZER CIRCUIT			
(6)	POOL MOTOR			
(6)	POOL HEATER			
(6)	POOL LIGHT			

TOTAL OF ALL LOADS FROM ABOVE:

FINAL LIGHTING LOAD CALCULATION

FIRST 10,000 VA OF THE ABOVE LIGHTING LOAD at 100%: **10,000**
 REMAINDER OF THE ABOVE LIGHTING LOAD AT 40%:
TOTAL LIGHTING LOAD (LOAD 1):

HEATING/AIR CONDITIONING (LOAD 2)

NOTE (x)	APPLIANCE OR CIRCUIT	NUMBER OF UNITS (7)	VA (EA)	TOTAL VA
(8)	ROOF TOP UNIT 1 (PACKAGED UNIT)			
(8)	ROOF TOP UNIT 2 (PACKAGED UNIT)			
(8)	CONDENSING UNIT 1			
(8)	CONDENSING UNIT 2			
(8)	AIR HANDLER 1			
(8)	AIR HANDLER 2			
(8)	EVAPORATIVE COOLER			
(8)	OTHER			

TOTAL OF HEATING/AIR CONDITIONING LOAD (LOAD 2):

OTHER LOADS (LOAD 3)

OTHER LOADS NOT SHOWN ABOVE AT 100%	NUMBER OF UNITS (7)	VA (EA)	TOTAL VA
(3)(5) OTHER LIST:			

TOTAL OF OTHER LOADS (LOAD 3):

FINAL LOAD CALCULATION

TOTAL VA
TOTAL LIGHTING LOAD (LOAD 1 FROM ABOVE):
TOTAL HEATING/AIR CONDITIONING LOAD (LOAD 2 FROM ABOVE):
TOTAL OTHER LOAD (LOAD 3 FROM ABOVE):

TOTAL PROJECT LOAD IN VOLT AMPERES (VA)

CONVERT VOLT AMPERES TO AMPERES
VOLT AMPERES DIVIDED BY 240 VOLTS = AMPERES @ 240 VOLTS

TOTAL AMPERES - THIS SERVICE:

FOOTNOTES (x)

- (1): USE THE FIXTURE MAXIMUM RATING IN WATTS, NOT THE LAMP SIZE.
- (2): EACH HOME WILL HAVE A MINIMUM OF TWO SMALL APPLIANCE CIRCUITS BUT MAY HAVE MORE THAN TWO.
- (3): USE ACTUAL APPLIANCE VA (WATTS OR VOLTAMPS) WHERE POSSIBLE
- (4): IF A GAS APPLIANCE, PLEASE MARK AS "GAS" IN CALCULATION TO ASSIST IN THE PERMIT PROCESS
- (5): MAY NOT APPLY, PLEASE MARK AS "N/A" TO ASSIST IN THE PLAN REVIEW PROCESS
- (6): THESE APPLIANCES MAY BE SUPPLIED BY THE SMALL APPLIANCE BRANCH CIRCUIT. WHERE THIS OCCURS, PLEASE SHOW THE LOAD AS "N/A" TO ASSIST IN THE PLAN REVIEW PROCESS
- (7): WHERE MORE THAN ONE APPLIANCE OR PIECE OF EQUIPMENT IS PRESENT, MULTIPLY BY THE APPROPRIATE NUMBER OF UNITS.
- (8): USE THE MINIMUM CIRCUIT AMPACITY (MCA) OF UNIT FOR THE CALCULATIONS UNLESS A TOTAL AMPERE LOAD IS LISTED.

PROPERTY ADDRESS

CALCULATIONS

E-3

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BCAS #18

Maricopa Area Governments (MAG) Model Plan For Level 2 EV Charger

Submittal Package Instructions

The MAG Model Plan may be used to assist your Customer or Electrical Contractor in obtaining proper permits for a legal and safe installation of a Level 2 Electrical Charger in a single family home.

PROVIDE THE FOLLOWING:

1. MAG Model Plan – Utilize the Model plan to evaluate your existing electrical service and to perform the load calculation required by the building department of the jurisdiction where the single family home is located.

2. EV Charger Installation Documents – Provide the installation documents from the charger you intend to install.

3. Provide the correct square footage of the existing home per the Maricopa County Assessors website: [Maricopa County Assessor's Office](#)

4. Provide a plot plan showing the property with a simple floor plan. Use this to show:
 - a. Location of Service Entrance Section (SES)
 - b. Route of conduit from SES to location of EV Charger.
 - c. Note conduit length from SES to location of EV Charger.
 - d. Note conductor size selection.
 - e. Note height of charger between 15" min. and 48" max. above the finish floor.

5. Provide contractor license info and home owner information.