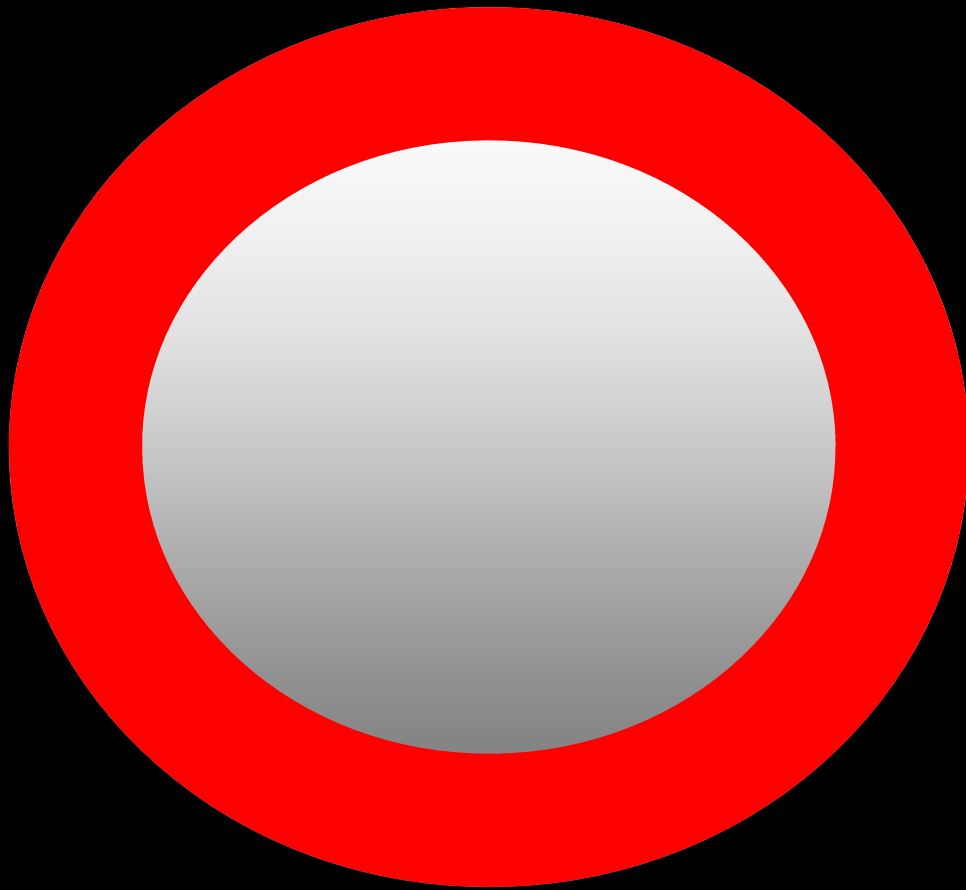


UNIFORM ELECTRICAL WIRING GUIDE



RECOMMENDATIONS
RELATING TO
ELECTRICAL INSTALLATIONS
FOR HOMES AND
OTHER SITUATIONS



This edition of the Uniform Wiring Guide is dedicated to the memory of the late Roger Bessinger, who lost his battle with cancer on January 8, 2010. For thirty years, Roger dedicated his life, knowledge, and talents to Warren RECC and its members.

As a certified energy advisor, Roger spent his career educating people about ways to use electricity wisely, efficiently, and safely. However, Roger's abilities shined the brightest when he stood in front of school children with his "traveling electric show." Using hands-on demonstrations, Roger taught thousands of children how electricity is generated, as well as stressing the importance of electrical safety.

Roger was truly an "educator," who shared his vast knowledge of electricity with countless groups over the years. However, Roger's greatest satisfaction came in knowing that he made a lasting impression on children when, years later as adults, they would approach him and say, "I remember when you came to my school, and now you are teaching my child about electricity."

"Our death is not an end if we can live on in our children and the younger generation."

~Albert Einstein

It is recommended that the local power supplier be contacted for information regarding local policies and procedures concerning electrical wiring in their service area prior to performing any electrical work.

This Uniform Electrical Wiring Guide has been distributed in the past by these local power suppliers.

Big Sandy RECC	Paintsville, KY	606-789-4095
Blue Grass ECC	Nicholasville, KY	859-885-4191
Clark Energy Cooperative	Winchester, KY	859-744-4251
Cumberland Valley Electric	Gray, KY	606-528-2677
Farmers RECC	Glasgow, KY	270-651-2191
Fleming-Mason Energy	Flemingsburg, KY	606-845-2661
Franklin Electric Plant Board	Franklin, KY	270-586-4441
Grayson RECC	Grayson, KY	606-474-5136
Hickman-Fulton Counties RECC	Hickman, KY	270-236-2521
Inter-County RECC	Danville, KY	859-236-4561
Jackson Energy Cooperative	McKee, KY	606-364-1000
Jackson Purchase	Paducah, KY	270-442-7321
Kenergy Corp.	Henderson, KY	270-826-3991
Licking Valley RECC	West Liberty, KY	606-743-3179
Meade County RECC	Brandenburg, KY	270-422-2162
Nolin RECC	Elizabethtown, KY	270-765-6153
Owen EC	Owenton, KY	502-484-3471
Pennyrile RECC	Hopkinsville, KY	270-886-2555
Salt River Electric	Bardstown, KY	502-348-3931
Shelby EC	Shelbyville, KY	502-633-4420
South Kentucky RECC	Somerset, KY	606-678-4121
Taylor County RECC	Campbellsville, KY	270-465-4101
Tri-County EMC	Lafayette, TN	615-666-2111
Warren RECC	Bowling Green, KY	270-842-6541
West Kentucky RECC	Mayfield, KY	270-247-1321

Revision Committee:

Franklin Electric Plant Board	Franklin, KY	270-586-4441
Kenergy Corp.	Henderson, KY	270-826-3991
Pennyrile RECC	Hopkinsville, KY	270-886-2555
South KY RECC	Somerset, KY	606-678-4121
Warren RECC	Bowling Green, KY	270-842-6541

UNIFORM ELECTRICAL WIRING GUIDE 2011 EDITION

This guide is intended to clarify and supplement that portion of the National Electrical Code (NFPA 70-2011) used by most homeowners and contractors. The information contained herein does not preempt any federal, state or local codes, including the National Electrical Code, NFPA 70-2011. The 2011 Uniform Wiring Guide is preceded by more than 45 years of development and change.

The Kentucky General Assembly (KGA) has enacted revisions to the Kentucky Revised Statutes (KRS), two (2) of which are identified here.

KRS - 198B: enacted in the 1978 Session of the Kentucky General Assembly (KGA) which in part requires electrical inspections of new electrical facilities and prohibits electric utilities from extending permanent electric service before the facility has been approved by the Authority Having Jurisdiction (AHJ), a State Certified Electrical Inspector, or others having statutory authority.

KRS 211-350: Enacted in the 1998 Session of the KGA prohibits the delivery of electrical power to dwellings, MANUFACTURED homes, buildings or other structures with sewage waste fixtures, without a county health department issued "on-site" sewage disposal permit prior to inspection by a State Certified Electrical Inspector. This statute affects extending temporary and permanent electrical power. This statute shall not apply to structures connected to a sewage waste disposal system approved by the National Resources and Environmental Protection Cabinet.

The KGA will adopt the National Electrical Code, NFPA 70-2011, as a part of the Kentucky Building Code. All electrical projects started before the adopted date, will be inspected in accordance with the 2008 NEC. Any electrical projects started after the adopted date, will be inspected in accordance with the 2011 NEC. The Code's purpose is the practical safeguarding of persons and property from electrical hazards.

We recommend all personnel installing and maintaining electrical systems receive safety training on the hazards involved. (See NFPA 70E-2009.)

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GENERAL

(NEC Article 90)

LEGAL AUTHORITY: Electrical wiring in the State of Kentucky shall be performed in compliance with the current National Electrical Code (NFPA-70) as adopted by the Kentucky General Assembly, and other local, state and national codes or policies. All electrical installations or alterations SHALL be inspected by a Kentucky State Certified Electrical Inspector, the Authority Having Jurisdiction (AHJ).

LEGAL DISCLAIMER: This 2011 edition of the Uniform Electrical Wiring Guide (UEWG) provides information “AS IS” and without warranty of any kind, either implied or expressed. The information in this UEWG may contain technical inaccuracies, typographical or diagram errors. The Electric Utilities listed herein assume NO responsibilities or liability for damages incurred directly or indirectly as a result of any errors, omissions or discrepancies. **The Legal Authorities are responsible for authorizing the energizing of any and all electrical installations They deem “IN GOOD ORDER” in the State of Kentucky.**

1-1 POWER SUPPLIER REQUIREMENTS:

- A. **THE ELECTRICAL CONTRACTOR SHALL CONTACT THE LOCAL POWER SUPPLIER FOR INFORMATION** regarding local policies and procedures concerning electrical wiring in their service area.
- B. **POWER SUPPLIER** shall determine all kWh meter and service drop locations, including temporary service. Alternate locations may incur additional costs to the customer.
- C. **ON-SITE HEALTH PERMITS:** See Section 1-6 through 1-8 relating to on-site health department permits prior to electrical inspections.
- D. **CALL BEFORE YOU DIG:** Always dial 811 (Before You Dig) to begin the process of getting all underground utility lines marked. It is a free service **required by law** to help protect workers from injury and/or expense and penalties associated with damaging underground lines.

NOTE: ALL UNDERLINED ITEMS ARE CHANGES FOR THIS UEWG.

GENERAL (continued)

1-2 PURPOSE:

- A. **THE MAIN PURPOSE OF THIS GUIDE** is to promote the practical safeguarding of persons from electrical hazards. Hazards may occur from overloaded circuits, undersized circuit conductors, oversized breakers or fuses, inadequate mechanical protection of conductors, overfilled outlet boxes and conduit, lack of proper ventilation around recessed light fixtures, blocked heating equipment and several other situations of which an untrained person may be unaware. The articles, diagrams and tables of this guide can aid the electrician in properly sizing conductors, circuit protection devices, conduit, outlet boxes and equipment.
- B. **THIS GUIDE IS PROVIDED TO AID** in proper wiring methods and **not to preempt** the National Electrical Code, which contains the provisions for the Authority Having Jurisdiction by which to inspect.

1-3 **MANDATORY AND ADVISORY RULES:** Mandatory rules of this guide are characterized by the use of the word "shall." Advisory rules are characterized by the use of the word "should," or are stated as recommendations of that which is advised but not required.

1-4 **MECHANICAL EXECUTION OF WORK:** Electrical equipment shall be installed in a neat, workmanlike manner and all unnecessary and complicated wiring avoided where practicable. Conductors, raceways, and equipment shall be firmly secured in place and attached to fittings.

1-5 **APPROVED EQUIPMENT:** All electrical equipment shall be approved and installed, in accordance with instructions furnished by the manufacturer and/or listing and labeling.

1-6 **TEMPORARY SERVICE:** Check with your power supplier on policies applicable to construction, installation and inspections. On-site health department permit shall be in place at this time. (See Definition 2-20 and Diagram 3-A.)

Note: Contact power supplier for their specifications and temporary service locations.

1-7 **ROUGH-IN INSPECTION REQUIREMENTS (See Definition 2-20):** Before rough-in inspection, all wiring shall be completed and ready for devices.

-The main service equipment shall be bonded to the incoming metallic cold water line
-The neutral bars bonded to the panelboard cabinet by an approved method (bonding screw, etc.).

-Service mast through-the-wall bolts, if required, shall be installed.

-Recessed lighting fixtures shall be in place and protected from insulation unless IC protected. (Diagram 6-H.)

-All cables shall be strapped.

GENERAL (continued)

-All electrical connections shall be made-up. (Exceptions: receptacles, fixtures and permanently installed utilization equipment.)

-All electrical wiring shall be exposed and accessible.

-Insulation shall not be installed in the walls before the rough-in inspection is completed.

1-8 **FINAL INSPECTION REQUIREMENTS (See Definition 2-20):** All devices, wiring, and electrical utilization equipment intended to be permanently installed shall be in place and electrical connections completed. All circuits shall be labeled properly. On-site health department permit shall be in place at this time.

1-9 **ELECTRICAL INSPECTION REQUIREMENTS:** All electrical installations of new, additional or altered wiring requires an electrical inspection by a state certified electrical inspector. (See Definition 2-20)

2. DEFINITIONS OF TERMS

(NEC Article 100)

- 2-1 **ACCESSIBLE:** (As applied to equipment) Admitting close approach; not guarded by locked doors, elevation, or other effective means.
- 2-2 **ACCESSIBLE:** (As applied to wiring methods) Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building.
- 2-3 **ACCESSIBLE, READILY:** (Readily Accessible) Capable of being reached quickly for operation, renewal, or inspections, without requiring one to climb over, remove obstacles or to resort to portable ladders, chairs, etc.
- 2-4 **AMPACITY:** Current-carrying capacity of electric conductors expressed in amperes.
- 2-5 **APPLIANCE:** An appliance is utilization equipment, generally other than industrial, normally built in standardized sizes or types. An appliance is installed or connected as a unit to perform one or more functions, such as clothes washing, air conditioning, food mixing, deep frying, etc.
- A. **FIXED (fastened in place):** An appliance which is fastened, or otherwise secured, at a specific location.
- B. **TABLE (cord and plug):** An appliance which is actually moved, or can be easily moved, from one place to another in normal use.
- C. **STATIONARY:** An appliance which is not easily moved from one place to another in normal use.
- 2-6 **APPROVED:** Acceptable to the Authority Having Jurisdiction (AHJ).
- 2-7 **ARC-FAULT CIRCUIT INTERRUPTER (AFCI):** A circuit interruption technology which offers protection beyond the standard circuit breaker, intended to recognize characteristics unique to arcing, and de-energizing the circuit it is protecting when an arc-fault is detected.
- 2-8 **AUTOMATIC:** Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence. (For example, a change in current strength, temperature, or mechanical configuration.)
- 2-9 **AUTHORITY HAVING JURISDICTION (AHJ):** The organization office or individual responsible for approving equipment, materials, and installation or procedure. The AHJ may be federal, state, or local authority having statutory authority for such approval. This authority could be a state certified or licensed electrical inspector, state or county building inspector, etc.

DEFINITIONS OF TERMS (continued)

- 2-10 **BATHROOM:** A bathroom is defined as any area including a basin with one or more of the following: toilet, tub or shower.
- 2-11 **BONDING (BONDED):** The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and conductivity with the capacity to conduct safely any current likely to be imposed.
- 2-12 **BONDING JUMPER:** A reliable conductor installed to ensure the required electrical conductivity between metal parts required to be electrically connected.
- 2-13 **BRANCH CIRCUIT:** That portion of a wiring system between the final over-current device protecting the circuit and the outlet. A device not approved for branch circuit protection such as a thermal cutout or motor overload protective device is not considered as the overcurrent device protecting the circuit.
- 2-14 **BRANCH CIRCUIT-- APPLIANCE:** A circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits are to have no permanently connected lighting fixtures which are not a part of an appliance.
- 2-15 **BRANCH CIRCUIT-- GENERAL PURPOSE:** A branch circuit that supplies a number of outlets for lighting and appliances.
- 2-16 **BRANCH CIRCUIT-- INDIVIDUAL:** A branch circuit that supplies only one item of utilization equipment.
- 2-17 **BRANCH CIRCUIT-- MULTIWIRE:** A branch circuit consisting of two or more ungrounded conductors having a potential difference between them, and a grounded conductor having equal potential difference between it and each ungrounded conductor of the circuit.
- 2-18 **BRANCH CIRCUIT OVERCURRENT DEVICE:** A device providing protection for service, feeder, and branch circuits, including equipment. The device must protect over its stated range of overcurrents between its rated current and its interrupting rating. This device must provide appropriate interrupting rating properly sized for the intended use but no less than 5,000 amperes.
- 2-19 **BUILDING:** A structure that stands alone or is separated from adjoining structures by a fire separation wall.
- 2-20 **CERTIFICATE OF COMPLIANCE:** The AHJ will document the electrical installation and equipment to assure compliance with the NEC and other local requirements. Once electrical service is certified, additions or alterations to this electric service shall require re-inspection.
Types of certificates include:
-Temporary Inspection
-Service Only Inspection
-Rough-in Inspection
-Final Inspection
- 2-21 **CIRCUIT BREAKERS:** A device designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overcurrent, without damage to itself when properly applied within its rating.

DEFINITION OF TERMS (continued)

- 2-22 **CLOSET, CLOTHES:** A room or space, non-habitable, intended principally for storage of garments and apparel.
- 2-23 **CONCEALED:** Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.
- 2-24 **CONDUCTOR -- CURRENT-CARRYING:** A conductor that carries current in the normal operation of the device or apparatus.
- 2-25 **CONTINUOUS LOAD:** A load where the maximum current is expected to continue for three hours or more.
- 2-26 **CONTROLLER:** A device or group of devices, which serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.
- 2-27 **DAPIA (Design Approved Primary Inspection Agency):** A HUD recognized agency which approves those manufactured homes that meet NEC 550-32(B), thus qualify to have service entrance equipment mounted on the home.
- 2-28 **DEVICE:** A unit of an electrical system, as its principal function, is intended to carry or control but not utilize electric energy.
- 2-29 **DISCONNECTING MEANS:** A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.
- 2-30 **DRIP LOOP:** The service entrance conductor shall be arranged to form a 'drip loop' below the service head level to prevent moisture from entering service entrance conduit.
- 2-31 **DWELLING UNIT:** One or more rooms for the use of one or more persons providing a complete and independent living unit with space for eating, living and sleeping, and permanent provisions for cooking and sanitation.
- 2-32 **ELECTRIC POWER DELIVERY SYSTEM:** A network of power production, distribution, utilization and appurtenant facilities, such as electric utility systems that deliver power to the connected loads which are outside of, and not controlled by, interactive systems.
- 2-33 **ENCLOSED:** Surrounded by a case, housing, fence or walls that prevents a person from accidentally contacting live parts.
- 2-34 **EQUIPMENT:** A general term including material, fittings, devices, machinery, appliances, fixtures, apparatus and the like, used as a part of, or in connection with, an electrical installation.

DEFINITION OF TERMS (cont.)

- 2-35 **EQUIPOTENTIAL PLANE (GRID)**: The equipotential plane is an area where a reinforcing welded wire mesh; or other conductive elements, i.e. rebar, form a grid and are embedded in or placed under concrete or are placed under unpaved surfaces to reduce voltage gradients within the plane area. The plane area should extend out in all directions and under walking surfaces around metal surfaces that may become energized. The metal grid shall be bonded to all metal structures and fixed nonelectrical equipment that may become energized and connected to the electric grounding system. This bonding conductor shall be solid copper insulated, covered or bare and not smaller than 8 AWG. The means of bonding the metal grid shall be by listed clamps or pressure connections of copper, brass, copper alloy or stainless steel for like or dissimilar metals.
- 2-36 **EXPOSED**: (as applied to wiring methods) On or attached to the surface or behind panels designed to allow access.
- 2-37 **FEEDER**: The circuit conductors between the service equipment and the final branch circuit overcurrent device, or the generator switchboard of an isolated plant and the final branch circuit overcurrent device.
- 2-38 **FITTING**: A mechanical accessory such as a bushing, cable clamp, fixture stud, hickey, locknut, or other part of an electrical wiring system primarily intended to perform a mechanical rather than an electrical function.
- 2-39 **GARAGE**: A building or a portion of a building with doors and capable of storing vehicles. (Non-commercial)
- 2-40 **GROUND (GROUNDING)**: A system is considered grounded when properly connected to the earth or to a metallic body that effectively extends to the earth.
- 2-41 **GROUND CONDUCTOR (NEUTRAL)**: A system or circuit conductor, which is intentionally grounded. (This shall be accomplished only at the main service panelboard.)
- 2-42 **GROUNDING CONDUCTOR, EQUIPMENT (EGC)**: The conductor used to connect the non-current carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor at the main panelboard or at the source of a separately derived system.
- 2-43 **GROUNDING ELECTRODE SYSTEM (GES)**: A device, (i.e. ground rod(s), ground ring, concrete-encased rebar, etc.) that is interconnected to establish a low-resistance connection between the intentionally grounded conductor of the electrical service and the earth.
- 2-44 **GROUND EFFECTIVELY**: Intentionally connected to earth through a sufficiently low impedance ground connection(s) and having sufficient current carrying capacity to prevent voltage build-up which may result in undue hazard to connected equipment or to personnel.
- 2-45 **GROUNDING ELECTRODE CONDUCTOR**: A conductor that connects the grounding electrode system (GES) to the service entrance system grounded conductor, or at the source of separately derived systems.

DEFINITION OF TERMS (cont.)

- 2-46 **GROUND-FAULT CIRCUIT INTERRUPTER (GFCI):** A device whose function is to protect personnel by interrupting the electric circuit to the load when fault current flowing to ground exceeds a predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.
- 2-47 **HOT TUB OR SPA:** A hydromassage tub or pool used for therapy or recreation designed for immersion of users and usually having a heater, motor-driven blower, and filter. May be located inside or outside the home. The water is not changed with each use.
- 2-48 **HYDROMASSAGE BATHTUB:** A bathtub, permanently installed, that uses a pump to circulate and recirculate the water to massage the bather. Normally the water is changed with each use.
- 2-49 **IDENTIFIED:** Recognizable as suitable for the specific purpose, function, use, environment, application, etc., where described in a particular Code requirement.
- 2-50 **IN SIGHT OF OR FROM:** To be considered in sight, a piece of equipment must be visible **and** not more than 50-feet distant from that piece of equipment.
- 2-51 **INTERACTIVE SYSTEM:** An electric power production system that is capable of operating in parallel with, and suitable for delivering energy to, an electric primary source system.
- 2-52 **INTERSYSTEM BONDING TERMINATION:** Its principle function is to provide a device with positions to interconnect to other utility's systems (i.e. communication systems, cable TV, telephone, etc.) by bonding or grounding to the service equipment grounding system. It is also needed as a main disconnecting means for buildings, structures, etc., supplied by a feeder or branch circuit.
- 2-53 **KITCHEN:** An area or room with permanent facilities for food preservation, preparation and cooking, including a sink.
- 2-54 **LABELED:** A label from an organization (the organization must be acceptable to the Authority Having Jurisdiction who enforces the provisions of the National Electrical Code) that is attached to an electrical component, appliance or piece of equipment. The labeling organization indicates that they maintain periodic inspections of the products during the production process, and that it is in compliance with standards or performance specifications.
- 2-55 **LIGHT EMITTING DIODE (LED):** A semiconductor light source with technological advances; it is being adapted to replace some incandescent light applications. Advantages over incandescent are lower energy consumption and a longer lifetime. Heating issues must be managed when installed in confined space. Always follow manufacturers recommendations for use.
- 2-56 **LIGHTING FIXTURE (LUMINAIRE):** The accepted term used to describe a luminaire in this guide. This is a complete lighting unit designed to accommodate a lamp, (i.e. bulb) or lamps, together with parts to position, protect, and connect the lamps to the power source.

DEFINITIONS OF TERMS (continued)

2-57 **LISTED:** A published list of materials and equipment tested by an organization acceptable to the Authority Having Jurisdiction for enforcing the provisions of the National Electrical Code. The listed materials and equipment are verified by the acceptable organization that they meet the standards or have been tested and will perform suitably in a specified manner.

2-58 **LOCATION:**

A. **DAMP LOCATIONS INCLUDE:**

- Partially protected locations under canopies, marquees, roofed open porches, and like locations
- Interior locations subject to moderate degrees of moisture (i.e. basements, barns, and cold- storage warehouses)

B. **DRY LOCATIONS INCLUDE:**

- Locations not normally subject to dampness or wetness (A location classified as dry may be temporarily subject to dampness or wetness, such as a building under construction.)

C. **WET LOCATIONS INCLUDE:**

- Installations underground or in concrete slabs or masonry in direct contact with the earth
- Locations subject to saturation with water or other liquids (i.e. vehicle washing areas)
- Unprotected locations exposed to weather

2-59 **MANUFACTURED HOME (MFD):**

A. NOT DAPIA QUALIFIED: A factory assembled structure, transportable in one or more sections , that is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation. It is connected to the required utilities and includes plumbing, HVAC, and electric systems contained therein. This home and installation shall be acceptable to the Authority Having Jurisdiction (AHJ). The electric main service equipment shall be located adjacent to the manufactured home and not mounted on the home. (See Diagrams 15A, B, C, and D.)

B. DAPIA QUALIFIED: A factory assembled structure transported in one or more sections, built on a permanent chassis and designed to be used as a dwelling with a permanent foundation. It is connected to the required utilities and includes the plumbing, HVAC, and electric systems contained therein. This dwelling unit shall comply with the NEC 550-32(B) for electrical service equipment and be acceptable to the Authority Having Jurisdiction (AHJ). For electric service see Diagram 15-E.

2-60 **MODULAR HOME:** A Kentucky Residential Code Qualified factory-assembled structure or structures which is not a manufactured home. It can be transported in one or more sections, on a transportable chassis and designed to be used as a dwelling with a permanent foundation acceptable to the Authority Having Jurisdiction where connected to the required utilities, and includes the plumbing, HVAC, and electric systems contained therein. (For electric service see Sections 3 and 4).

DEFINITIONS OF TERMS (continued)

- 2-61 **NATIONAL ELECTRICAL CODE:** (ANSI/NFPA 70) Contains provisions considered necessary to safely utilize electricity from the service point through the premises wiring system. This code is adopted by the Kentucky General Assembly requiring compliance of all electrical installations, operations and maintenance.
- 2-62 **NATIONAL ELECTRICAL SAFETY CODE:** (ANSI C2-2007) Contains rules for the practical safeguarding of persons and property during the installation, operations and maintenance of electrical supply and communications lines from the point of generation to the service point.
- 2-63 **NEUTRAL CONDUCTOR:** The grounded conductor that is intended to carry return current under normal conditions.
- 2-64 **OUTLET:** A point on the wiring system at which current is taken to supply utilization equipment.
- 2-65 **PANELBOARD:** A single panel or group of panel units designed for assembly in the form of a single panel, including buses, automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.
- 2-66 **PLENUM:** A compartment or chamber with one or more air ducts connected and which forms part of an air distribution system. (See Section 7-7C.)
- 2-67 **PREMISES WIRING SYSTEM:** Includes wiring, both permanently and temporarily installed, interior and exterior systems, further defined as:
A. Extending from the service point to the loads or outlets,
B. Wiring extending from, and including, the power source to the loads or outlets where there is no service point; i.e. interactive system.
- 2-68 **QUALIFIED PERSON:** A person with skills and knowledge related to the construction, installation, and operation of electrical systems or equipment, and has appropriate safety training to recognize and avoid the hazards.
- 2-69 **RACEWAY:** An enclosed channel designed expressly for holding wires, cables, or bus bars.
- NOTE:** Raceways may be of metal or insulating material, and the term raceway includes rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquid-tight flexible conduit, flexible metallic tubing, flexible metallic conduit, electrical nonmetallic tubing, electrical metallic tubing, under floor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wire ways, and bus ways.
- 2-70 **RAINTIGHT:** So constructed or protected that exposure to a beating rain will not result in the entrance of water.

DEFINITIONS OF TERMS (continued)

- 2-71 **RECEPTACLE (CONVENIENCE OUTLET):** A contact device installed at the outlet for the connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.
- 2-72 **RECREATIONAL VEHICLE:** Camping trailers, motor homes, travel trailers and truck campers are all types of recreational vehicles. They are designed for temporary living quarters, camping and traveling.
- 2-73 **SERVICE:** The conductors and equipment that deliver electricity from the power supplier's lines to the structure being served electrical energy.
- 2-74 **SERVICE DROP:** The overhead service conductors between the last pole or other aerial support and the first point of attachment to the building or other structure.
- 2-75 **SERVICE POINT:** The point where the facilities of the power supplier and the premises wiring make connection.
- 2-76 **SERVICE-ENTRANCE CONDUCTORS, OVERHEAD SYSTEM:** The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop.
- 2-77 **SERVICE-LATERAL CONDUCTORS, UNDERGROUND SYSTEM:** The service conductors between the terminals of the service equipment and the point of connection to the power supplier's lateral.
- 2-78 **SERVICE ENTRANCE EQUIPMENT:** The necessary equipment, usually consisting of circuit breakers or switches and fuses and their accessories, located near point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the power.
- 2-79 **SPA:** A hydromassage tub or pool used for therapy or recreation designed for immersion of users and usually having a heater, motor-driven blower, and filter. May be located inside or outside the home. The water is not changed with each use.
- 2-80 **SPECIAL PERMISSION:** The written consent of the Authority Having Jurisdiction (AHJ).
- 2-81 **SUBPANELBOARD (NON-SERVICE PANELBOARD):** A remote breaker panelboard or fuse panelboard fed from the main service panelboard.
- 2-82 **SURGE-PROTECTIVE DEVICE (SPD):** A protective device designed to limit transient voltage (very short term overvoltage) by diverting or limiting the surge current. It also prevents continued flow of follow-through current, while maintaining its capability to repeat this function up to its capabilities. (See UL 1449 for classifications.)

DEFINITIONS OF TERMS (continued)

2-83 **SWITCHES:**

- A. **GENERAL USE SWITCH:** A switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage.
- B. **MOTOR CIRCUIT SWITCH:** A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.
- C. **TRANSFER SWITCH:** A device for transferring manually or automatically one or more load conductor connections from one power source to another.

2-84 **TEMPORARY SERVICE:** Service to provide power on construction sites prior to the connection of permanent service.

2-85 **THERMAL CUTOUT:** An over-current protective device which contains a heater element in addition to, and affecting, a renewable fusible member which opens the circuit. It is not designed to interrupt short circuit current.

2-86 **UNFINISHED BASEMENTS:** Unfinished basements are defined as portions of the basement not intended for habitable rooms, but as storage areas, work spaces, etc.

2-87 **UTILITY- INTERACTIVE INVERTER:** An inverter (system) intended for use in parallel operation with an electric utility to supply common loads that may deliver power back to the serving utility.

2-88 **UTILIZATION EQUIPMENT:** Equipment that uses electricity.

2-89 **VOLTAGE:** An electromotive force, or electrical pressure commonly referred to as voltage. It is measured by the unit volt(s) which is the difference of potential between the supply and return conductors of the concerned circuit.

- A. **Nominal Voltage:** is a voltage value designation applied to the circuit or system for the convenience of referencing its voltage class; i.e. the typical home or manufactured home would be supplied with a nominal system voltage of 120/240 volts.
- B. **Service Voltage:** The voltage measured at the service point.
- C. **Utilization Voltage:** The voltage measured at the line terminals of the electric utilization equipment.

2-90 **WEATHERPROOF:** So constructed or protected that exposure to the weather will not interfere with successful operation.

NOTE: Raintight or watertight equipment may fulfill the requirements for "weatherproof." However, weather conditions vary and consideration should be given to conditions such as snow, ice, dust or temperature extremes.

2-91 **WITHIN SIGHT OF OR FROM:** (See 2-50.)

3. SERVICES

(NEC Articles 230, 408 and 590)

3-1 **TEMPORARY SERVICE:** Temporary electrical power installations shall be permitted for the period of construction; remodeling; repair; demolition of buildings, structures, equipment, or similar activities. The temporary wiring shall be removed immediately upon completion of temporary power needs or purpose for which the wiring was installed. **CONTACT POWER SUPPLIER FOR TEMPORARY SERVICE LOCATION.**

3-2 **POINT OF ATTACHMENT:** The point of attachment shall be specified by an authorized employee of the power supplier. Service attachment shall be within 24" of service head and at or below the service attachment zone as noted in Diagram 3B. Any extra cost incurred by the power supplier for customer's convenience, or failure to confer with the power supplier prior to building the service, may be billed to the customer.

3-3 **CLEARANCE:** All service entrances must be located as to facilitate proper connections and to provide adequate clearances. The point of attachment of a service drop to a building must be of sufficient height to maintain minimum clearances under the service drop of 18 feet above loading platforms or public driveways, 12 feet above finished grade, residential property and driveways. Service drop conductors shall not be readily accessible. (See Diagrams 3-B, 3-C, 3-E, and Section 16-1.A.3.)

NOTE: Contact the power supplier for installation procedures on non-typical structures (earth-berm home, basement home, etc.).

3-4 **SERVICE ENTRANCES:**

A. **BELOW THE ROOF (WALL MOUNTED):** Rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing is recommended for all service entrances that do not extend above the roof. (See Diagram 3-B.)

NOTE: Water pipe is not listed for use as electrical conduit.

B. **CONDUIT MAST RISER:** Required where sufficient clearance cannot be maintained by attaching service drop to the building structure. A rigid or intermediate grade galvanized steel conduit riser shall extend through the roof a minimum of 2 feet and a maximum of 3 1/2 feet.

NOTE 1: Contact local power supplier for conduit size.

NOTE 2: Through-the-wall bolts must be used on conduit risers and placed approximately 6 inches above the meter base and 6 inches below the eaves or cornice. Through-the-wall bolts must go through the stone or sheathing and fasten through the studs or header. (See Diagram 3-C.)

C. **SERVICE DROP CONDUCTOR:** Only the power service drop conductor shall be attached to a service mast. Clearance must meet National Electrical Safety Code. Requirements may be greater than National Electrical Code.

SERVICES (continued)

- D. **SERVICE ENTRANCE CONDUCTORS:** Service entrance conductors shall be installed in a workmanlike manner, suitable for wet location, sunlight resistant and provide a minimum length of 18 inches for a drip loop. (See Definition 2-30.) Neutral must be identified by coloring, (either white or gray) or by other effective means, throughout service equipment.

TABLE 3 Three-wire, Single-phase Dwelling Services and Feeders Conductor Types and Sizes (See Note) FEPW-RH-RHH-RHW-THW-THWN-THHN-XHHW-THHW-ZW		
Copper	Aluminum and Copper-Clad AL	Service Rating in Amps
AWG	AWG	
4	2	100
1	2/0	150
2/0	4/0	200
400 kcmil	600 kcmil	400

NOTE 1: Non-dwelling units, i.e. pole buildings, etc. see Table 8C for proper conductor types and sizes.

NOTE 2: In dwelling units, conductors shall be permitted to be utilized as 125/250-volt, 3-wire, single-phase service entrance conductors and feeder conductors that supply the total load to a dwelling unit and installed in a raceway or cable with or without an equipment-grounding conductor. The grounded neutral conductor shall be permitted to be reduced according to NEC 220.61(B). For service entrance conductors, when installed in thermal insulation, See NEC 338.

- E. **SERVICE DROP CLEARANCE FROM BUILDING OPENINGS:** Service conductors, either in multi conductor cable or open conductor, shall have a clearance of at least 3 feet from windows, doors, porches, fire escapes or other paths of approach.

EXCEPTION 1: If the conductors are above the level of the top of a window, a clearance of less than 3 feet shall be permitted.

EXCEPTON 2: Service conductors shall not be installed beneath openings through which materials may be passed, as in farm structures or commercial building openings. Overhead conductors shall not obstruct entrance to building openings.

- F. **CONTRACTOR RESPONSIBILITY:** The electrical contractor shall be responsible for the installation of an eye bolt in new construction at the point of attachment of service wires where a mast riser is not required. (See Diagram 3-B.)

3-5 **UNDERGROUND SERVICE: Check with power supplier regarding local policies concerning underground service.** (For construction details, see Diagram 3-D.) Service laterals that are buried at least 18 inches deep and are not encased in concrete, shall have a warning ribbon buried in the trench at least 12 inches above the underground conductors.

SERVICES (continued)

3-6 **STRUCTURES RELATED TO DWELLING UNITS:** The service entrance conductors of the dwelling unit shall be of sufficient ampacity to accommodate the house and other related loads. Circuits supplying power to such buildings shall originate in the service entrance panel of the dwelling unit which shall be provided with a disconnecting means having overcurrent protection.

On premises having a number of outbuildings to be served, a meter pole or pedestal installation may be used when installed in compliance with the NEC and power supplier's rules and regulations. (See Diagram 16-A.)

3-7 **SINGLE FAMILY DWELLING REQUIREMENTS:**

A. **SINGLE FAMILY DWELLINGS:** A minimum of 100-amp service shall be installed using No. 4 copper or No. 2 aluminum conductor rated at 75C or greater. See NEC Annex D1(a) and Table 310.15(B)(7) for conductor size calculation.

NOTE: The total square footage of a single family dwelling shall include basement and second floor area. It shall not include porches, carports, unfinished attic or cellar which cannot be remodeled for future living space.

B. ELECTRICALLY HEATED AND/OR COOLED HOMES OR STRUCTURES:

NOTE: Your power supplier suggests a Manual J or equivalent heat loss/heat gain calculation be completed for each home to properly size heating and cooling equipment.

1. Residences using electric heat shall:

- (a.) Be limited to 12 kW (kva) of electric heat on a 100-amp service with No. 4 THWN copper or equivalent conductors. Furnace limited to 10 kW (kva).
- (b.) Be limited to 22 kW (kva) of electric heat on a 150-amp service with No. 1 THWN copper or equivalent conductors. Furnace limited to 15 kW (kva).
- (c.) Be limited to 32 kW (kva) of electric heat on a 200-amp service with No. 2/0 THWN copper or equivalent conductors. Furnace(s) to be limited to 25kW(kva).
- (d.) Heat pumps plus auxiliary heat shall be limited as follows:

Total Load		Service Size	
15 kva	on	150 amp	
25 kva	on	200 amp	

- (e.) Special permission and instructions must be obtained from the power supplier for service exceeding 200 amps so provisions can be made for metering, sizing of transformers and service conductors.

SERVICES (continued)

- D. **ADEQUATE CIRCUITS IN PANEL:** Total number of overcurrent devices shall not exceed the total number for which the equipment is listed and rated.

At least 2 spare circuits in the main panelboard are recommended. Each spare circuit must be identified in the panelboard. (See Section 7-5)

3-8 SERVICE EQUIPMENT:

- A. **APPROVAL:** All service equipment shall be listed for the purpose used and of the solid-neutral type. Such protective equipment shall be protected from mechanical damage and shall not be located in the vicinity of easily ignitable materials.
- B. **SERVICE DISCONNECTING MEANS:** Main disconnect handle or breaker is recommended to be not more than 6 feet nor less than 4 feet from floor or earth level. (Orient vertically operated switches or breakers so that they are to be "ON" when in the "UP" position). An enclosed service switch or circuit breaker shall be externally operable. The disconnecting means shall plainly indicate whether it is in the open or closed position. In damp or wet locations, cabinets and cutout boxes of the surface type shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 1/4-inch air space between enclosure and the wall or other supporting surface.

Working clearances shall be in accordance with Section 7-14. Service switches and panelboards shall not be installed in bathrooms, clothes closets, kitchen cabinets, over laundry equipment, or over the steps of a stairway.

1. **LOCATION:** The service disconnecting means shall be installed either inside or outside a building or other structure at a readily accessible location nearest the point of entrance of the service conductors.
 2. **MARKING:** Each service disconnecting means shall be permanently marked to identify it as a service disconnecting means and shall be of the type that is suitable for use as service equipment.
 3. **SUITABLE FOR USE:** Each service disconnecting means shall be suitable for the prevailing conditions. It should include an internal dead-front cover.
 4. **NEW CONSTRUCTION:** In newly constructed residences, it is recommended that a single means of disconnect (up to 200 amp) be provided. Two or more disconnects must be grouped together and identified.
- C. **TRANSFER SWITCH:** Typically the transfer switch is located between power supplier's meter and the load(s) to be served. Suitable as used for service equipment. (See Section 20.)

SERVICES (continued)

- D. **BUSHINGS:** Where ungrounded conductors of No. 4 or larger enter a raceway in a cabinet, pull box, junction box, or auxiliary gutter, the conductors shall be protected by a substantial bushing providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by substantial insulating material securely fastened in place. If the conduit bushing is constructed wholly of insulating material, a locknut shall be provided both inside and outside the enclosure to which the conduit is attached.

Bonding bushings and jumpers, or other approved means shall be used in service equipment.

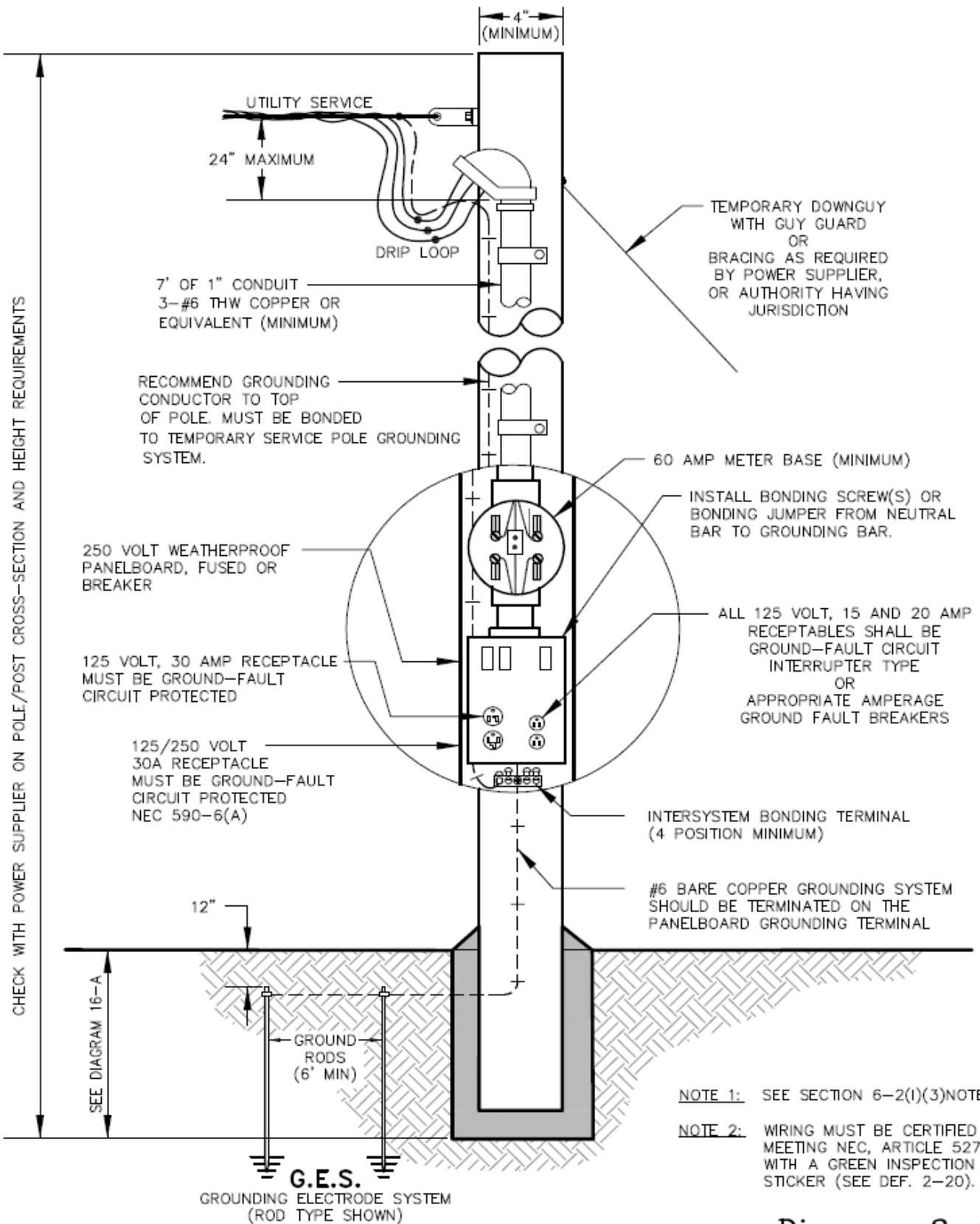
- E. **BRANCH CIRCUIT PROTECTION:** Branch circuits shall be protected by use of circuit breakers or type "S" fuses with adapters. No overcurrent device shall be connected in series with any conductor that is intentionally grounded.
- F. **SUBPANELBOARD:** Each subpanelboard must have separate terminal bars; one for equipment grounding and one for grounded neutral conductors. The equipment grounding terminal bar is bonded to the enclosure by a bonding screw or strap. The terminal bar for the neutral conductors must be isolated from the enclosure.

Single phase 125-250 volt subpanelboard(s) are to be fed by four conductor cables, one (the bare or green) being an equipment grounding conductor connected to the grounding terminal bar. Approved metal conduit may serve in place of the bare or green wire. (See Diagram 4-C.)

- 3-9 **GROUND-FAULT CIRCUIT (GFCI) PROTECTION FOR CONSTRUCTION SITES:**
All receptacle outlets shall have ground-fault circuit interrupters for personnel protection. (See Diagram 3-A.)

TEMPORARY SERVICE GUIDE

(CONTACT POWER SUPPLIER FOR THEIR SPECIFICATIONS)



NOTE 1: SEE SECTION 6-2(1)(3)NOTE

NOTE 2: WIRING MUST BE CERTIFIED AS MEETING NEC, ARTICLE 527 WITH A GREEN INSPECTION STICKER (SEE DEF. 2-20).

Diagram 3-A

SERVICE BELOW ROOF

VERTICAL CLEARANCES

①

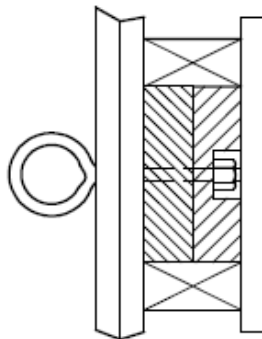
12 FT. OVER RESIDENTIAL PROPERTY AND THOSE COMMERCIAL AREAS NOT SUBJECTED TO TRUCK TRAFFIC WHERE VOLTAGE IS LIMITED TO 300 VOLTS TO GROUND.

15 FT. WHERE SUBJECT TO NON-ROUTINE VEHICULAR TRAFFIC

18 FT. MINIMUM ABOVE PUBLIC STREETS, ALLEYS AND CULTIVATED OR GRAZING AREAS.

②

SERVICE ATTACHMENT ZONE POINT OF ATTACHMENT SHOULD NOT BE FARTHER THAN 2 FEET FROM THE WEATHERHEAD AND INSTALLED BY THE ELECTRICIAN TO ATTACH UTILITY SERVICE DROP. (SEE UTILITY FOR LOCATION.)



③

MINIMUM CONDUIT SIZE
SEE TABLES 8-C, 8-E, 8-F

FOR SINGLE FAMILY DWELLINGS ONLY				
AMP	COPPER	CONDUIT	ALUM.	CONDUIT
100	#4	1 1/4"	#2	1 1/4"
200	#2/0	1 1/2"	#4/0	2"

④

GROUNDING ELECTRODE CONDUCTORS SHALL BE UNSPLICED AND HAVE 6" EXPOSED FOR THE INTERSYSTEM BONDING TERMINAL (4 POSITION, MINIMUM) FOR OTHER SYSTEMS. ELECTRICAL NONMETALLIC OR METAL CONDUIT SHALL BE USED FOR PROTECTION. IF METALLIC, BOND BOTH ENDS. (SEE SECTION 4.1 THRU 4.6) & (NEC 250.64E)

⑤

GROUNDING ELECTRODE SYSTEM (G.E.S.)
ALL NEW BUILDING FOUNDATIONS CONTAINING QUALIFIED CONCRETE-ENCASED REINFORCING RODS, MUST BECOME A PART OF THE G.E.S. ALL OTHER INSTALLATIONS MUST CONSIDER PIPE, ROD OR PLATE TYPE G.E.S. (SEE SECTION 4.1 THRU 4.6)

⑥

CONTACT LOCAL UTILITY FOR METERBASE AND RISER/WEATHERHEAD LOCATION, BY-PASS REQUIREMENT, AND POINT OF ATTACHMENT.

UTILITY SERVICE DROP

①

12'-0" MIN. FINAL GRADE TO ATTACHMENT

5'-0" MIN
6'-0" MAX

12"

G.E.S.

⑤

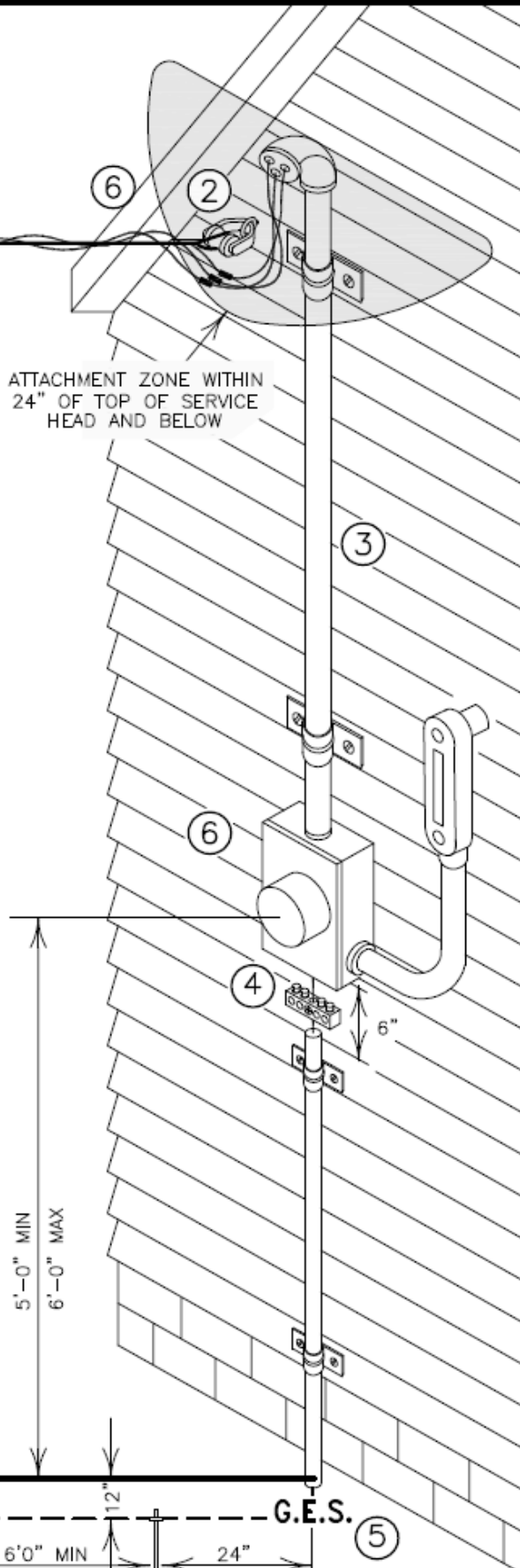
6'-0" MIN

24" MIN

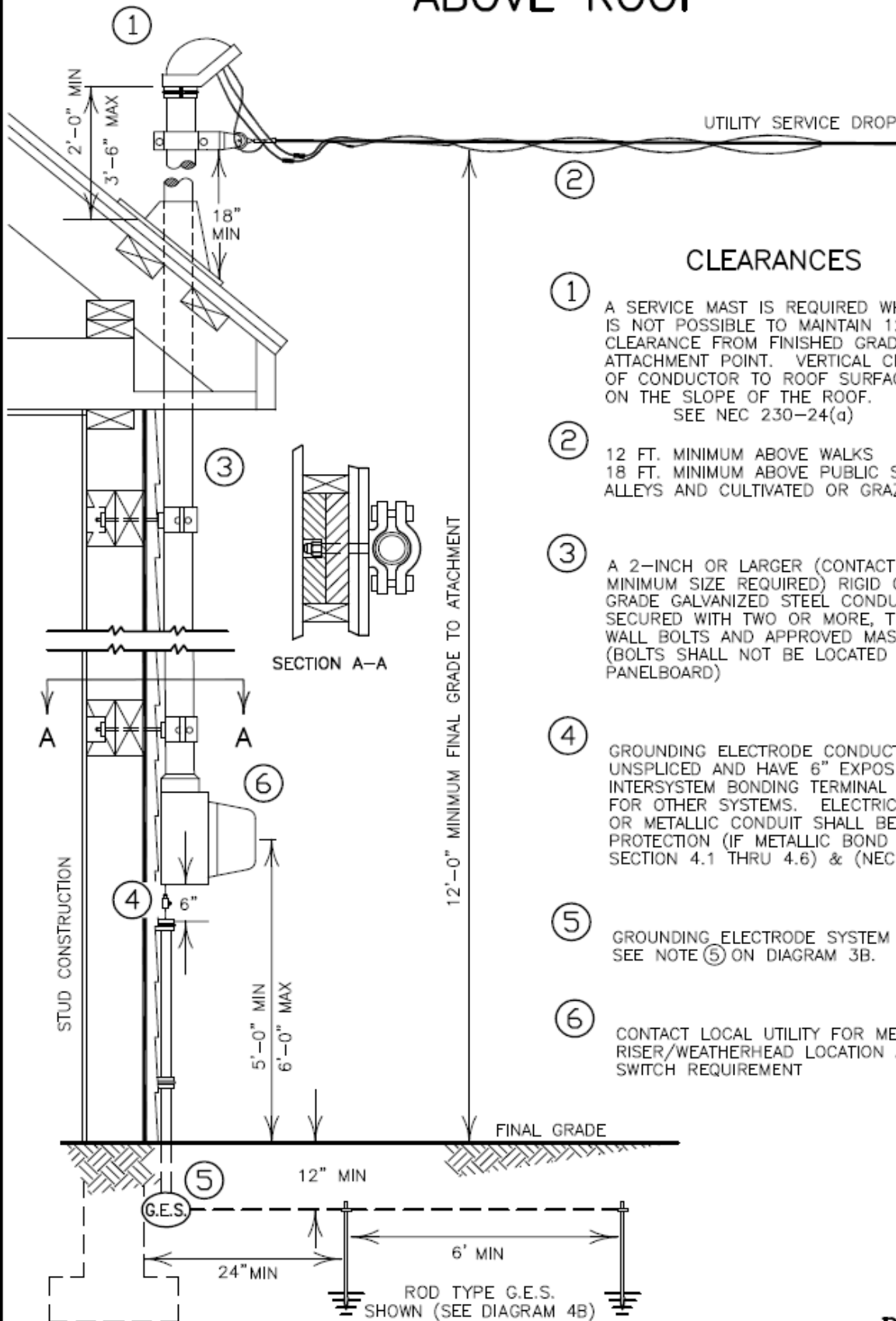
ROD TYPE
G.E.S.
SHOWN

(SEE DIAGRAM 4B)

Diagram 3-B



SERVICE ABOVE ROOF



CLEARANCES

- ① A SERVICE MAST IS REQUIRED WHEN IT IS NOT POSSIBLE TO MAINTAIN 12-FT. CLEARANCE FROM FINISHED GRADE TO ATTACHMENT POINT. VERTICAL CLEARANCE OF CONDUCTOR TO ROOF SURFACE DEPENDS ON THE SLOPE OF THE ROOF.
SEE NEC 230-24(a)
- ② 12 FT. MINIMUM ABOVE WALKS
18 FT. MINIMUM ABOVE PUBLIC STREETS, ALLEYS AND CULTIVATED OR GRAZING AREAS.
- ③ A 2-INCH OR LARGER (CONTACT LOCAL UTILITY FOR MINIMUM SIZE REQUIRED) RIGID OR INTERMEDIATE GRADE GALVANIZED STEEL CONDUIT TO BE SECURED WITH TWO OR MORE, THROUGH-THE-WALL BOLTS AND APPROVED MAST CLAMPS. (BOLTS SHALL NOT BE LOCATED INSIDE PANELBOARD)
- ④ GROUNDING ELECTRODE CONDUCTORS SHALL BE UNSPLICED AND HAVE 6" EXPOSED FOR THE INTERSYSTEM BONDING TERMINAL (4 POSITION, MINIMUM) FOR OTHER SYSTEMS. ELECTRICAL NON-METALLIC OR METALLIC CONDUIT SHALL BE USED FOR PROTECTION (IF METALLIC BOND BOTH ENDS SECTION 4.1 THRU 4.6) & (NEC 250.64E)
- ⑤ GROUNDING ELECTRODE SYSTEM (G.E.S.)
SEE NOTE ⑤ ON DIAGRAM 3B.
- ⑥ CONTACT LOCAL UTILITY FOR METERBASE AND RISER/WEATHERHEAD LOCATION AND TRANSFER SWITCH REQUIREMENT

Diagram 3-C

SERVICE — UNDERGROUND

200 AMP MAXIMUM

SEE SECTION 3-7, C-1(e)

①

METER BASE TO BE ATTACHED SECURELY. LEAD ANCHORS OR TOGGLE BOLTS TO BE USED ON BRICK VENEER OR EQUIVALENT. PLASTIC ANCHORS WILL NOT BE PERMITTED.

②

GROUNDING ELECTRODE CONDUCTOR SHALL BE UNSPLICED AND HAVE 6" EXPOSED FOR THE INTERSYSTEM BONDING TERMINAL (4 POSITION, MINIMUM) FOR OTHER SYSTEMS. (NEC 250.94) ELECTRICAL NON-METALLIC, OR METALLIC CONDUIT SHALL BE USED FOR PROTECTION. IF METALLIC CONDUIT, BOND BOTH ENDS (SEE SECTION 4-1 THRU 4-6)

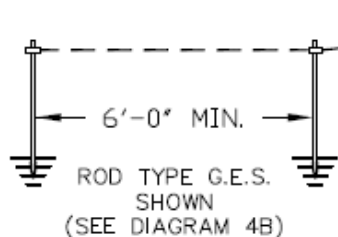
③

2.5 INCH (CONTACT LOCAL UTILITY FOR EXACT SIZE REQUIRED) RIGID CONDUIT (METAL OR PVC) ATTACHED WITH 2- TWO BOLT MAST CLAMPS A CONTINUOUS RUN OF CONDUIT LIMITED TO 3-90° BENDS EXTENDED TO PREDETERMINED UTILITY POLE/PEDESTAL. EXTEND CONDUIT ONE FOOT ABOVE FINAL GRADE AT POLE. TEMPORARILY CAP OR CLOSE END OF CONDUIT.

ALL PVC SUBJECT TO PHYSICAL DAMAGE SHALL BE SCH. 80

④

GROUND MOVEMENT REQUIRES DIRECT BURIED CONDUCTORS TO HAVE "S" LOOP IN TRENCH AT CONDUIT TRANSITION. CONTINUOUS CONDUIT RUNS MUST HAVE EXPANSION FITTING.



⑤

SEE NOTE ⑤ ON DIAGRAM 3B FOR G.E.S.

⑥

CONTACT LOCAL UTILITY FOR METERBASE AND UNDERGROUND RISER LOCATION AND BY-PASS REQUIREMENTS.

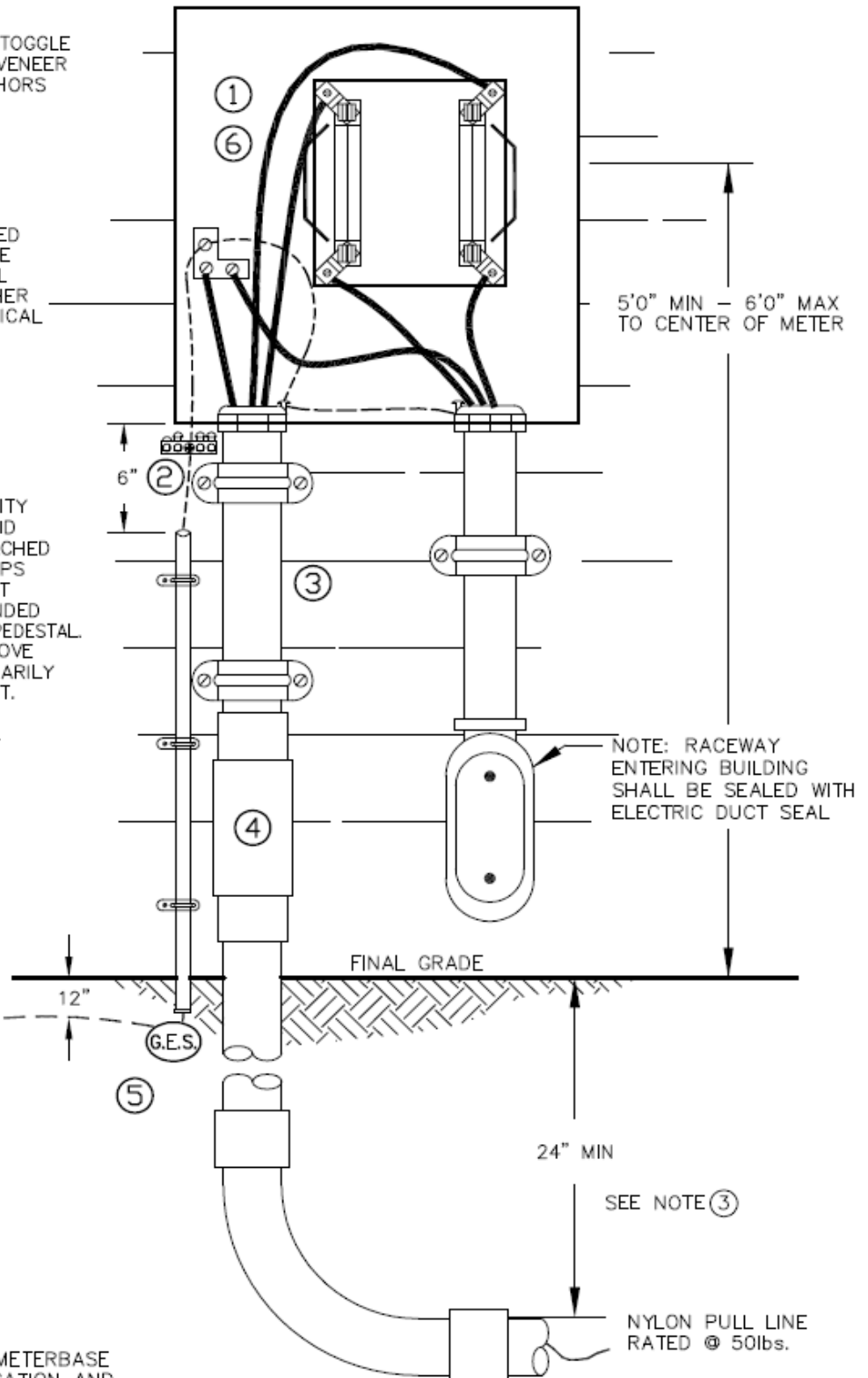


Diagram 3-D

ELECTRIC METER – SERVICE ENTRANCE WORKING SPACE – 'KEEP CLEAR AREA'

(CONTACT SERVING UTILITY FOR THEIR POLICY ON WORKING SPACE)

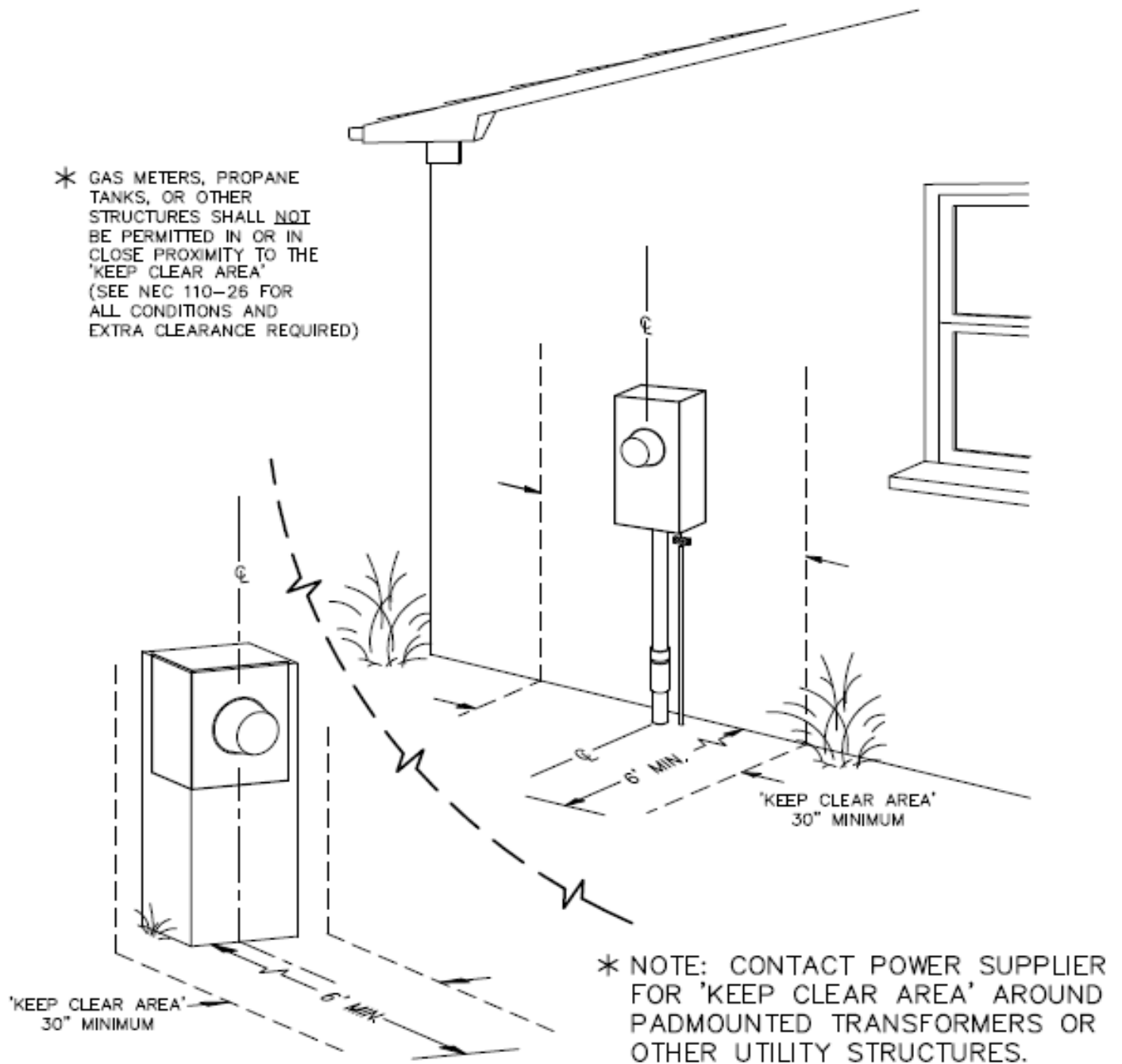


Diagram 3-E

4. GROUNDING, BONDING AND EQUIPMENT **GROUNDING SPECIFICATIONS**

(NEC Article 250)

- 4-1 **GROUNDING**: Grounding is required at the point of electrical service which requires a grounding system to be constructed and utilized to achieve the lowest practical resistance from the grounded point of that electrical system to the earth. This system should be efficient and effective to provide the facility protection for 3 fundamental sub systems:
1. Lightning and line surge protection
 2. Fault protection
 3. Signal reference protection.

- 4-2 **GROUNDING ELECTRODE SYSTEM (GES)**: All grounding electrodes present at each building/structure served with electricity shall be bonded together to form the GES.

NOTE: Metal gas lines shall not be used as a grounding electrode.

- 4-3 **GROUNDING ELECTRODES (DRIVEN RODS/PIPES)**: A driven electrode shall be either 1/2-inch copper , 1/2 inch copper bonded or 5/8-inch galvanized steel . It must be 8 feet in length and listed for the purpose. The electrode shall be driven a minimum of 2 feet away from building and the top of the electrode a minimum of 12 inches below the grade. The electrode must not be located under paved driveways, sidewalks, or patios. The electrode shall be installed so that at least 8 feet of length is in contact with the soil. It shall be driven to a depth of not less than 9 feet. Where rock is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees from the vertical or shall be buried in a trench that is at least 2 1/2 feet deep. The largest size required for driven rod/pipe electrodes is No. 6 copper.

Any single electrode consisting of a rod or pipe having greater than 25 ohms of resistance to earth must be supplemented by an additional electrode. If paralleling rods are used, the rods shall be installed at least 6 feet apart.

When available on the premises, a metal water line with 10 feet or more in contact with soil shall also be used as a grounding electrode. The grounding electrode conductor must be connected to the metal water line 5 feet or less from the point of entrance to the building at the cold water line. The grounding electrode conductors may be connected to grounded conductor (neutral) at weatherhead, meter base (factory installed separate lug) or main service panelboard neutral bar. It shall be sized according to Table 4-A. When metal water lines do not come in contact with 10 feet of soil, they must be bonded. (Size jumper according to Table 4-A.)

GROUNDING, BONDING AND EQUIPMENT SPECIFICATIONS (continued)

- 4-4 **CONCRETE-ENCASED ELECTRODE (UFER GROUND):** A concrete encased electrode is an electrode encased in at least 2 inches of concrete, and located within and near the bottom of the foundation in direct contact with the earth. All new foundations containing at least 20 feet of No. 4 steel reinforcing rod that are 1/2 inch in diameter and has a galvanized or other conductive coating or 20 feet of No. 4 or larger AWG size copper shall be part of the grounding electrode system.

NOTE 1: Existing building foundations with qualified rebar, but inaccessible without breaking out a portion of the foundation, shall NOT be required to become a part of the GES.

NOTE 2: NEC 250 covers other methods of grounding and bonding.

- 4-5 **GROUNDING ELECTRODE CLAMP:** A listed clamp shall be used to bond the electrode to the grounding electrode conductor.

- 4-6 **GROUNDING ELECTRODE CONDUCTOR ENCLOSURES:** A grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried.

Enclosures shall be rigid nonmetallic or metal conduit and provide protection from physical damage. If metal conduit is used, it shall be bonded at each end to the grounding electrode conductor.

- 4-7 **EQUIPMENT GROUNDING:** All non-current-carrying metal parts of equipment (including submersible water pump) or metal housing containing electrical conductors shall be grounded. (See Diagram 4-C.)

NOTE: The earth shall not be used as the only equipment grounding conductor.

- 4-8 **CONDUCTOR IDENTIFICATION:**

EQUIPMENT GROUNDING CONDUCTOR (EGC) Bare, covered or insulated equipment grounding conductors shall be permitted. Individually covered or insulated grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes. Bare conductors or conductors with green insulation can only be used for equipment grounding purposes.

GROUNDING, BONDING AND EQUIPMENT SPECIFICATIONS (continued)

OTHER CONDUCTOR IDENTIFICATION:

- A. **UNGROUND CONDUCTOR (CURRENT-CARRYING):** Ungrounded conductors shall be finished as to be clearly distinguishable from grounded conductors and grounding conductors. They shall be identified by colors other than white, gray or green.
- B. **GROUND CONDUCTOR (NEUTRAL):** Insulated grounded conductors 6 AWG and smaller shall be identified by a continuous white or gray outer finish along its entire length. Conductors larger than 6 AWG must be identified with white or gray at each terminating point, or along its continuous length.
- 4-9 **BONDING (BONDED):** The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and conductivity with the capacity to conduct safely any current likely to be imposed.
- 4-10 **INTERSYSTEM BONDING TERMINAL BAR:** The multi-terminal (4 positions minimum) shall be installed and accessible at all times, mounted to the grounding electrode conductor to provide a terminal position for all intersystem bonding or grounding.
- 4-11 **SNAP SWITCH BONDING:** Where a grounding means exists within the enclosure, the demand switch, dimmer switch, etc., shall be effectively bonded and shall provide a means to ground metal face plates.
- 4-12 **SAFETY BONDING:** Required bonding to metallic water, gas and sewer piping, exposed metal structural members, and metallic air ducts within the premises will provide additional safety. (See Tables 4-A, 4-B and Diagrams 4-B and 4-C.)

NOTE 1: Point of bonding attachment to metallic water pipe shall be accessible.

NOTE 2: Gas lines should be bonded by the gas supplier with #8 copper in accordance with NFPA 54 at the intersystem bonding terminal provided.

TABLE 4-A			
Grounding Conductor for AC Systems			
Size of Largest Service-Entrance Conductor or Equivalent for Parallel Conductors	*Size of Grounding Electrode Conductor		
Copper	Aluminum or Copper-clad Aluminum	Copper	**Aluminum or Copper-clad Aluminum
2 or smaller	0 or smaller	8	6
1 or 0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250 kcmil	4	2
Over 3/0 thru 350 kcmil	Over 250 kcmil thru 500 kcmil	2	0
Over 350 kcmil thru 600 kcmil	Over 500 kcmil thru 900 kcmil	<u>1/0</u>	3/0

*Where connected to made electrodes, that portion of the grounding electrode conductor which is the sole connection between the grounding electrode and the grounded conductor at the service equipment shall not be required to be larger than No. 6 copper wire, except concrete-encased electrode shall be a minimum of No. 4 copper. (See Diagram 4-A)

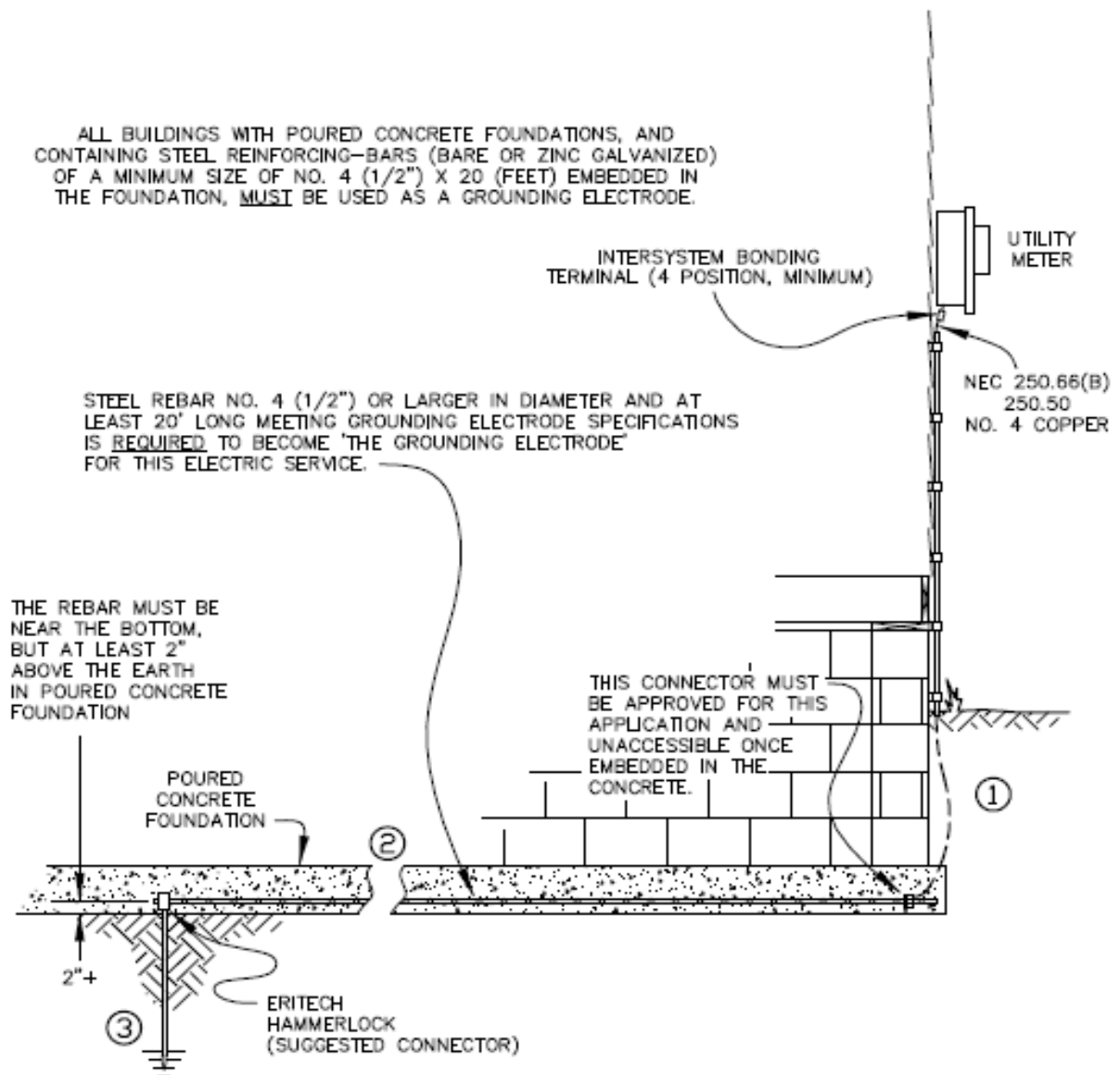
**Aluminum conductors shall not be used within 18 inches of soil.

TABLE 4-B		
Size of Equipment Grounding Conductors for Raceway and Equipment		
Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., not exceeding (Amperes)	Copper Wire Size	Aluminum Copper-clad Aluminum Wire Size
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
600	1	2/0

CONCRETE-ENCASED ELECTRODE

UFER GROUND

ALL BUILDINGS WITH POURED CONCRETE FOUNDATIONS, AND CONTAINING STEEL REINFORCING-BARS (BARE OR ZINC GALVANIZED) OF A MINIMUM SIZE OF NO. 4 (1/2") X 20 (FEET) EMBEDDED IN THE FOUNDATION, MUST BE USED AS A GROUNDING ELECTRODE.



①

NO. 4 COPPER MUST BE CONNECTED TO THE GROUNDED CONDUCTOR AT THE SERVICE EQUIPMENT AND CONNECTED TO THE REBAR.

②

IF CONCRETE-ENCASED ELECTRODE IS DESIRED, BUT, APPROVED REBAR IS NOT AVAILABLE, A NO. 4 BARE COPPER CONDUCTOR WITH AT LEAST 20 (FEET) EMBEDDED IN THE POURED CONCRETE FOUNDATION CAN BE USED.

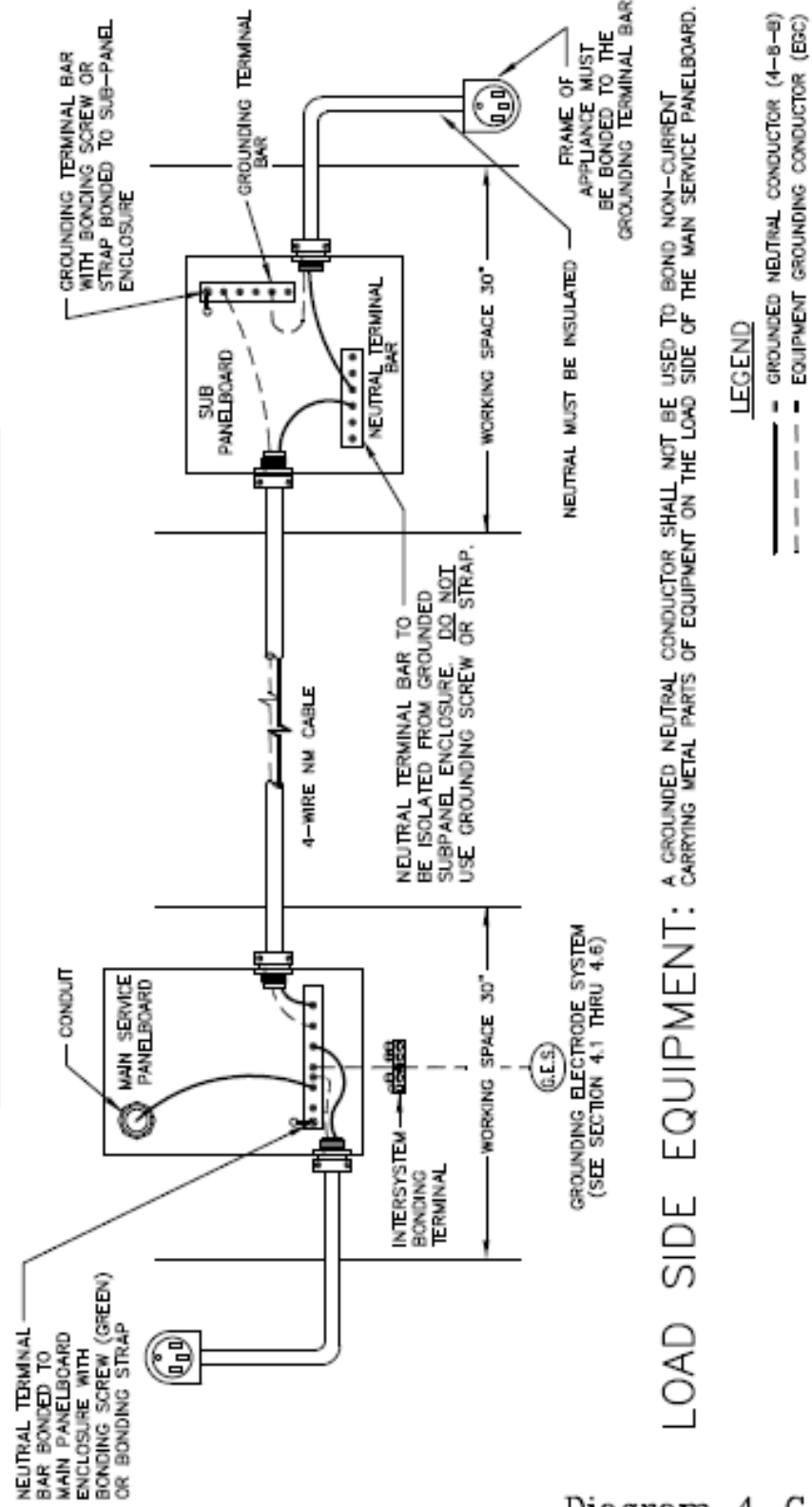
③

THE CONCRETE-ENCASED ELECTRODE CAN HAVE A SUPPLEMENTAL 8 (FEET) GROUND ROD INSTALLED NEAR THE FAR END TO PROVIDE A METALLIC PATH FROM THE REBAR INTO THE EARTH TO IMPROVE LIGHTNING DISSIPATION. THE SUPPLEMENTAL ROD IS NOT REQUIRED TO ASSURE THE 25 OHMS RESISTANCE (NEC 250.53(A)(2)).

Diagram 4-A

GROUNDING AND BONDING AT MAIN AND SUB PANELBOARDS

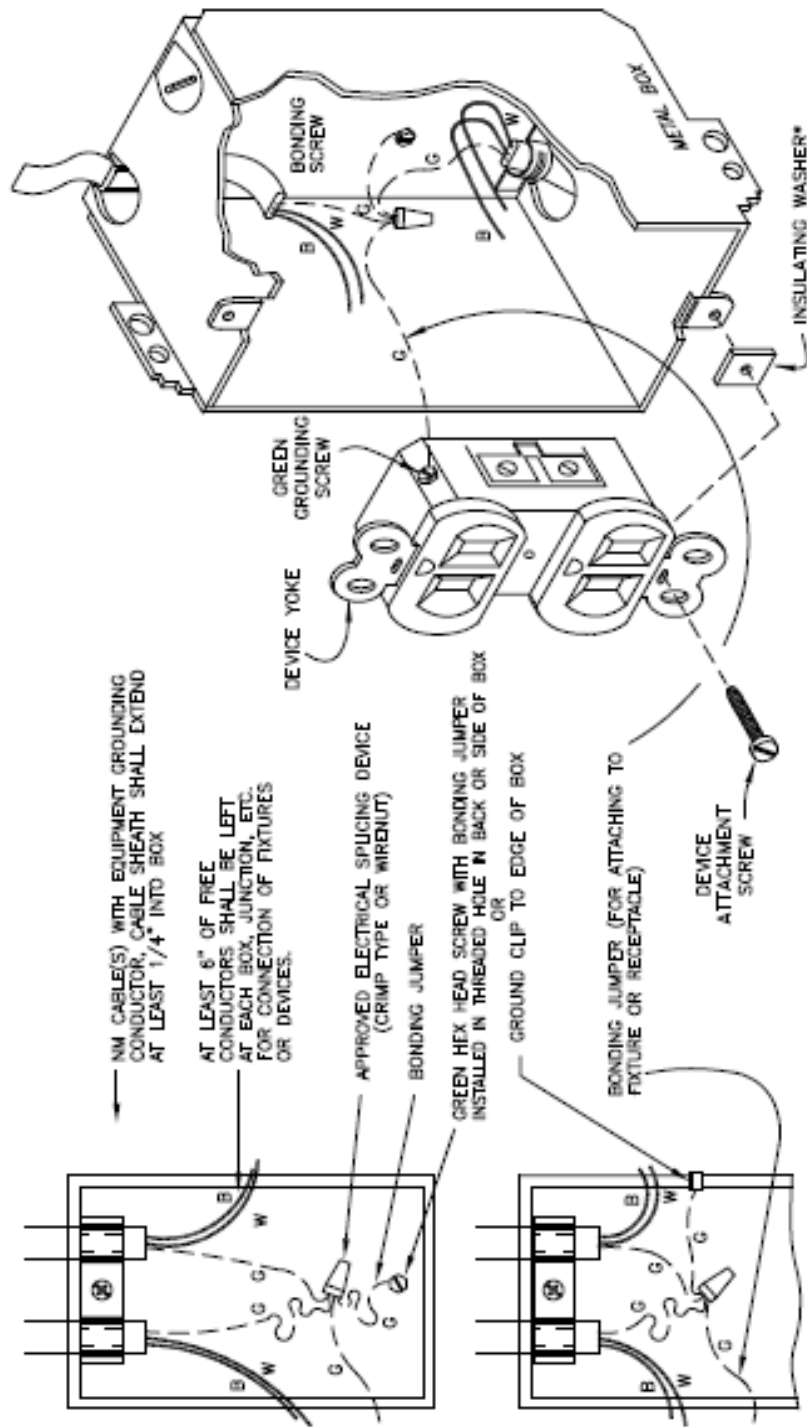
NOTE:
ONE CONDUCTOR PER LUG ON NEUTRAL BAR



LOAD SIDE EQUIPMENT: A GROUNDED NEUTRAL CONDUCTOR SHALL NOT BE USED TO BOND NON-CURRENT CARRYING METAL PARTS OF EQUIPMENT ON THE LOAD SIDE OF THE MAIN SERVICE PANELBOARD.

Diagram 4-C

BONDING CONNECTIONS TO METALLIC BOXES, FIXTURES AND DEVICES



* NOTE: SURFACE MOUNTED METAL BOX MUST HAVE DIRECT METAL-TO-METAL CONTACT BETWEEN THE DEVICE YOKES AND THE BOX. AN INSULATING WASHER MUST BE REMOVED TO ACCOMPLISH THIS BOND, OR LISTED SELF-GROUNDED DEVICE SHALL BE PERMITTED.

Diagram 4-D

5. HOUSE MOVING & STRUCTURAL DAMAGE

- 5-1 **HOUSE MOVING:** Houses that have been moved from one location to another shall be inspected to see if damage to the existing wiring has resulted from the move. Service grounding electrode system shall meet provisions of Section 4. GFCI's and AFCI's should be improved to meet current NEC standards before reconnecting power.
- 5-2 **STRUCTURAL DAMAGE:** When a structure has been moved, received structural damage, or been submerged in a flood and the electric service has been discontinued, an electrical inspection shall be performed by a licensed electrical inspector before the electric service is restored.
- A. **AFTER FLOOD:** All electrical devices and wiring submerged in flood waters shall be replaced, including the main breaker and all overcurrent devices (i.e. fuses and circuit breakers.)
- NOTE:** Contact UL for their brochure on flood water safety: (www.ul.com; 800-664-3731)
- B. **AFTER FIRE:** The wiring and devices shall be checked. If any smoke or water damage is evident, wiring and/or devices should be replaced.
- 5-3 **ON-SITE HEALTH DEPARTMENT PERMIT:** Sticker required to be in place prior to electrical inspection. (See Sections 1-6 and 1-8.)

6. BRANCH CIRCUIT WIRING

(NEC Articles 210 and 220)

- 6-1 **GENERAL PURPOSE CIRCUIT:** All convenience outlets shall be of the three-wire type and shall be tamper resistant. All outlets (lighting outlets, switch outlets, etc.) shall be grounded. Ten outlets is the suggested maximum number of lights or receptacles on any GENERAL PURPOSE CIRCUIT.

NOTE: Receptacles (single or duplex) located 5'6" above the floor or for a fixed appliance is not required to be tamper-resistant.

- A. **ARC-FAULT CIRCUIT PROTECTION (AFCI):** All 125-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sun rooms, recreation rooms, closets, hallways, or similar rooms or areas shall be protected by a listed arc-fault circuit interrupter, combination-type, installed to provide protection of the branch circuit.

- B. **DEDICATED CIRCUIT:** Any fixed appliance that uses 50% or more of the circuit capacity shall have a dedicated circuit.

6-2 RECEPTACLE OUTLETS:

- A. **GENERAL PROVISIONS:** In every kitchen, family room, dining room, parlor, library, den, sun room, bedroom, recreation room or similar room or area of a dwelling unit, receptacle outlets shall be installed so that no point along the floor line in any wall space is more than 6 feet—measured horizontally—from an outlet in that space, resulting in no more than 12 feet between receptacles.

This spacing requirement includes any wall space 2 feet or more in width, wall space occupied by fixed panels in exterior walls, and fixed room dividers such as freestanding bar-type counters and open railings.

AS USED IN THIS SECTION, A "WALL SPACE" shall be considered a wall unbroken along the floor line by doorways, fireplaces, or similar openings.

Each wall space 2 or more feet in width shall be treated individually and separately.

A wall space shall be permitted to include two or more walls of a room (around corners) where unbroken at the floor line. (See Diagram 6-A)

NOTE 1: The purpose of this requirement is to minimize the use of cords across doorways, fireplaces, and similar openings.

NOTE 2: Permanently installed electric baseboard heaters equipped with factory-installed receptacle outlets or outlets provided as a separate assembly by the manufacturer, shall be permitted as the required outlet or outlets for the wall space utilized by such permanently installed heaters. Such receptacle outlets shall not be connected to the heater circuits.

NOTE 3: Listed baseboard heaters include instructions which may not permit their installation below receptacle outlets.

BRANCH CIRCUIT WIRING (continued)

- B. **SMALL APPLIANCE BRANCH CIRCUITS:** A 20-ampere small appliance branch circuits shall serve all receptacle outlets (with a recommended maximum of 4 per circuit), including refrigeration equipment, in the following: kitchen, pantry, breakfast room, dining room, or similar area of a dwelling unit. Such circuits shall have no other outlets. 15- or 20-ampere duplex receptacles are permitted to be installed on these circuits. No small appliance branch circuit shall serve more than one kitchen.

EXCEPTION: A receptacle installed solely for the electrical supply and support of an electric clock in any of the rooms specified above.

- C. **COUNTER TOPS:** Receptacles installed to serve counter top surfaces shall be supplied by not less than two small appliance branch circuits, either or both which shall also be permitted to supply receptacle outlets in the kitchen and other rooms specified in Section 6-2 B above.

In kitchens and dining areas of dwelling units, a receptacle outlet shall be installed at each counter space 12 inches or wider.

Receptacles shall be installed so that no point along the wall line is more than 24 inches (measured horizontally) from a receptacle outlet in that space, resulting in no more than 4 feet between receptacles, and may be no more than 20 inches above or 12 inches below the counter top. Where the receptacles are located below the counter top, they shall not be located where the counter top extends more than 6 inches beyond its support base. Receptacles shall not be installed face up in counter tops.

Island and peninsular counter tops 12 inches or wider, shall have at least one receptacle. (See Diagram 6-B.) On peninsular counter tops, measure from the connecting edge.

Counter top spaces separated by range tops, refrigerators, or sinks, shall be considered as separate counter top spaces.

Receptacles rendered **inaccessible** by appliances fastened in place or appliances occupying dedicated space shall not be considered as these required outlets.

All 125-volt, 15- or 20-ampere receptacles installed to serve counter top surfaces SHALL have **ground-fault circuit interrupter** protection. (See Diagram 6-B.)

NOTE 1: A MICROWAVE OVEN shall have a separate 125-volt, dedicated circuit.

NOTE 2: A REFRIGERATOR should have a separate 125-volt, dedicated circuit.

NOTE 3: A DISHWASHER shall have a separate 125-volt, 20-ampere circuit. Also, a dishwasher shall have a disconnecting means **within sight, or** the switch or circuit breaker must be capable of being LOCKED in the open position. (See NEC 422-31 (B)(C) and 422-34) If a cord and plug method of disconnecting is used, the 4-foot maximum cord, and plug connection must be accessible.

BRANCH CIRCUIT WIRING (continued)

NOTE 4: A GARBAGE DISPOSAL of 1/8 hp, or more, shall have a disconnecting means (wall switch acceptable) **within sight, or** the switch or circuit breaker must be capable of being LOCKED in the open position. (See NEC 422-31.) If a cord and plug method of disconnecting is used, the 3-foot maximum cord and plug connection must be accessible.

NOTE 5: A TRASH COMPACTOR may require a separate 125-volt, 20-ampere circuit. Cord and plug connections are same requirements as dishwasher. (See Section 6-2 C, Note 3.)

- D. **LAUNDRY AREAS:** At least one (1) 20-ampere, 125-volt circuit shall serve laundry outlet(s), and shall be located within 6 feet of the intended location of said appliances. This circuit shall have no other outlets. (See Section 11-1 for dryer circuit specifications.)
- E. **BATHROOMS:** At least one wall receptacle outlet shall be installed in bathrooms within 36 inches of outside edge of each basin location. If mounted on side or front of cabinet, the receptacle cannot be more than 12 inches below the top.

All 125-volt, 20-ampere receptacles installed in bathrooms shall have ground-fault circuit interrupter for personal protection, and it shall be supplied by a 20-ampere branch circuit supplying no other receptacles except those in bathrooms.

EXCEPTION: When a single 20-ampere circuit is supplying receptacles in a single bathroom, outlets for other equipment within the same bathroom may be permitted.

Hydromassage bathtubs shall be on a dedicated GFCI protected circuit and all metal water lines bonded to the motor with No. 8 solid copper or larger. **Motors shall be accessible** and have means of disconnection. GFCI device shall be horsepower rated for the motor being served and readily accessible.

- F. **HALLWAYS:** At least one receptacle outlet shall be installed in hallways of 10 feet or greater in length and AFCI protected.

A hallway is considered as the length along the centerline of the hall without passing through a doorway.

G. BASEMENTS, GARAGES, OUTBUILDINGS, AND CRAWL SPACES:

1. At least one (1) receptacle outlet (in addition to any provided for laundry equipment) shall be installed in each basement, attached garage and each detached garage with electric power.
2. All 125-volt, 15- and 20-ampere receptacles installed in garages or outbuildings used for storage or work areas shall have ground-fault circuit interrupter protection for personnel.

EXCEPTION: In an unfinished basement, a single receptacle supplying only a permanently installed fire alarm or burglar system shall not be required to have ground fault circuit interrupter for personal protection.

3. All 125-volt, 15- and 20- ampere receptacles installed in crawl spaces and in unfinished basements shall have ground fault circuit interrupters for personal protection.

NOTE: For unfinished basements, see Section 6-4D.

- H. **SERVICING HEATING, AIR CONDITIONING AND REFRIGERATION EQUIPMENT:** A 125-volt, 15- or 20-ampere receptacle outlet shall be installed on the same level and within 25 feet for the servicing of heating, air conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnection means. (See Section 6-4) (See Diagram 14-A.)
- I. **OUTDOORS:** All 125-volt, 15- and 20-ampere receptacles installed outdoors shall have ground-fault circuit interrupter for personal protection.
1. **ONE-FAMILY DWELLINGS:** At least one (1) receptacle outlet, accessible at grade level, shall be installed at the front and back of the dwelling. Decks, porches and balconies that are accessible from inside the dwelling unit, shall have at least one receptacle outlet installed and cannot be over 6 1/2 feet above the floor.
 2. **TWO-FAMILY DWELLINGS:** At least one (1) receptacle outlet, accessible at grade level, shall be installed at the front and back of each dwelling unit which is at grade level.
 3. **MULTI-FAMILY (OVER TWO) WITH COMMON WALL CONSTRUCTION:** Shall have one (1) receptacle outlet accessible at grade level, front and rear, for each dwelling unit which is at grade level.

NOTE: Receptacles in wet locations (See Sections 2-57 and 2-89) shall be in weatherproof enclosures which will maintain their integrity when receptacle is in use.

6-3 **LIGHTING OUTLETS REQUIRED:** Lighting outlets shall be installed where specified in (A) and (B) below:

- A. **DWELLING UNITS:** At least one wall switch-controlled lighting outlet shall be installed in every habitable room: bathrooms, hallways, stairways, attached garages, detached garages with electric power and at outdoor entrances or exits.

NOTE 1: A vehicle entrance in an attached garage is not considered as an outside entrance.

Where lighting outlets are installed in interior stairways, there shall be a wall switch at each floor level to control the lighting circuit where the difference between floor levels is six (6) steps or more.

At least one lighting outlet, controlled by a light switch, shall be installed and located at the point of entry to the attic, under floor space, utility room and basement where these spaces are used for storage or containing heating and air conditioning equipment. The light fixture should provide physical protection for the bulb if fixture height is less than 6 foot 7 inches.

The lighting outlet shall be provided at or near the equipment requiring servicing. This includes indoor service equipment and panelboards.

EXCEPTION: In habitable rooms; other than kitchens, bathrooms, hallways, stairways and garages; one or more receptacles controlled by a wall switch shall be permitted in lieu of lighting outlets.

NOTE 2: Switched receptacles cannot be counted to satisfy outlet requirements in Section 6-2 unless split-wired, thus leaving part of the receptacle usable at all times.

BRANCH CIRCUIT WIRING (continued)

- B. **FIXTURES IN CLOTHES CLOSETS:** (See Diagram 6-G.) When a lighting fixture is installed in a clothes closet, it shall be installed as follows:

1. LOCATION:

- (a.) Surface-mounted enclosed incandescent and LED fixtures installed on the wall above the door or on the ceiling provided there is a minimum clearance of 12 inches between the fixture and the nearest point of storage area.
- (b.) Surface-mounted fluorescent fixtures installed on the wall above the door or on the ceiling provided there is a minimum clearance of 6 inches between the fixture and the nearest point of storage area.
- (c.) Recessed incandescent and LED fixtures with a completely enclosed lamp installed in the wall or the ceiling provided there is a minimum clearance of 6 inches between the fixtures and the nearest point of storage area (must have solid lens).
- (d.) Recessed fluorescent and LED fixtures installed in the wall or on the ceiling provided there is a minimum clearance of 6 inches between the fixtures and the nearest point of storage area.

2. **FIXTURE TYPES PERMITTED:** Listed fixtures of the following types shall be permitted to be installed in a closet:

- A surface-mounted or recessed incandescent fixture with a **completely enclosed** lamp.
- A surface-mounted or recessed fluorescent fixture.

3. **FIXTURE TYPES NOT PERMITTED:** The following fixtures shall not be permitted-(See Diagram 6-G.)

- Incandescent fixtures with open or partially enclosed lamps
- Pendant fixtures or lamp holders
- Compact fluorescent fixtures

- C. **RECESSED LIGHTING FIXTURES:** Thermal insulation shall not be installed any closer than manufacturers recommendations to the side of a recessed fixture enclosure, wiring compartment or ballast unless the fixture is labeled for the purpose. Fixture shall be vented either to the top or side and installed at time of rough-in inspection and fixture shall have approved trim and bulb.

Recessed portions of enclosures, other than points of support, shall be spaced no closer than manufacturers recommendation from combustible material. (See Diagram 6-H)

- D. **SPACE FOR COVE AND OTHER STRUCTURAL LIGHTING:** Structural lighting shall have adequate space and shall be located so that lamps and equipment can be properly installed and maintained.

BRANCH CIRCUIT WIRING (continued)

6-4 GROUND FAULT CIRCUIT INTERRUPTER PROTECTION (GFCI): The following shall have GFCI protection:

- A. **BATHROOM:** All 125-volt, 20-ampere receptacle outlets installed.
- B. **GARAGES, GRADE-LEVEL PORTIONS OF UNFINISHED ACCESSORY BUILDINGS USED FOR STORAGE OR WORK AREAS:** All 125-volt, 15- and 20-ampere receptacle outlets installed.
- C. **OUTDOORS:** All 125-volt, 15- and 20-ampere receptacle outlets installed.
- D. **CRAWL SPACES AND UNFINISHED BASEMENTS:** All 125-volt, 15- and 20-ampere receptacle outlets shall be GFCI protected.

NOTE: See definition of unfinished basement (Section 2-85.)

- E. **KITCHEN:** All 125-volt, 15- and 20-ampere receptacle outlets installed to serve counter top surfaces, whether such receptacle outlets are above or below the counter top, including "island" cabinet structures.
- F. **SWIMMING POOLS AND BOATHOUSES:** All 125-volt, 15- and 20- ampere receptacle outlets installed within 20 feet of the inside wall of the pool, boathouses, piers and boatyards. (See Section 17.)
- G. **HOT TUBS, ETC:** All fountains, hydromassage tubs, hot tubs, spas, and similar installations. (See Section 17.) A dedicated circuit is required for these installations.

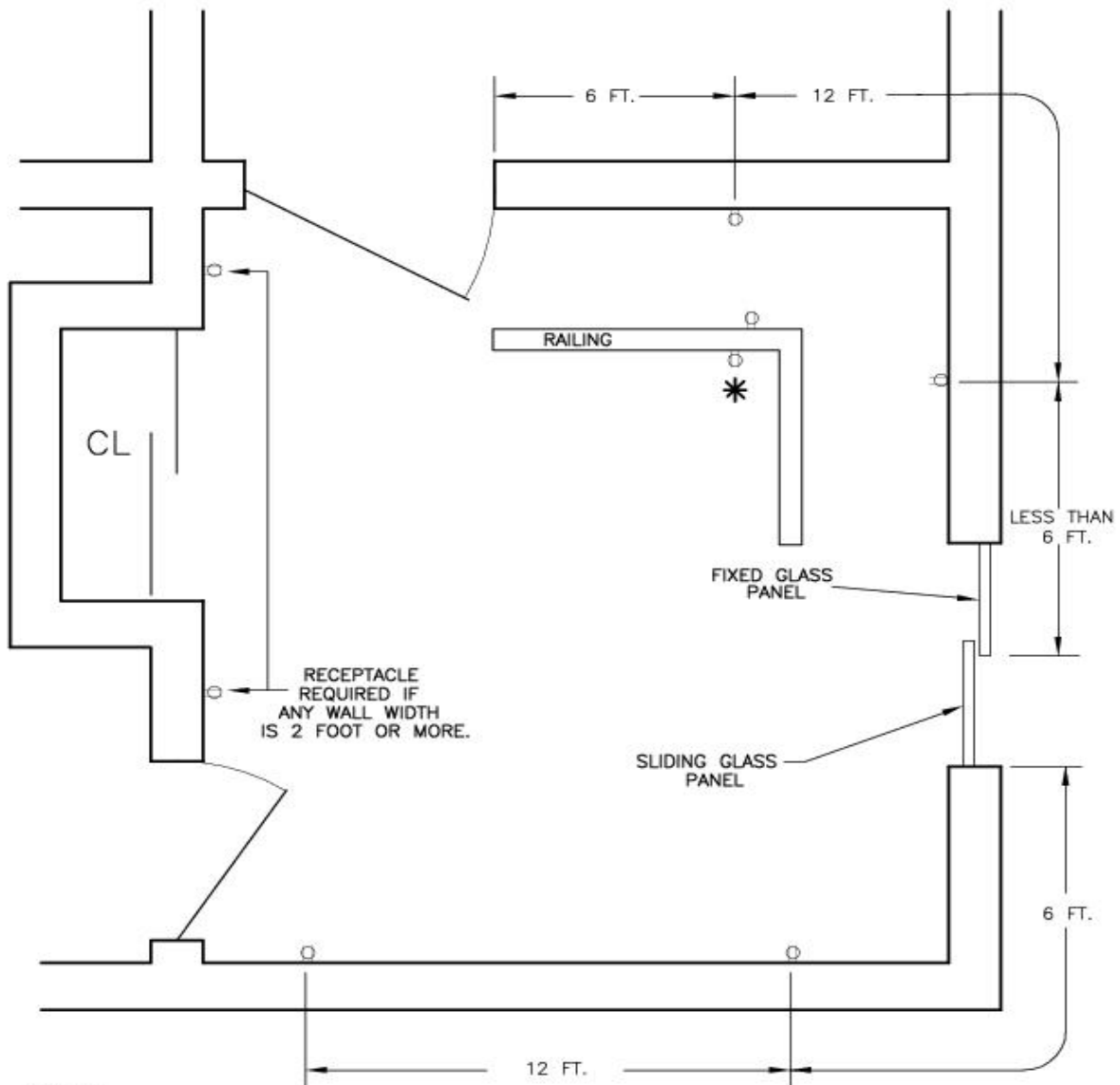
NOTE: Such ground-fault circuit interrupter protection shall be provided for receptacles located within 5 feet of the above-mentioned equipment.

- H. **SINKS:** If a receptacle is installed, it shall be GFCI protected when within 6 feet of the sink.
- I. **RECEPTACLE REPLACEMENTS:** Ground-fault circuit interrupter protected receptacles shall be installed when replacements are made in areas requiring GFCI protection.

NOTE: All GFCI receptacles shall be readily accessible

MINIMUM REQUIRED RECEPTACLE SPACING

(DWELLING UNIT RECEPTACLE OUTLETS)



NOTE:

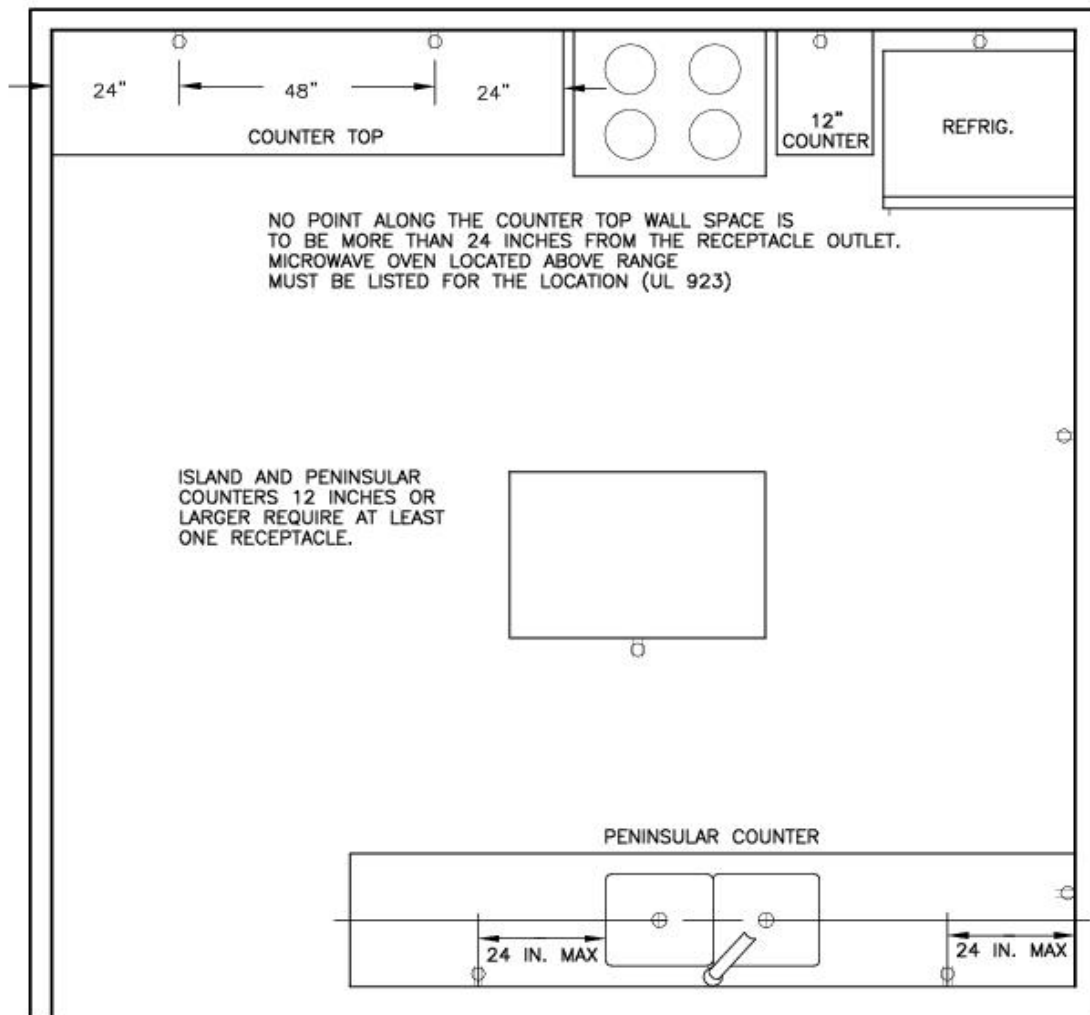
RECEPTACLES SHALL BE SPACED SO THAT NO POINT ALONG THE FLOOR LINE IN ANY WALL SPACE IS MORE THAN 6' FROM A RECEPTACLE OUTLET, OR MORE THAN 12' BETWEEN RECEPTACLE OUTLETS.

* PERMANENT RAILINGS/ROOM DIVIDERS WITH FURNITURE, LAMP, ETC. PLACED ADJACENT SHALL HAVE RECEPTACLES SPACED THE SAME AS FOR WALL SPACINGS

Diagram 6-A

KITCHEN COUNTER TOP AND SMALL APPLIANCE

MINIMUM RECEPTACLE OUTLET SPACING



RECEPTACLE FOR COUNTER TOP USE, SHALL BE G.F.C.I. PROTECTED.

Diagram 6-B

UNFINISHED BASEMENT RECEPTACLE OUTLET GUIDE

(See Section 6.2H and 6.4D)

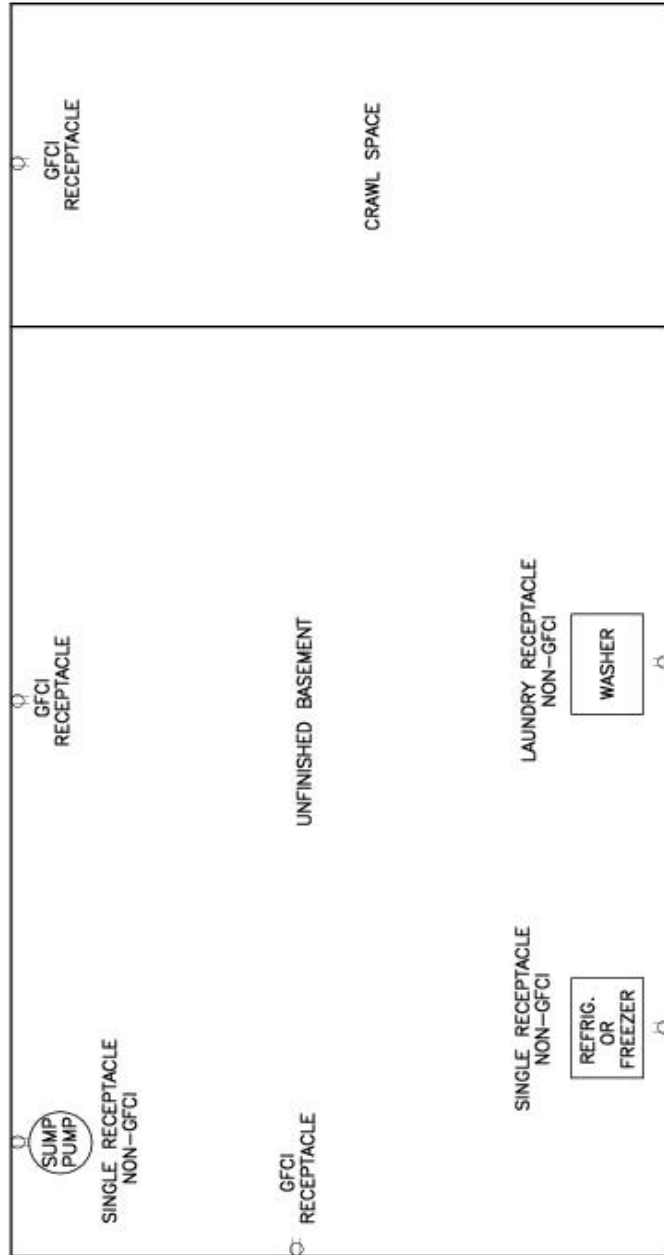


Diagram 6-C

SPLIT-WIRED RECEPTACLES (WITH LOWER HALF CONTROLLED BY SWITCH) FEED THROUGH CIRCUIT

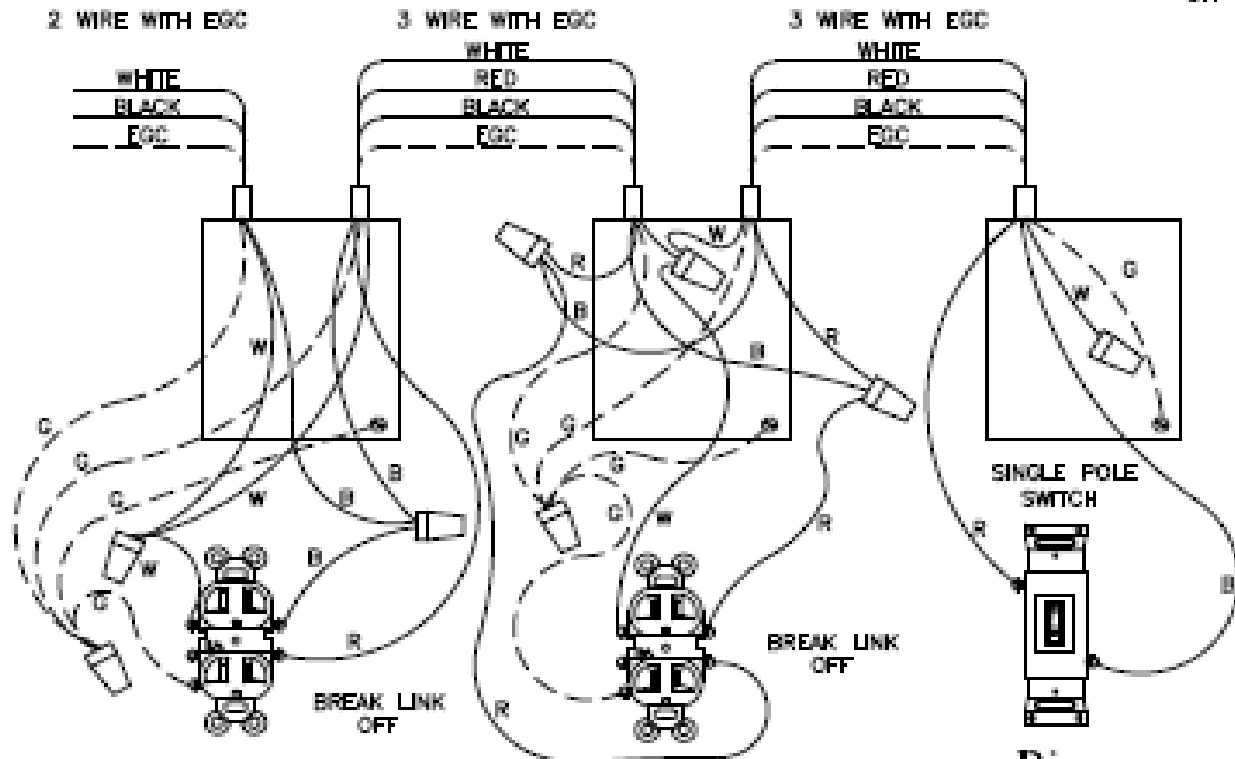
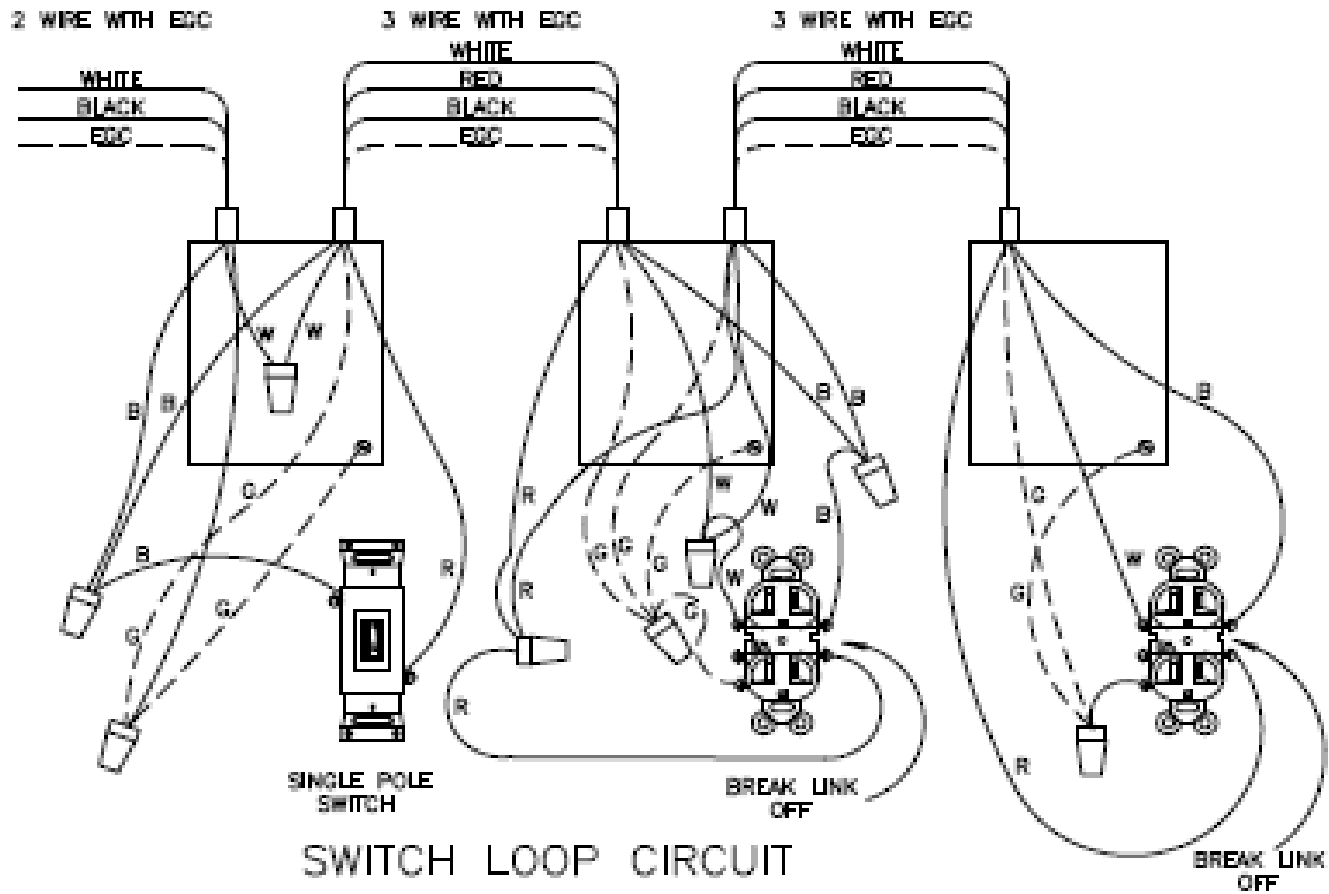


Diagram 6-D

125/250 MULTIWIRE BRANCH CIRCUITS (SPLIT WIRED)

IN MULTIWIRE CIRCUITS THE CONTINUITY OF A GROUNDED CONDUCTOR SHALL NOT BE DEPENDENT UPON DEVICE CONNECTIONS, SUCH AS RECEPTACLES, WHERE THE REMOVAL OF SUCH DEVICES WOULD INTERRUPT THE CONTINUITY.

* MULTIWIRE BRANCH CIRCUITS SUPPLYING MORE THAN ONE DEVICE ON THE SAME YOKE SHALL BE PROVIDED WITH A MEANS TO DISCONNECT ALL UNGROUNDED CONDUCTORS SIMULTANEOUSLY AT THE PANELBOARD WHERE THE CIRCUIT ORIGINATES.

MULTIWIRE BRANCH CIRCUITS SHALL SUPPLY ONLY LINE TO NEUTRAL LOADS.

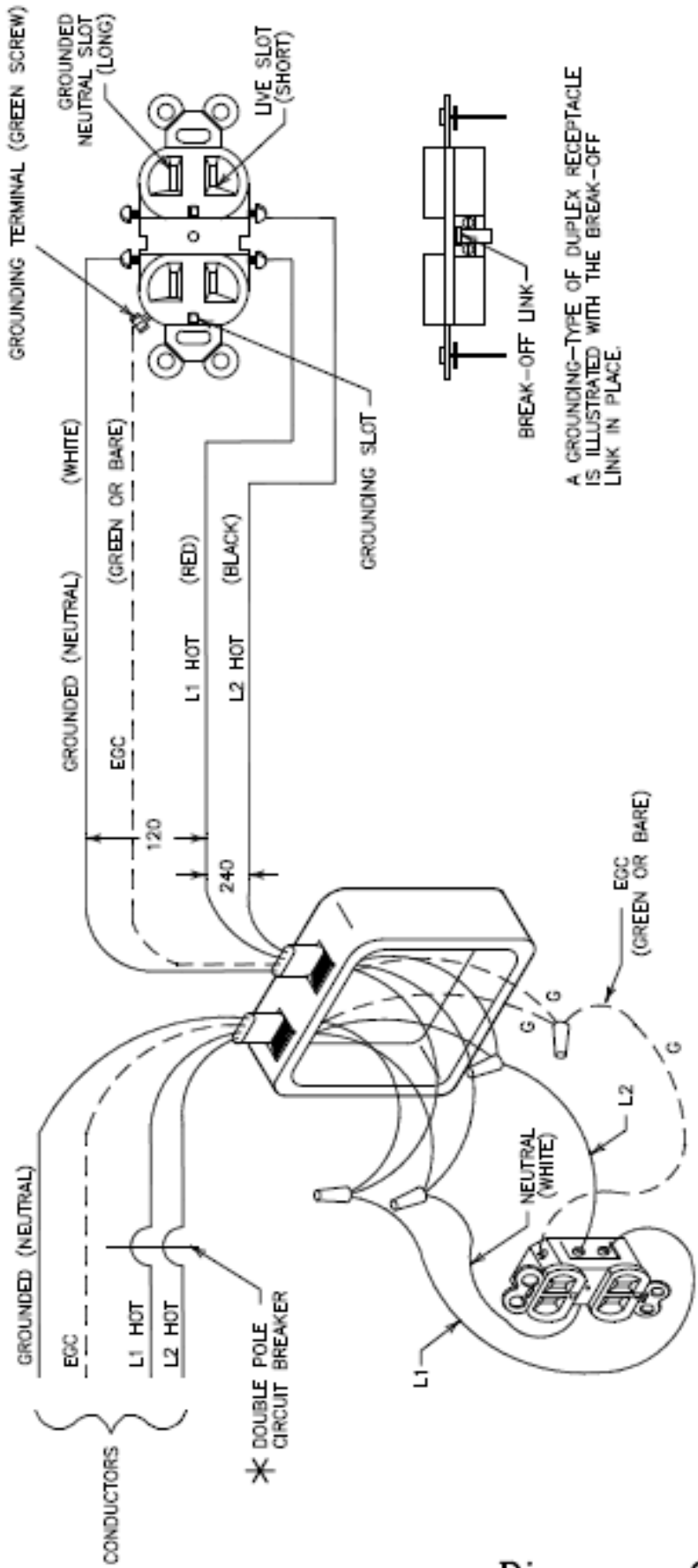


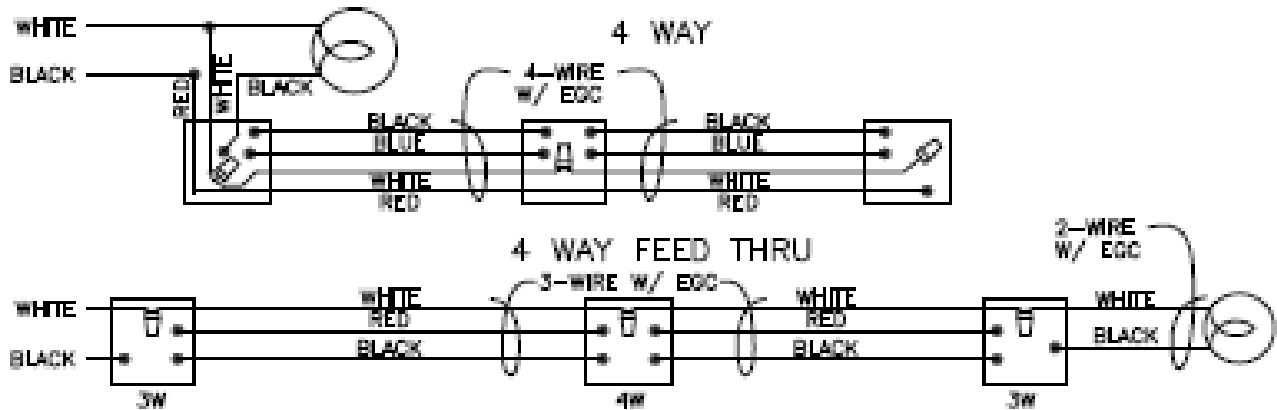
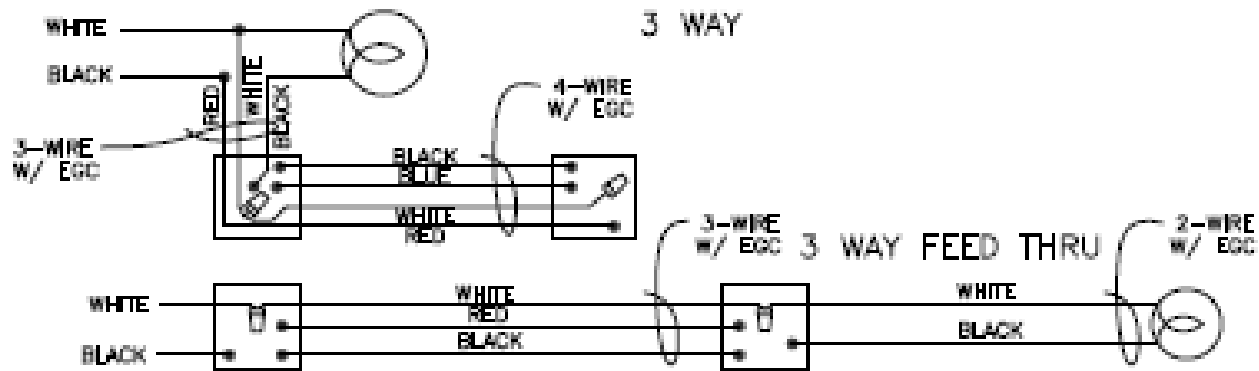
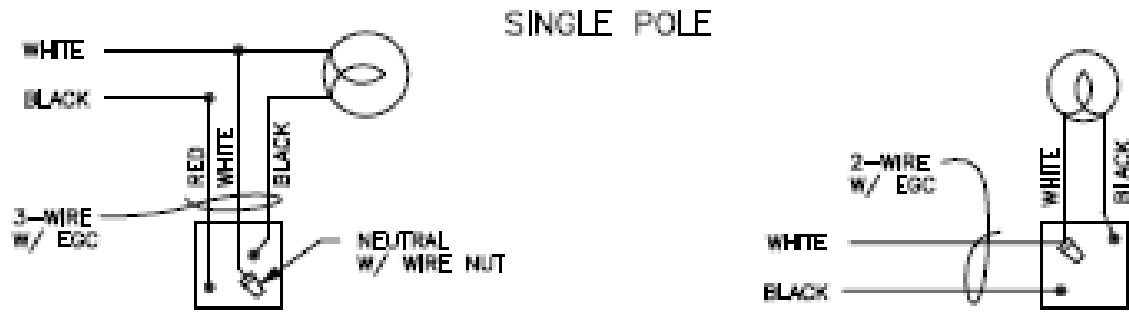
Diagram 6-E

SWITCH LOOPS

SINGLE POLE, 3 OR 4-WAY

EQUIPMENT GROUNDING CONDUCTORS (EGC) NOT SHOWN
(FOR WIRING CLARIFICATION ONLY)

WIRE NUT SYMBOL - 



NOTE:

EVERY LIGHT (FIXTURE) SWITCH SHALL HAVE A GROUND (NEUTRAL) CONDUCTOR AVAILABLE. A WHITE CONDUCTOR IS NOT PERMITTED TO BE USED TO SUPPLY CURRENT TO A FIXTURE (SUCH AS A "SWITCH LOOP"). THE GROUND (NEUTRAL) CONDUCTOR IN THIS DIAGRAM SHOWS A WIRE NUT CONNECTOR FOR FUTURE RETURN CURRENT REQUIREMENT AT THAT SWITCH LOCATION.

Diagram 6-F

LIGHTING FIXTURES IN CLOTHES CLOSETS

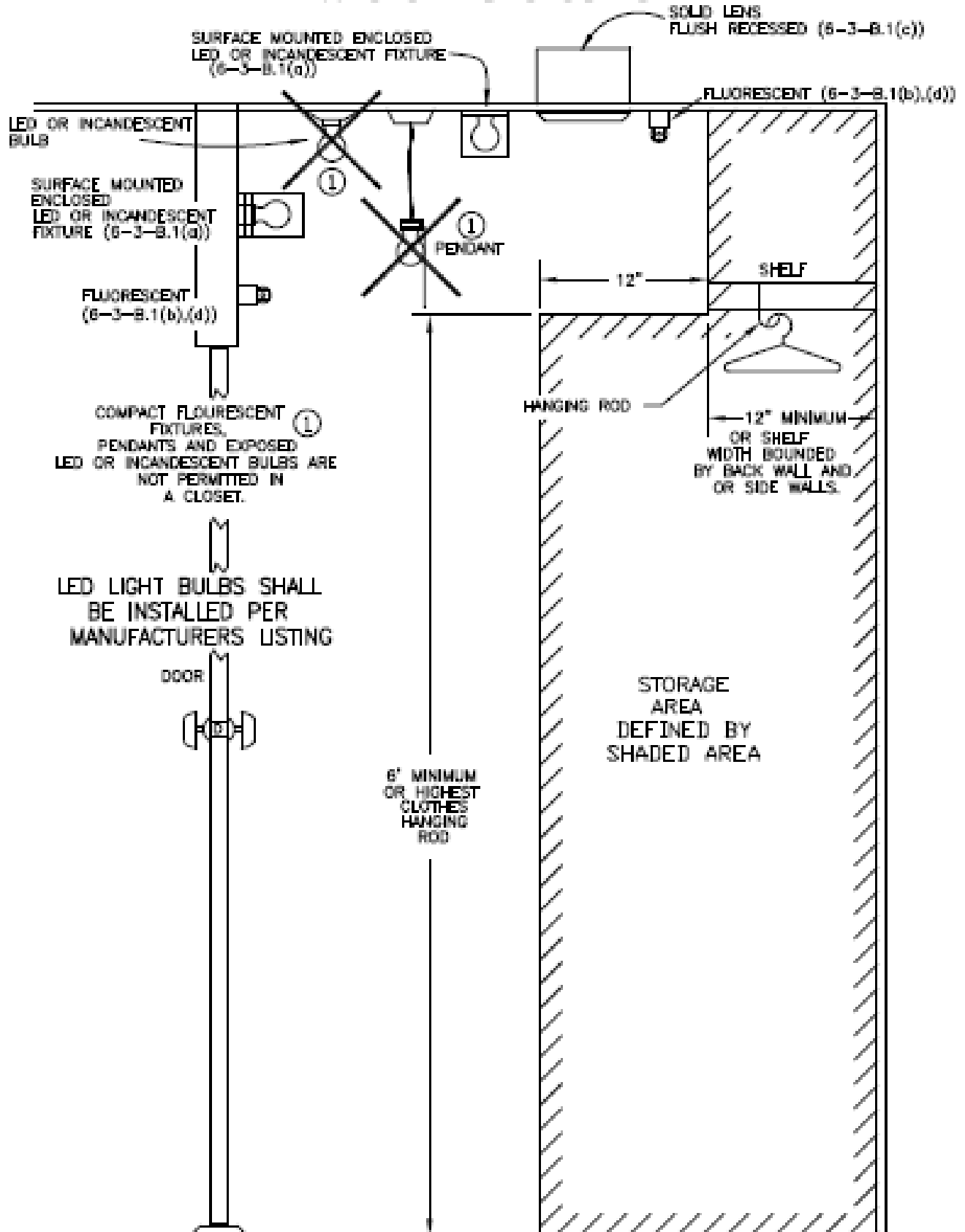
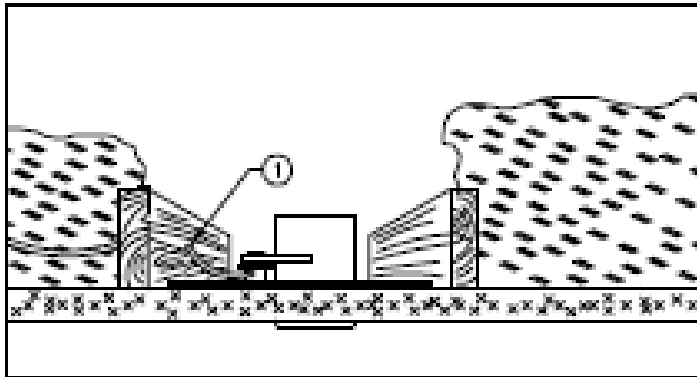


Diagram 6-G

RECESSED LIGHTS

INCANDESCENT FIXTURE CATEGORIES

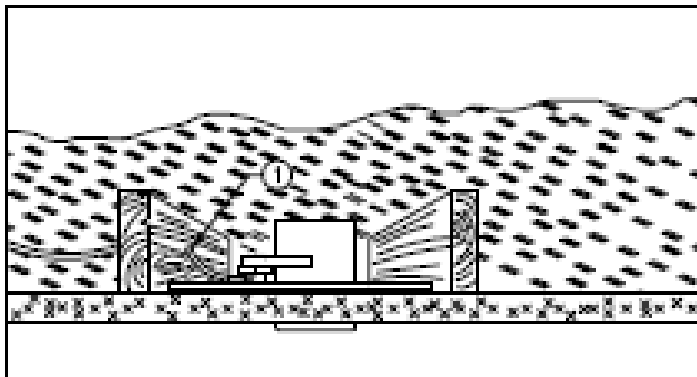
(SEE SECTION 7-13)



① HOLES BORED IN WOOD MEMBERS
(SEE SECTION 7-1)

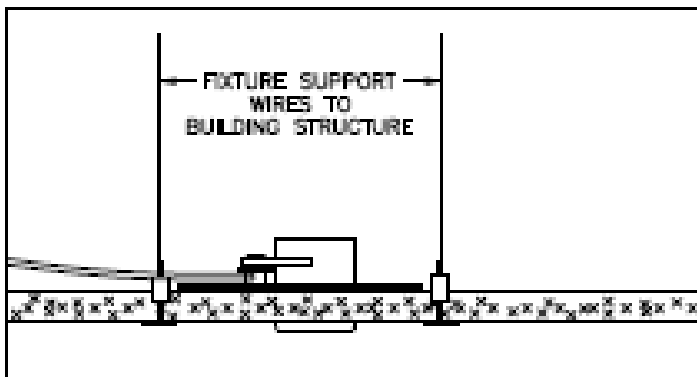
TYPE NON-I.C.

THIS FIXTURE SHALL BE INSTALLED
ACCORDING TO MANUFACTURER'S LISTING
AND LABELING.
(SEE SECTION 6-3-C)



TYPE I.C.

THIS FIXTURE SHALL BE INSTALLED
ACCORDING TO MANUFACTURER'S LISTING
AND LABELING.
(SEE SECTION 6-3-C)



SUSPENDED CEILINGS ONLY

SUITABLE FOR USE IN A SUSPENDED T-BAR
GRID WITH LAY-IN PANELS THAT ARE NOT
A PART OF THE BUILDING'S STRUCTURAL
ELEMENTS.
FIXTURE SUPPORT WIRES ARE REQUIRED AND
DEDICATED AND SHALL BE LABELED AS
FIXTURE SUPPORT WIRES.

Diagram 6-H

7. INSTALLATION PROCEDURES

(NEC Article 300)

- 7-1 **GENERAL:** Nonmetallic-sheathed cable (Type NM-B) is acceptable for residential wiring. All wiring shall be spliced or terminated in approved type boxes. Wiring shall enter boxes through approved type raceways or connectors or clamps and shall be securely fastened in, or near, the box. There shall be at least 6 inches of free wire, and at least 1/4-inch of the sheath inside the box in order that future connections or repairs may be made.

Holes bored in joists, rafters, or wood members shall be bored so that edge of hole is not less than 1-1/4 inches from the nearest edge of wood member. In unfinished basements and crawl spaces, cables smaller than no. 6 AWG shall be bored through joists. Where this distance cannot be maintained, a metal plate or bushing of at least 1/16-inch thickness shall be used. In metal members, bushings or grommets fastened in the holes prior to cable installation shall protect the cable from metal edges.

The grounded neutral conductor shall be made up solid to the point of application. All lighting and receptacle outlets shall be polarized. (The grounded neutral conductor (white) shall be connected to the nickel or chrome screw of receptacle and lighting outlets.)

7-2 **OUTLET AND JUNCTION BOXES:**

- A. **ROUND BOXES** shall not be used where conduit or connectors requiring the use of locknuts or bushings are to be connected to the side of the box.
- B. **NONMETALLIC BOXES** approved for the purpose may be used with nonmetallic-sheathed cable. Nonmetallic cable shall be secured within 12 inches of the box, and secured with cable clamps in all nonmetallic boxes, except wall mounted boxes 2-1/4 inches x 4 inches or smaller. **Metal boxes shall be bonded.** (See Diagram 4-D.)
- C. **SIZE BOX AND NUMBER OF CONDUCTORS ALLOWED:** Boxes shall be of sufficient size to provide free space for all conductors enclosed in the box. For the maximum number of conductors, not counting fixture wires, permitted in outlet and junction boxes see Section 8-1.
- D. **SUPPORT:** Metallic boxes shall be supported from a structural member of the building. Nails passing through the interior of the box shall stay within 1/4-inch of the back, sides or top of the box. Nonmetallic boxes shall have mounting means or provisions for support from outside the box, or the box shall be constructed to prevent contact between the conductors in the box and supporting screws.
- E. **CEILING FANS:** Outlet boxes shall not be used as the only support for paddle fans. Only listed ceiling-suspended fan box used as sole support must be listed by manufacturer for the purpose and marked with the maximum weight and clearance as labeled.
- F. **BOXES IN WALLS/CEILINGS:** Drywall, plaster, and plasterboard shall not have any spaces/gaps greater than 1/8-inch around an outlet box or cabinet using flush-type covers. And, the front edge of the box or cabinet, plaster ring or extension ring, shall not be set back more than 1/4-inch from the wall or ceiling surface.

NOTE: All ceiling boxes shall be ceiling fan rated.

INSTALLATION PROCEDURES (continued)

7-3 CONDUCTORS:

- A. **CONDUCTORS** normally used to carry current shall be of copper unless otherwise provided in this guide. Where conductor sizes are given in this guide, they shall apply to copper conductors. If other materials are used, the size shall be changed accordingly. Only one cable assembly is permitted in each cable connector or clamp, unless listed for multiple cables.
- B. **CONDUCTORS OF THE SAME CIRCUIT** shall be contained within a single cable, raceway and/or trench, including the grounded conductor and equipment grounding conductor.
- C. **COLOR-CODING:** (typical single family dwelling cable permitted; i.e. NM-B12-2 with ground.)
 - Ungrounded (load) conductor-black insulated
 - Grounded (neutral) conductor-white insulated
 - Equipment grounding conductor (EGC)-bare uninsulated

7-4 ELECTRICAL CONNECTIONS:

- A. **SPLICES:** Conductors shall be spliced using an approved splicing device or joined as to be mechanically and electrically secure without solder. Unless spliced, conductors shall then be soldered with a fusible metal alloy, brazed or welded. All splices, joints and the free ends of conductors shall be covered with an insulation equal to that on the conductors. Splices shall be made only in approved outlets or junction boxes with covers.
- B. **TERMINALS:** Terminals suited for the installation of more than one conductor and terminals for use with aluminum wire shall be so identified. (Observe manufacturer's recommendations for terminal-connector capacity and torque requirements.)

NOTE: Outdoor terminations shall be approved for applications (including landscape lighting).

- C. **INTERSYSTEM BONDING TERMINALS:** This set of terminals shall be external to enclosures and accessible for connecting other systems. This set of terminals (4 position minimum) shall be listed for this purpose, and securely mounted at the meter enclosure, service equipment enclosure, or on the grounding electrode conductor. The connections to this terminal bar must provide a bonding point for other systems at the electrical system grounded point. (See Definition 2-51)
- D. **CORROSION INHIBITOR:** Inhibitors approved for electrical application must be used on all aluminum connections.
- E. **DISSIMILAR METALS:** Conductors of dissimilar metals shall not be inter-mixed in a terminal or splicing connector unless the device is approved for the purpose and conditions of use.
- F. **FLEXIBLE FINE STRANDED CABLE:** See NEC , Chapter 9, Table 10.

7-5 **PROVISIONS FOR FUTURE:** It is recommended, as a good design practice, that a means be provided for future circuits. Two spare circuits should be provided in the main distribution panel-board.

7-6 **BALANCING LOAD:** Arrange the connected loads so that when operating they will attempt to balance across the panelboard.

INSTALLATION PROCEDURES (continued)

7-7 USES PERMITTED OR NOT PERMITTED FOR NM, NMC, NMS OR UF CABLE:

NOTE: Cable identified by the markings NM-B, NMC-B, NMS-B meets the requirements of types NM, NMC, and NMS.

- A. **Type NM and Type NMC or UF Cables** shall be permitted to be used in one or two family dwellings and accessory buildings. (See Table 8-C for ampacity rating.)

Type NM cable (nonmetallic sheathed cable) shall be permitted to be installed for both exposed and concealed work in normally dry locations. It shall be permissible to install or fish type NM cable in air void, in masonry block or tile walls where such walls are above grade and are not exposed or subject to excessive moisture or dampness.

NOTE: NM cable shall be guarded when exposed in living or working space.

Type NM cable shall NOT:

- Be installed where exposed to corrosive fumes or vapors.
- Be embedded in masonry, concrete fill, plaster or similar finish.
- Be subject to physical damage.
- Be used above suspended ceilings, except in residential applications.

- B. **Type NMC or UF cable** shall be permitted for both exposed or concealed work in dry, moist, damp, or corrosive locations, and in outside and inside walls of masonry block or tile, but shall not be subject to physical damage.

NOTE: If UF cable is substituted for NM cable, then the UF cable conductor insulation must be rated 90°C.

- C. **Type NM and NMC cable** cannot be used in ducts or plenums, or spaces designed for environmental air.

EXCEPTION: This does not include joist or stud spaces in dwelling units where cable passes through such spaces perpendicular to long dimension of such spaces.

- 7-8 **CIRCUIT IDENTIFICATION:** Each branch circuit shall be identified on the service entrance panel cover.

- 7-9 **CABLE CLAMPS AND CONNECTORS:** Cables entering any switch box, panel, junction box, or other enclosure shall be secured by an approved box clamp or cable connector except where a single-gang nonmetallic wall box up to 2 1/4 inches x 4 inches is used. In this case the cable shall be stapled within 8 inches of the outlet box. Only one cable assembly is permitted in each cable connector or clamp, unless listed for multiple cables.

- 7-10 **CABLE SUPPORTS:** Cable shall be supported by approved straps or staples on or above ceiling at intervals not exceeding 4 1/2 feet and within 12 inches of any box or panel. Where run across the top of ceiling joists, across the face of rafters or studding, in attics and roof spaces which are accessible. The cable shall be protected by substantial guard strips which are at least as high as the cable, protection shall only be required within 7 feet of the nearest edge of the scuttle hole or attic entrance.

INSTALLATION PROCEDURES (continued)

- 7-11 **UNUSED OPENINGS:** Where knockouts have been removed from switch box, panel, junction box, meter base or other enclosure and/or openings which are not in use, openings shall be covered with approved type knockout closures.
- 7-12 **BENDING RADIUS:** The radius (bend) shall not be less than 5 times the diameter of the cable.
- 7-13 **INSTALLATION AND USE:** Listed or labeled equipment shall be used or installed in accordance with all instructions included in the listing or labeling.
- 7-14 **WORK SPACE:** Maintain working clearance of 36 inches in front of electrical equipment. Work-space must not be less than 30 inches wide with headspace of 6 1/2 feet. Panelboard doors must be able to be opened at least 90 degrees.

8. SIZING BOXES, CONDUITS, CONDUCTORS AND CIRCUITS

(NEC Chapter 9, Articles 310 and 314)

8-1 BOX FILL:

A. DEPTH OF BOXES:

1. **OUTLET BOXES WITHOUT ENCLOSED DEVICES OR UTILIZATION EQUIPMENT:** No box shall have an internal depth of less than 12.7 mm (1/2 inch).
2. **Larger Equipment:** Boxes that enclose utilization equipment that projects more than 48 mm (1-1/2 inches) rearward from the mounting plane of the box shall have a depth that is not less than the depth of the equipment plus 6 mm (1/4 in.).
3. **Boxes at Luminaire Outlets (See Definition 2-55):** Boxes used at luminaire or lampholder outlets in a ceiling shall be designed for the purpose and shall be required to support a luminaire weighing a minimum of 23 kg (50 lbs.). Boxes used at luminaire or lamp holder outlets in a wall shall be designed for the purpose and shall be marked on the interior of the box to indicate the maximum weight of the luminaire that is permitted to be supported by the box in the wall if other than 23 kg (50 lb.). At every outlet used exclusively for lighting, the box shall be designed or installed so that a luminaire may be attached.
4. **Utilization Equipment:** Boxes used for the support of utilization equipment other than ceiling-suspended (paddle) fan shall meet the listed requirements for the support of a luminaire.
5. **Utilization equipment weighing not more than 3 kg (6 lbs.):** are permitted to be secured to boxes or plaster rings with not fewer than two No. 6 machine screws.

PROCEDURE FOR DETERMINING CONDUCTOR COUNT: Each current-carrying (insulated) conductor within the box shall be counted as one conductor.

- B.** Fixture studs, cable clamps and hickey within the box shall be counted as one conductor for each type of device. Each wiring device and mounting strap (or yoke) installed shall be counted as two conductors.

All equipment grounding conductors within the box shall be counted as one conductor. Additional insulated equipment grounding conductors required to reduce electro-magnetic interference will add additional volume requirements.

Each fixture wire shall be counted as one conductor.

- C. CONDUCTORS OF SAME SIZE:** Determine number of conductors as shown in Table 8-B.

SIZING BOXES, CONDUITS, CONDUCTORS AND CIRCUITS (continued)

8-2 CONDUIT (RACEWAY):

A. **CONDUITS** are installed to provide an enclosed raceway with listed conduit, couplings and fittings of a circular cross section to protect electrical conductors or cables. Additional functions of raceways include ease of maintenance of the electrical circuit(s). Some typical conduit types: (See Section 2-68)

- Rigid metal conduit (RMC), (not water pipe)
- Intermediate metal conduit (IMC)
- Rigid non-metallic conduit (RNC)
- Electric metallic tubing (EMT)

NOTE: UG conduit color is GRAY.

B. **CONDUCTORS OF THE SAME SIZE:** Determine number of conductors as shown in Table 8-E and Table 8-F.

C. **COMBINATIONS OF CONDUCTOR SIZES:** Determine number of conductors by calculating the percent of conduit fill as outlined in Chapter 9 of the National Electrical Code.

8-3 CONDUCTOR AMPACITIES:

A. **GENERAL:** Determine allowable conductor ampacities as shown in Table 8-C.

B. **THREE-WIRE, SINGLE-PHASE DWELLING SERVICES:** In dwelling units, conductors, as listed in Table 3, shall be permitted to be utilized as service entrance conductors and feeders that carry the total current supplied by that service.

The grounded neutral conductor shall be of such ampacity to be able to carry the maximum unbalanced load between the neutral ungrounded conductor, or the neutral conductor shall be at least 70% of the ampacity of any ungrounded conductor.

8-4 DERATING CIRCUITS BY CONDITION OF USE:

A. **DERATING FOR NUMBER OF CONDUCTORS:** Where the number of conductors in a raceway or cable exceeds three, the ampacity of each conductor shall be reduced as shown in Table 8-D.

Where single conductors or multi-conductor cables are stacked or bundled longer than 24 inches without maintaining spacing and are not installed in a raceway, the ampacity of each conductor shall be reduced as shown in Table 8-D.

A grounding conductor shall not be counted when applying Table 8-D.

B. **OVERCURRENT PROTECTION:** In any case where the conductor ampacities have been reduced, overcurrent protection for that circuit must be based upon or provided at the reduced ampacity.

SIZING BOXES, CONDUITS, CONDUCTORS AND CIRCUITS (continued)

Example of Box Sizing Procedures:			
How many cubic inches (minimum) shall these two boxes have?			
Example #1		Example #2	
Metal wall box with 12-2 AWGNM cables, a device, and cable clamps		Nonmetallic ceiling box with two 12 –2 AWG NM switch loop, fixture wire, and cable clamps	
	CU. IN.		CU. IN.
12-2 NM incoming	$2.25 \times 2 = 4.50$	12-2 NM incoming	$2.25 \times 2 = 4.50$
12-2 NM outgoing	$2.25 \times 2 = 4.50$	12-2 NM outgoing	$2.25 \times 2 = 4.50$
Grounding conductors (All)	$2.25 \times 1 = 2.25$	12-3 NM switch loop	$2.25 \times \underline{3} = \underline{6.75}$
Device (Note 1)	$2.25 \times 2 = 4.50$	Grounding conductors (All)	$2.25 \times 1 = 2.25$
Cable clamps	<u>$2.25 \times 1 = 2.25$</u>	2-16 Fixture wires	$1.75 \times 2 = 3.50$
Minimum box size	18.00 cu. in.	Cable clamps (Note 2)	<u>$2.25 \times 1 = 2.25$</u>
		Minimum box size	23.75 cu. in.
<p>Note 1: The cubic inch volume of a device shall be based on the largest conductor entering the box. Note 2: Cable clamps are not required in non-metallic wall boxes 2 1/2 - x 4" or smaller. (See section 7-9.)</p>			

Table 8-A Volume Required Per conductor	
Size of Conductor	Free Space Within Box for Each Conductor
No. 18	1.50 cubic inches
No. 16	1.75 cubic inches
No. 14	2.00 cubic inches
No. 12	2.25 cubic inches
No. 10	2.50 cubic inches
No. 8	3.00 cubic inches
No. 6	5.00 cubic inches

TABLE 8-B
Metal Boxes

4 x 1 1/4 Round or Octagonal	12.5	8	7	6	5	5	5	2
4 x 1 1/2 Round or Octagonal	15.5	10	8	7	6	6	5	3
4 x 2 1/8 Round or Octagonal	21.5	14	12	10	9	8	7	4
4 x 1 1/4 Square	18.0	12	10	9	8	7	6	3
4 x 1 1/2 Square	21.0	14	12	10	9	8	7	4
4 x 2 1/8 Square	30.3	20	17	15	13	12	10	6
4 11/16 x 1 1/4 Square	25.5	17	14	12	11	10	8	5
4 11/16 x 1 1/2 Square	29.5	19	16	14	13	11	9	5
4 11/16 x 2 1/8 Square	42.0	28	24	21	18	16	14	8
3 x 2 x 1 1/2 Device	7.5	5	4	3	3	3	2	1
3 x 2 x 2 Device	10.0	6	5	5	4	4	3	2
3 x 2 x 2 1/4 Device	10.5	7	6	5	4	4	3	2
3 x 2 x 2 1/2 Device	12.5	8	7	6	5	5	4	2
3 x 2 x 2 3/4 Device	14.0	9	8	7	6	5	4	2
3 x 2 x 3 1/2 Device	18.0	12	10	9	8	7	6	3
4 x 2 1/8 x 1 1/2 Device	10.3	6	5	5	4	4	3	2
4 x 2 1/8 x 1 7/8 Device	13.0	8	7	6	5	5	4	2
4 x 2 1/8 x 2 1/8 Device	14.5	9	8	7	6	5	4	2
3 3/4 x 2 x 2 1/2 Masonry Box/Gang	14.0	9	8	7	6	5	4	2
3 3/4 x 2 x 3 1/2 Masonry Box/Gang	21.0	14	12	10	9	8	7	2
FS--Minimum Internal Depth 1 3/4 Single Cover/Gang	13.5	9	7	6	6	5	4	2
FD--Minimum Internal Depth 2 3/8 Single Cover/Gang	18.0	12	10	9	8	7	6	3
FS--Minimum Internal Depth 1 3/4 Multiple Cover/Gang	18.0	12	10	9	8	7	6	3
FD--Minimum Internal Depth 2 3/8 Multiple Cover/Gang	24.0	16	13	12	10	9	8	4

Note: For combinations of conductor sizes shown in this table, the maximum number of conductors permitted in a box shall be computed using the volume per conductor listed in Table 8-A*.

*See Section 8-1A for Table 8-A.

TABLE 8-C Ampacities of Insulated Conductors

Rated 0-2000 Volts, 60° to 90°C (140° to 194°F)

Not More Than Three Conductors in Raceway or Cable or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Size	Temperature Rating of Conductor. See Table 310-13 of NEC.						Size
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
AWG Kcmil	TYPES TW†, UF†	TYPES RHW†, THHW†, THW†, THWN†, XHHW† USE†, ZW†	TYPES TBS, SA SIS, FEP†, FEPB†ML, RHH†, RHW- 2, THHN†, THHW† THW-2, THWN-2 USE-2, XHH XHHW†, XHHW-2†, ZW-2†	TYPES TW†, UF†	TYPES RHW†, THHW†, THW†, THWN†, XHHW†,	TYPES TBS,SA,SIS, THHN†,THHW† THW-2, THWN-2, RHH†,RHW-2, XHH, USE-2 XHHN†, XHHW†, XHHW-2†, ZW-2†	
	COPPER			ALUMINUM OR COPPER CLAD			
18	....	....	14	....	....	....	....
16	....	....	18	....	....	....	....
14	<u>15</u>	20†	25†	....	....	....	....
12	<u>20</u>	25†	30†	<u>15</u>	20†	25†	12
10	30	35†	40†	25	30†	35†	10
8	40	50	55	<u>35</u>	40	45	8
6	55	65	75	40	50	<u>55</u>	6
4	70	85	95	55	65	75	4
3	85	100	<u>115</u>	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	<u>145</u>	85	100	115	1
1/0	125	150	170	100	125	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	190	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	<u>350</u>	420	475	285	340	385	600
700	385	460	520	<u>315</u>	375	<u>425</u>	700
750	400	475	535	<u>320</u>	385	435	750

Note: The overcurrent protection for conductor types marked with an obelisk(†) shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper, or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

TABLE 8-D More Than Three Conductors in Conduit or Raceways

Number of Conductors	Percent of Ampacity Values in Table 8-C
4 thru 6	80
7 thru 9	70
10 thru 20	50
21 thru 30	45
31 thru 40	40
41 and above	35

**TABLE 8-E
Maximum Number of Conductors in Trade Sizes of Conduit or Tubing**

Conduit Trade Size Inches	Maximum Number of Conductors in Trade Sizes of Conduit or Tubing									
	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4
Type Letters	Conductor Size AWG, kcmil									
	14	24	39	69	94	154	164	160		
THWN, THHN, FEP (14 through 2), FEPB (14 through 8), PFA (14 through 4/0), PFAH (14 through 4/0), Z (14 through 4/0), XHHW (4 through 500 kcmil)	13	18	29	51	70	114	104	79		136
	10	11	18	32	44	73	51			
	6	5	9	16	22	36				
	3									
	1									
	6	4	6	11	15	26	37	57	76	98
	4	2	4	7	9	16	22	35	47	60
	3	1	3	6	8	13	19	29	39	51
	2	1	3	5	7	11	16	25	33	43
	1	1	1	3	5	8	12	18	25	32
XHHW	1/0	1	1	3	4	7	10	15	21	27
	2/0	1	1	2	3	6	8	13	17	22
	3/0	1	1	1	3	5	7	11	14	18
	4/0	1	1	1	1	4	6	9	12	15
250			1	1	1	3	4	7	10	12
			1	1	1	3	4	6	8	11
			1	1	1	2	3	5	7	9
			1	1	1	1	3	5	6	8
500				1	1	1	2	4	5	7
				1	1	1	1	3	4	5
				1	1	1	1	3	4	5
				1	1	1	1	2	3	4
600	1	3	5	9	13	21	30	47	63	81
				1	1	1	1	3	4	5
				1	1	1	1	3	4	5

NOTE: The maximum number of conductors may vary depending upon the type of conduit.

TABLE 8-F
Maximum Number of Conductors in Trade Sizes of Conduit or Tubing

Conduit Trade Size Inches		1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4
Type Letters	Conductor Size AWG, kcmil										
TW, XHHW (14 thru 8), RH (14 thru 12)	14	9	15	25	44	60	99	142	171	176	
	12	7	12	19	35	47	78	111	131		
	10	5	9	15	26	36	60	85	62		108
	8	2	4	7	12	17	28	40	49		
RH (10 thru 8), RHW and RHH (without outer covering), THW, THHW	14	6	10	16	29	40	65	93	143	192	
	12	4	8	13	24	32	53	76	117	157	
	10	4	6	11	19	26	43	61	95	127	163
	8	1	3	5	10	13	22	32	49	66	85
TW,	6	1	2	4	7	10	16	23	36	48	62
	4	1	1	3	5	7	12	17	27	36	47
THW, THHW,	3	1	1	2	4	6	10	15	23	31	40
	2	1	1	2	4	5	9	13	20	27	34
	1	1	1	1	3	4	6	9	14	19	25
FEPB (6 thru 2), RH, RHW and RHH (without outer covering)	1/0		1	1	2	3	5	8	12	16	21
	2/0		1	1	1	3	5	7	10	14	18
	3/0		1	1	1	2	4	6	9	12	15
	4/0		1	1	1	1	3	5	7	10	13
250 300 350 400 500				1	1	1	2	4	6	8	10
				1	1	1	2	3	5	7	9
				1	1	1	1	3	4	6	8
				1	1	1	1	2	4	5	7
				1	1	1	1	1	3	4	6
600 700 750							1	1	3	4	5
							1	1	2	3	4
							1	1	2	3	4

NOTE: The maximum number of conductors may vary depending upon the type of conduit.

9. RANGE WIRING

(NEC Articles 220 and 422)

9-1 INSTALLATION:

- A. **RANGE RECEPTACLE** shall be installed for all household electric range installations. The minimum size conductors shall be 4-wire, No. 6 THWN copper or equivalent cable, unless calculations indicate another size may be used.
- B. **RANGE CIRCUIT** shall have proper overcurrent protection and shall not exceed rating of the receptacle (50 ampere).
- C. **COMPONENTS OF RANGES**, such as counter-mounted cooking units and wall-mounted ovens designed to be installed separately in counter top or walls, are considered as individual units and shall be supplied from individual branch circuits. Such individual branch circuits shall be of sufficient size and capacity to carry full nameplate rating of the component served. In no case shall the circuit be less than 4 No.10 copper conductors.

Each individual branch circuit to such components shall have an approved means of disconnect with proper overcurrent protection.

Each component shall be bonded properly. (If it is a 4-wire branch circuit, the equipment bonding jumper within the range shall be disconnected.)

- D. **BRANCH CIRCUIT SUPPLYING HOUSEHOLD ELECTRIC RANGES**, counter-mounted cooking units and wall-mounted ovens, the maximum unbalanced load shall be considered as 70% of the load on the unbalanced conductors.

The branch circuit neutral capacity may be reduced accordingly.

9-2 **MICROWAVE OVENS:** Microwave ovens are considered small appliances. (See Section 6-2,C.) However, it is recommended that an individual branch circuit be installed.

NOTE: If installed above cooking surface, a microwave oven must be listed for that purpose and mounted according to manufacturer's instructions.

10. WATER HEATER WIRING

(NEC Article 422)

10-1 INSTALLATION:

- A. **CIRCUITS FOR ALL HEATERS** shall have a disconnect means other than the main service switch. A breaker or pullout device in the main panelboard may serve as the disconnecting means if it is within sight of the water heater or capable of being locked in the open position. If not, then an additional disconnect is required within sight of the water heater or capable of being locked in the open position. White or gray covered conductors used as phase conductors shall be identified at terminal ends. Permanent markers or tape may be used.
- B. **RESIDENTIAL WATER HEATERS** minimum conductor size shall be 2-wire, No.10 copper, or equivalent, with equipment grounding conductor. For tankless (or high wattage, quick recovery) water heaters, where interlocking is not required, larger conductor shall be used based on requirements of Table 8-C.

NOTE: Contact the serving utility before purchasing or installing a tankless water heater.

- C. **BONDING:** The tank of the water heater shall be effectively bonded.

11. CLOTHES DRYER WIRING

(NEC Articles 422, 220 and 250)

- 11-1 **INSTALLATION:** It is required that 30-amp dryer receptacles be installed on all dryer installations. The minimum size branch circuit shall be 4-wire, No. 10 copper conductor from panelboard to equipment. The dryer frame and outlet box shall be effectively bonded. (See Section 4-8.)

NOTE: If it is a 4-wire branch circuit, the equipment bonding jumper within the clothes dryer shall be disconnected.

12. FIXED MOTOR DRIVEN EQUIPMENT

(NEC Articles 430 and 440)

12-1 INSTALLATION:

- A. **ALL MOTORS OVER 1/8 HP, or 300 VA**, shall have a means of disconnect located near and in sight of the motor and controller.
- B. **ALL MOTORS OF 1/2 HP** and over should be wired for 240 volts for maximum operational efficiency.
- C. **WATER PUMPS** should be provided with electric lighting and heating.
- D. **HERMETICALLY SEALED COMPRESSOR MOTOR PROTECTION** shall meet the nameplate specifications.
- E. **CONDUCTORS SERVING TWO OR MORE MOTORS** shall have an ampacity of 125% of the largest motor plus the nameplate rating of the other motors.
- F. **All MOTORS** shall be protected thermally in the motor or the controller.

NOTE 1: This section applies to water pumps, central heat pumps or air conditioners, furnace blowers, etc.

NOTE 2: Contact the serving utility for their policy or restrictions when considering special application motors, large motors (5hp or more) or phase converters to assure the utility can provide adequate starting and running currents with existing infrastructure.

13. INDIVIDUAL ROOM HEATING AND COOLING

(NEC Articles 424 and 440)

13-1 **GENERAL:** Electric space heating equipment will not operate efficiently and economically unless equipment, devices and circuits are properly sized. Design recommendations should be secured from a qualified HVAC contractor prior to the installation of equipment.

13-2 **WIRE SIZE FOR RESISTANCE HEATING:** The minimum wire size to electric heating units shall be as follows: (1) 2-wire, No.12 copper wire with grounding conductor shall be used for units rated 3.3 kW and smaller; (2) 2-wire, No.10 copper wire with grounding conductor shall be used with units rated 3.4 kW to 4.9 kW and on all 240-volt portable heater outlets serving equipment rated at no more than 4.9 kW.

It is expected that all electrically heated buildings be properly insulated to minimize heat loss. Conductors such as nonmetallic-sheathed cable, when buried in insulating material, will not carry their full rated capacity; therefore, conductors buried in insulating material will be derated to 80% of rated capacity.

Wiring located above heated ceilings and within thermal insulation shall be spaced not less than 2 inches above the heated ceiling and shall be considered as operating at an ambient of 50°C.

13-3 **DISCONNECTING MEANS:**

- A. A MEANS SHALL BE PROVIDED and shall simultaneously disconnect the heater, motor controller, and supplementary protective devices for each fixed electric space heating equipment from all ungrounded conductors. Where heating equipment is supplied by multiple circuits, the disconnecting means shall be grouped and identified.
- B. A SWITCH OR CIRCUIT BREAKER that is the disconnecting means for fixed electric space heating equipment shall have an ampere rating not less than 125 percent of the total load of the heaters and any motors involved. The disconnecting means shall be located within sight of the equipment or capable of being locked in the open position.

13-4 **PORTABLE HEATER RECEPTACLES:** Receptacles used on portable heater circuits shall be at least 20-ampere capacity. Three-wire polarized receptacles shall be used and heaters shall be bonded.

INDIVIDUAL ROOM HEATING AND COOLING (continued)

13-5 CEILING CABLE AND PANELS:

INSTALLATION:

- A. **1,650 WATTS** is the maximum allowable on 125-volt circuits.
- B. **HEATING PANELS AND CABLES SHALL BE INSTALLED IN THE COMPLETE SIZES OR LENGTHS** as supplied by the manufacturer. Units which are shortened or from which the nameplate labels are missing shall not be installed. Units shall be suitable for use with approved wiring systems.
- C. **HEATING CABLES SHALL BE FURNISHED** complete with factory assembled, non-heating leads that are at least 7 feet in length. The leads shall consist of conductors and wiring approved for general use.
- D. **SPLICES WHERE THE NON-HEATING LEADS CONNECT** to the heat cable shall be located no further than 4 inches from the point where the leads enter the ceiling. Any excessive, non-heating lead shall hang free in the hollow wall space at the thermostat.
- E. **HEATING PANELS SHALL NOT EXTEND BEYOND THE ROOM** in which they originate. Cables shall not be installed in closets, over cabinets which extend to the ceiling, under/over walls or partitions which extend to the ceiling except that single runs of cable may pass over partitions where embedded. This requirement shall not prohibit where embedded. This requirement shall not prohibit low temperature heat sources in closets to control relative humidity.
- F. **HEATING PANELS AND CABLES SHALL BE SEPARATED:**
 - 1. At least 8 inches from lighting fixtures, outlets and junction boxes
 - 2. 6 inches from walls and cabinets
 - 3. 2 inches from ventilating and other such openings in room surface
 - 4. Sufficient area shall be provided to assure that no heating cables or panels will be covered by surface-mounted lighting units.
- G. **EMBEDDED CABLES MAY BE SPLICED** only where necessary and only by approved means. In no case shall the length of the heating cable be altered.
- H. **CABLES SHALL NOT BE INSTALLED IN WALLS.**
- I. **ADJACENT RUNS OF CABLE** not exceeding 2-3/4 watts per foot shall be installed not less than 1-1/2 inches on centers.

INDIVIDUAL ROOM HEATING AND COOLING (continued)

- J. **HEATING CABLES MAY BE APPLIED** only to gypsum board, plaster lath, and similar fire-resistant materials. With metal lath or other conducting surfaces, a coat of plaster (brown or scratch coat) shall be applied to completely cover the metal lath or conducting surface before the cable is attached.
- K. **THE ENTIRE CEILING SURFACE** shall have a finish of thermally non-insulated plaster, or other approved material, having a nominal thickness of 1/2 inch.
- L. **CABLES SHALL BE SECURED** at intervals not exceeding 16 inches by stapling, tape, plaster, or other approved means. Staples or metal fasteners which straddle the cable shall not be used with metal lath or other conducting surface.
- M. **IN DRY BOARD INSTALLATIONS**, the entire ceiling shall be covered with gypsum board not exceeding 1/2 inch in thickness. The void between the upper layer of gypsum board shall be filled with thermally conducting plaster or other approved material.
- N. **CABLES SHALL BE KEPT FREE** from contact with metal or conducting surfaces.
- O. **CAUTION SHALL BE USED** in attaching a surface layer of gypsum so that the nails or other fasteners do not pierce the heating cable.

13-6 **THERMOSTATS:**

- A. **SWITCHING DEVICES** consisting of combined thermostats and manually controlled switches which serve both as controllers and disconnecting means shall: (1) open, regardless of temperature, all ungrounded conductors when manually placed in the "off" position (double-pole thermostat); (2) be so designed that the circuit cannot be energized automatically after the device has been manually placed in the "off" position.
- B. **THERMOSTAT OR TIMER** shall control each permanently installed electric heater.

13-7 **BASEBOARD HEATERS** shall not be installed under receptacles.

NOTE: Permanently installed electric baseboard heaters equipped with factory installed receptacle outlets shall be permitted as the required outlet, as shall outlets for the wall space utilized by such permanently installed heaters. Such receptacle outlets shall not be connected to heater circuits.

INDIVIDUAL ROOM HEATING AND COOLING (continued)

13-8 **CONDUCTIVE HEATED FLOORS:** Ground-fault circuit interrupter protection shall be provided for electrically heated floors in bathrooms and hydro-massage bathtub locations.

13-9 **PROHIBITED AREAS:**

AREAS NOT SUITED FOR ELECTRIC SPACE HEATING: Space heating systems shall not be used in the following cases:

- A. **AREAS EXPOSED TO SEVERE MECHANICAL INJURY** unless adequately protected.
- B. **IN WET OR DAMP LOCATIONS** unless specially approved for the purpose.
- C. **IN HAZARDOUS AREAS** unless approved for the purpose and location used.
- D. **WITHIN 3 FEET OF** tub, shower, or similar location unless listed for such location.

14. CENTRAL HEATING AND AIR CONDITIONING

(NEC Article 440)

- 14-1 **GENERAL:** The following are specifications for centrally installed electric heating and air conditioning equipment, heat pumps, furnaces, duct or plenum heaters, air conditioner compressors, etc. Heat pumps with auxiliary heat should have at least one outdoor thermostat.
- 14-2 **LOCATION AND CLEARANCE:** Air handling units and heating equipment shall be installed within the heated space whenever possible. Filters, belts, blower equipment, electronic cleaning equipment, and humidifiers shall be readily accessible for service and maintenance, and have adequate clearance for service and replacement of the equipment. Furnaces and related equipment installed in damp or wet locations shall be approved for such locations and shall be constructed and installed so that water cannot enter or accumulate in wire ways, electrical components, or ductwork. A condensate drain line shall be installed on all central air conditioning units. A float switch should be provided to cut off the compressor in the event of a clogged condensate line.
- 14-3 **DISCONNECTING MEANS:**
- A. **A MEANS SHALL BE PROVIDED** to disconnect all fixed electric space heating equipment from all ungrounded conductors. Where heating equipment is supplied by multiple circuits, the disconnecting means shall be grouped and identified.
- B. **A SWITCH OR CIRCUIT BREAKER** that serves as the disconnecting means for an electric furnace and/or air conditioning unit(s) shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters. The electric disconnecting means for the central heating/cooling units shall be located within sight of the equipment to be disconnected or capable of being locked in the open position at the switch or circuit breaker used as the disconnecting means. The means of disconnecting shall be permitted to be installed on the heating/cooling equipment but shall NOT be located on panels that are designed to allow access for servicing the equipment or block the view of the equipment nameplate(s).
(See Diagram 14-A.)
- 14-4 **OVERCURRENT PROTECTION:** Electric space heating equipment (furnaces or duct heaters) employing resistance-type heating elements rated more than 48 amperes shall have the heating elements subdivided. Each subdivided load shall not exceed 48 amperes and shall be protected at not more than 60 amperes. These overcurrent protective devices shall be;
- A. **FACTORY-INSTALLED** within or on the heater enclosure or provided as a separate assembly by the heater manufacturer.

CENTRAL HEATING AND AIR CONDITIONING (continued)

B. **ACCESSIBLE** but need not be readily accessible.

C. **SUITABLE FOR BRANCH-CIRCUIT PROTECTION.**

NOTE: The main conductors supplying these overcurrent protective devices shall be considered branch-circuit conductors.

14-5 CIRCUIT CAPACITY:

A. **WIRING FOR FURNACES, DUCT, AND PLENUM HEATERS** shall comply with Table 14-A.

B. **125-VOLT RECEPTACLE OUTLET** should be installed in the immediate area of the central heating system to provide power for air cleaner, humidifier, condensate pump, etc.

NOTE: Receptacles used for servicing equipment in crawl spaces shall be GFCI protected (See Section 6-2, G.)

C. **WIRING FOR AIR CONDITIONING COMPRESSOR AND CONDENSING UNITS** shall comply with Table 14-B.

D. **HEAT PUMP AND AIR CONDITIONER COMPRESSORS** should be of the capacitor start-and-run type. Should voltage problems exist with regard to other type units and where adequate capacity has been provided by power supplier, the customer may be required to install a capacitor kit in order to reduce starting current at their own expense.

E. **THE LOCK ROTOR AMPERES (LRA)** designated on the nameplate of the air conditioner or heat pump shall not exceed the ampere rating of the main service equipment.

CENTRAL HEATING AND AIR CONDITIONING (continued)

<p align="center">TABLE 14-A Wiring Information for Furnaces</p>						
Maximum kW (KVA) of Heat (with blower)	Copper Wire 75°C Type THW, THWN, RH, RHW, (90°C Type MTW, RHH, XHHW, THHN)		Copper Wire Type NM NMC 60°C Cable		Minimum Size Grounding Conductor if run with Circuit Conductors	Minimum Size Grounding Conductor if run separate from Multi-circuit Conductors
	Size	Overcurrent Protection	Size	Overcurrent Protection		
5					10	
7 1/2	10	30	10	30		
10	8	50	6	40		
Multi-circuits:	6	65	6	55	10	
15						8
20						8
25						6

The cabinet or metal enclosure(s) of the above mentioned heating, equipment and its disconnect switches shall be bonded to the grounding conductor. (See table above for size.)

Furnaces, boilers, duct, or plenum heaters exceeding 20 kW (kva) should have a two-stage control system with the second stage of heat coming on only under adverse conditions.

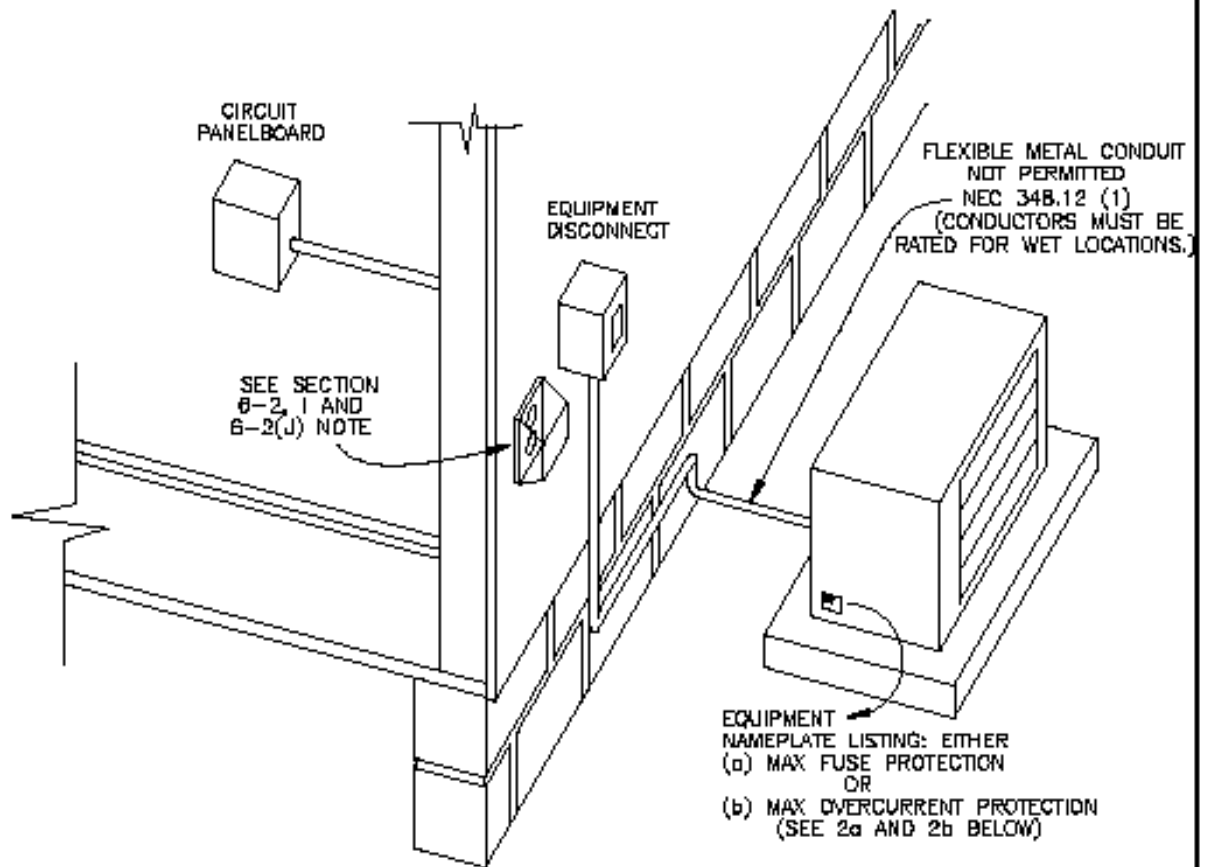
<p align="center">TABLE 14-B Wiring for Air Conditioners</p>		
Total Full Load Amperes	Wire Size	Conduit Size
15-16	12	1/2"
17-20	10	1/2"
21-24	10	1/2"
25-28	8	3/4"
29-32	8	3/4"
33-40	6	1"

TABLE 14-C SINGLE PHASE MOTORS AND CIRCUITS

Size of Motor (NEC Table 430-148)	Dual Element Fuse For Motor Running Overload Protection (NEC Table 430-32) (Also branch circuit protection)		Branch Circuit Protection Short Circuit Protection Only, fuses do not give motor running protection (NEC Table 430-52)				Minimum Size of Starter (NEMA)	†† Minimum Size of Copper Wire (AWG or MCM) a-TW (60°C) b-THW (75°C) c-THWN (75°C) d-THHN (90°C)	Min. Size of Trade Conduit for Copper Wire (inches)
	HP	Amp Rating	FUSETRON or LOW-PEAK FUSES (Amps)	Switch (115% min. or HP rated) or fuse holder size	†Time-delay Fuse FUSETRON or LOW-PEAK Dual-Element	†Non-time Delay Fuse			
		Motor rated not over 40°C or not less than 1.15 S.F.(Max. fuse 125%)	All Other motors (Max. fuse 115%)	Fuse Amps	Switch or Fuse-holder size	Fuse Amps	Switch or Fuse-holder size		
115 Volt †††									
1/6	4.4	5	5	8	30	15	30	0	1/2
1/4	5.8	7	6 1/4	10	30	20	30	0	1/2
1/3	7.2	9	8	12	30	25	30	0	1/2
1/2	9.8	12	10	15	30	30	30	0	1/2
3/4	13.8	15	15	20	30	45	60	0	1/2
1	16	20	17 1/2	25	30	50	60	0	1/2
1 1/2	20	25	25	30	30	60	60	1	1/2
2	24	30	30	35	30	80	100	1	1/2
230 Volt									
1/6	2.2	2 1/2	2 1/2	4	30	10	30	0	1/2
1/4	2.9	3 1/2	3 1/5	5	30	10	30	0	1/2
1/3	3.6	4 1/2	4	6 1/4	30	15	30	0	1/2
1/2	4.9	5 6/10	5 6/10	8	30	15	30	0	1/2
3/4	6.9	8	7 1/2	12	30	25	30	0	1/2
1	8	10	9	15	30	25	30	0	1/2
1 1/2	10	12	10	15	30	30	30	0	1/2
2	12	15	12	20	30	40	60	0	1/2
3	17	20	17 1/2	25	30	60	60	1	1/2
5	28	35	30	40	60	90	100	2	1/2
7 1/2	40	50	45	60	60	125	200	2	3/4
10	50	60	50	80	60	150	200	3	1/2(b-3/4) 1 3/4

† If manufacturer's overload relay table states a maximum branch circuit protective device of a lower rating, that lower maximum rating must be used in lieu of above recommendation (NEC Table 430-52).
 †† Conductor maximum operating temperature should equal controller termination temperature rating.
 ††† On 125 volts or less, Fustat Type S fuses or Fusetron dual-element plug fuses can be used in place of 0 to 14 ampere Fusetron dual-element cartridge fuses.

DISCONNECT LOCATION AND OVERCURRENT PROTECTION FOR CENTRAL AIR CONDITIONING EQUIPMENT



DISCONNECTING MEANS AND OVERCURRENT PROTECTION IS DEPENDENT UPON SEVERAL OPTIONS.

1. DISCONNECT LOCATION:
ALL SPACE HEATING AND OR AIRCONDITIONING EQUIPMENT SHALL HAVE A DISCONNECTING MEANS.
(SEE SECTION 14-3)
2. OVERLOAD PROTECTION:
 - (a) "MAXIMUM FUSE PROTECTION" LISTING REQUIRES PROPERLY SIZED AND COORDINATED TIME DELAY FUSES FOR OVERCURRENT PROTECTION. THESE FUSES CAN BE LOCATED IN THE CIRCUIT PANELBOARD, OR IN THE EQUIPMENT DISCONNECT.
 - (b) "MAXIMUM OVERCURRENT PROTECTION" LISTING REQUIRES PROPERLY SIZED AND COORDINATED TIME DELAY FUSE, OR INVERSE-TIME CIRCUIT BREAKER (HACR LISTED) THE TIME DELAY FUSE OR HACR CIRCUIT BREAKER CAN BE LOCATED IN EITHER THE CIRCUIT PANELBOARD OR IN THE EQUIPMENT DISCONNECT.

Diagram 14-A

15. MANUFACTURED AND MODULAR HOMES

(NEC Article 550)

15-1. **MANUFACTURED HOMES** :

A factory-assembled structure or structures, transportable in one or more sections, that is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation where connected to the required utilities; and the plumbing, heating, air-conditioning and electric systems are contained therein.

NOTE 1: The phrase “without a permanent foundation” indicates that the support system is constructed with the intent that the manufactured home placed thereon may be moved from time-to-time at the convenience of the owner.

NOTE 2: Manufactured homes are inspected for their intended purpose by the Federal Manufacturing Housing Construction and Safety Standards (commonly referred to as the HUD Code) at the manufacturers’ facilities. The new home will bear the HUD certification seal once approved. (See Definitions 2-59 and 2-60 and Diagram 15-F(A).)

HUD recognizes the Design Approved Primary Inspection Agency (DAPIA) as the authority to qualify manufactured homes which comply with the seven conditions of NEC 550-32(B) for electrical service equipment. (See Definition 2-59)

NOTE 3: KRS 227-550 thru 650 (Section 13) requires USED manufactured home or MANUFACTURED homes entering the state of Kentucky, and those which have been moved from original service location to a new service location to be certified as safe and habitable by the state of Kentucky Fire Marshall’s Office or certified HUD inspector and bear a Kentucky “B-1 Seal” (blue and silver in color). Also required is a C-1 sticker baring home location and setup provider’s certification (See Diagram 15-F (a) and Diagram 15-F(c)).

NOTE 4: MANUFACTURED HOMES CERTIFICATION SEALS:
(See Diagram 15-F)

15-2. **SERVICE EQUIPMENT** : The equipment containing the disconnecting means, over current protection devices and receptacles or other means for connecting a manufactured home feeder assembly.

The service equipment shall consist of, but not be limited to:

- A. **A STRUCTURE FOR TERMINATING SERVICE DROP** or underground lateral from utility.
- B. **SERVICE ENTRANCE CONDUCTORS AND CONDUIT.**
- C. **A METER BASE.**
- D. **WEATHERPROOF DISCONNECT SWITCH WITH OVERCURRENT PROTECTION**, dead front cover, and provisions for future load.
- E. **MANUFACTURED HOMES THAT PERMIT HOME SERVICE EQUIPMENT** to

MANUFACTURED AND MODULAR HOMES (continued)

- E. **MANUFACTURED HOMES THAT PERMIT HOME SERVICE EQUIPMENT** to be mounted on the manufactured home must meet all requirements of the manufacturer per 2008 UWG page 70.

15-3 FEEDER ASSEMBLY:

- A. **MANUFACTURED HOMES (DAPIA Qualified)** If this home is approved for the service equipment to be mounted on the home. The overhead or underground service can be extended to the home when all seven conditions of the NEC 550-32(B) are met. (See Diagram 15-E and Section 3.)
- B. **MANUFACTURED HOMES (Not DAPIA Qualified):** The home's four (4) conductor feeder, (or under-chassis feeder) conductors, including the equipment grounding conductor, fittings and equipment necessary to supply energy from the service equipment to the distribution panelboard within the manufactured home shall meet the requirements of Section 15-3(B) and Diagrams 15-A, -B, -C, and -D.

NOTE: Check with power supplier concerning local policy and service entrance requirements.

NOTE 1: POINT OF ATTACHMENT: A substantial pole sufficient to support the service equipment and the service drop wires shall be installed at the point of delivery for service connection at designated location. Point of attachment for the service drop shall be not less than 12 feet above sidewalks, lawns, walk ways, and not less than 18 feet above public roads and driveways. (See Section 16-1 A.3..)

Underground service lateral from power supplier shall terminate in an approved factory-assembled pedestal. (See Diagrams 15-C, D.)

NOTE 2: LOCATION: Manufactured home service equipment shall be located adjacent to the manufactured home and not mounted in or on the manufactured home.

Manufactured home service equipment shall be readily accessible and shall be located in sight of, and not more than 30 feet nor less than 3 1/2 feet from, the exterior wall of the manufactured home it serves.

NOTE 3: RATING: Manufactured home service equipment shall have a main disconnect and be rated at not less than 100 amperes and provisions shall be made for connecting a new manufactured home feeder assembly by a permanent wiring method.

NOTE 4: ADDITIONAL OUTSIDE ELECTRIC EQUIPMENT: Manufactured home service equipment shall contain a means for connecting an accessory building, structure or additional electrical equipment located outside the manufactured home.

MODULAR AND MANUFACTURED HOMES (continued)

NOTE 5: GFCI RECEPTACLES OUTSIDE OF MANUFACTURED HOME: Additional receptacles shall be permitted for connection of electrical equipment located outside the manufactured home. All such 125-volt, single-phase, 15 and 20-ampere receptacles shall be ground-fault circuit protected.

NOTE 6: MOUNTING HEIGHT: Outdoor manufactured home disconnecting means shall be installed so that the bottom of the enclosure is not less than 2 feet above finished grade. Also, the center of the grip of the operating handle, when in its highest position, shall not be more than 6 1/2 feet above finished grade.

- 15-4 **FEEDER CIRCUITS:** (For Manufactured Homes NOT DAPIA Approved) (See Diagrams 15 A, --B, -C, -D) Power supply to the manufactured home shall be a feeder assembly consisting of not more than one manufactured home power supply cord or permanently installed and adequately sized 4-conductor circuit.

NOTE: USE-2 type cable is only permitted if the cable is dual rated with a flame retardant insulation i.e. RHW.

- A. **POWER SUPPLY CORD:** Any power supply cord to a manufactured home shall be permanently attached to the distribution panel or junction box permanently attached to the distribution panel at one end. The free end must terminate in a plug cap.

Extension cords, pigtails, or adapters shall not be part of the cord.

The cord shall be a four-conductor listed cord. The grounding conductor shall be green or green with yellow stripes.

The plug cap shall be rated at 50 amperes and 125/250 volts and shall be 4-pole type.

The overall length of a power cord shall not be less than 21 feet and shall not exceed 36 1/2 feet.

- B. **PERMANENTLY INSTALLED FEEDER:** Shall contain four continuous, Insulated and color-coded conductors. One of which shall be identified by a green color. (See Diagram 15-B, C & D.)

NOTE: USE-2 type cable is only permitted if the cable is dual rated with a flame retardant insulation.

- C. **DISTRIBUTION PANELBOARD:** Inside manufactured home shall have a main disconnecting means and a proper overcurrent device. (See Diagram 15-C.)

NOTE: USE-2 type cable only permitted if the cable is dual rated with a flame retardant insulation i.e. RHW.

MODULAR AND MANUFACTURED HOMES (continued)

- D. **UNDER-CHASSIS WIRING:** Where exposed to moisture or physical damage, rigid metal conduit or intermediate metal conduit shall be used.

Electrical metallic tubing or rigid nonmetallic conduit (RNC) may be used when closely routed against frames and equipment enclosures. Listed devices shall be used for support of this conduit (conduit straps, beam clamps, etc.).

NOTE 1: Plumber's strapping, tie wires, tape, etc. shall not be used.

NOTE 2: Listed expansion fittings for RNC shall be provided for thermal expansion and stress relief of conduit in a straight-run between the secure mounting point of manufactured home panelboard and the point at which conduit enters the earth.

15-5 **GROUNDING/BONDING MANUFACTURED HOMES: (NOT DAPIA Qualified)**

- A. **EQUIPMENT GROUNDING CONDUCTOR (EGC):** Bonding of both electrical and non-electrical metal parts in a manufactured home shall be through connection to a grounding bus in the manufactured home distribution panelboard. The grounding bus shall be grounded through the green insulated conductor in the supply cord or the feeder wiring to the service grounded terminal in the service entrance equipment located adjacent to the manufactured home. Neither the frame of the manufactured home nor the frame of any appliance shall be connected to the grounded conductor in the manufactured home.
- B. **INSULATED GROUNDED NEUTRAL CONDUCTOR:**
1. The grounded circuit conductor (neutral) shall be insulated from the grounding conductors and from equipment enclosures and other bonded parts. The grounded (neutral) circuit terminals in the distribution panel ranges, clothes dryers, counter-mounted cooking units, or wall-mounted ovens shall be insulated from the equipment enclosure. **Neutral bonding screws, straps, or buses in the distribution panelboard or in appliances are to be removed and discarded.**
 2. Connection of ranges and clothes dryers shall be made with 4-conductors. Each component shall be bonded properly. (The equipment bonding jumper within the range or clothes dryer shall be disconnected.)
- C. **EQUIPMENT BONDING MEANS:**
1. In the electrical system, all exposed metal parts, enclosures, frames, lamp fixture canopies, etc., shall be effectively bonded to the grounding bus terminal or enclosure of the distribution panelboard.

MODULAR AND MANUFACTURED HOMES (continued)

2. Cord-connected appliances; such as clothes washers, dryers, refrigerators, and the electrical system of gas ranges, etc.; shall be grounded by means of an approved cord with equipment grounding conductor and grounding-type attachment plug.

D. BONDING OF NON-CURRENT-CARRYING METAL PARTS:

1. All exposed non-current-carrying metal parts that may become energized shall be effectively bonded to the grounding terminal or enclosure of the distribution panelboard. A bonding conductor shall be connected between each distribution panelboard and an accessible terminal on the chassis.
2. Grounding terminals shall be of the solderless type and approved as pressure-terminal connectors recognized for the wire size used. The bonding conductor may be solid or stranded, insulated or bare, and shall be a minimum No. 8 copper wire or equivalent. The bonding conductor shall be routed so as not to be exposed to physical damage. Protection can be afforded by the configuration of the chassis.
3. Metallic gas, water pipes and air circulating ducts are considered bonded if they are connected to an accessible terminal on the chassis by clamps, solderless connectors or by suitable bonding-type straps.

15-6

GROUNDING OF DAPIA QUALIFIED MANUFACTURED HOMES WITH SERVICE EQUIPMENT MOUNTED ON IT: Manufactured homes that permit the attachment of service equipment to the manufactured home must have grounding and bonding installed in compliance with NEC 250 and have written installation instructions from the manufacturer for compliance.

Refer to Sections 3 and 4 of this guide for grounding electrode requirements of a manufactured home with service equipment attached to it.

15-7

MODULAR HOME: A Kentucky Residential Code Qualified factory assembled structure, or structures, which is not a manufactured home. It can be transported in one or more sections that are built on a transportable chassis and designed to be used as a dwelling with a permanent foundation, acceptable to the Authority Having Jurisdiction where connected to the required utilities; including the plumbing, heating, air conditioning, and electric systems contained therein. (For service see Sections 3 & 4)

MANUFACTURED HOME SERVICE TERMINATION (NOT DAPIA QUALIFIED)

50 AMP PLUG-IN TYPE TO SERVICE POLE

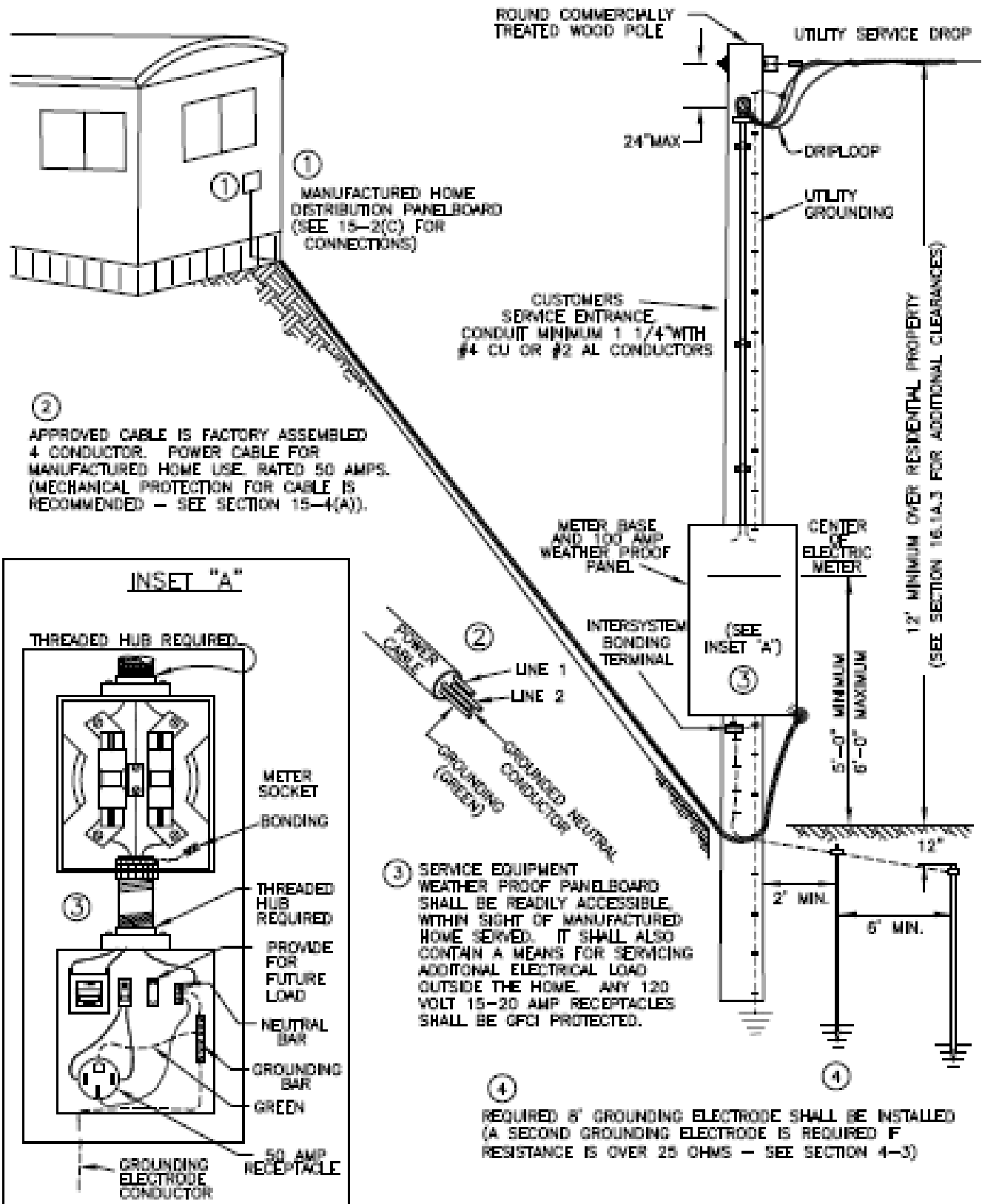
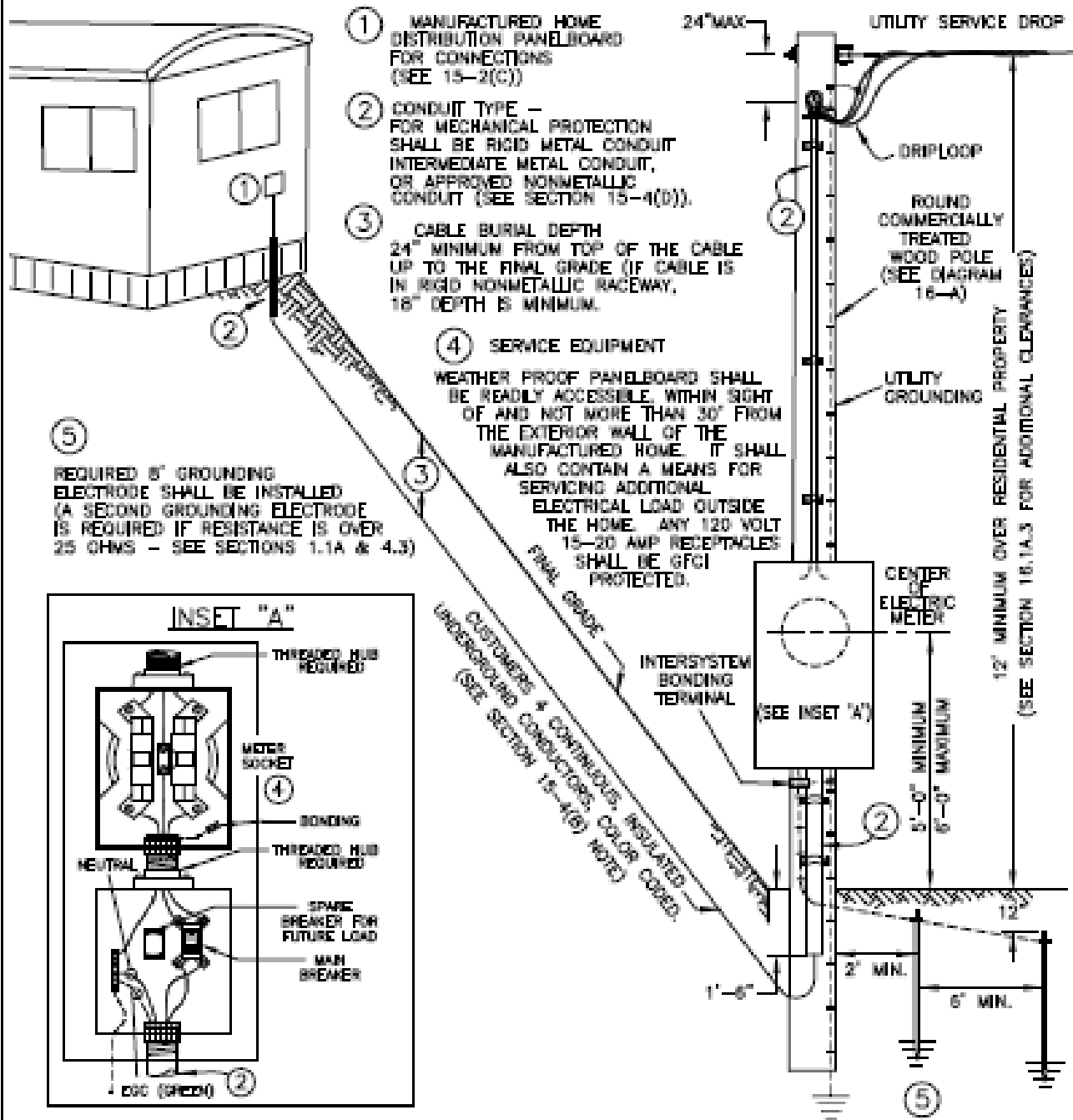


Diagram 15-A

MANUFACTURED HOME SERVICE TERMINATION (NOT DAPIA QUALIFIED)

DIRECT WIRE TYPE TO SERVICE POLE

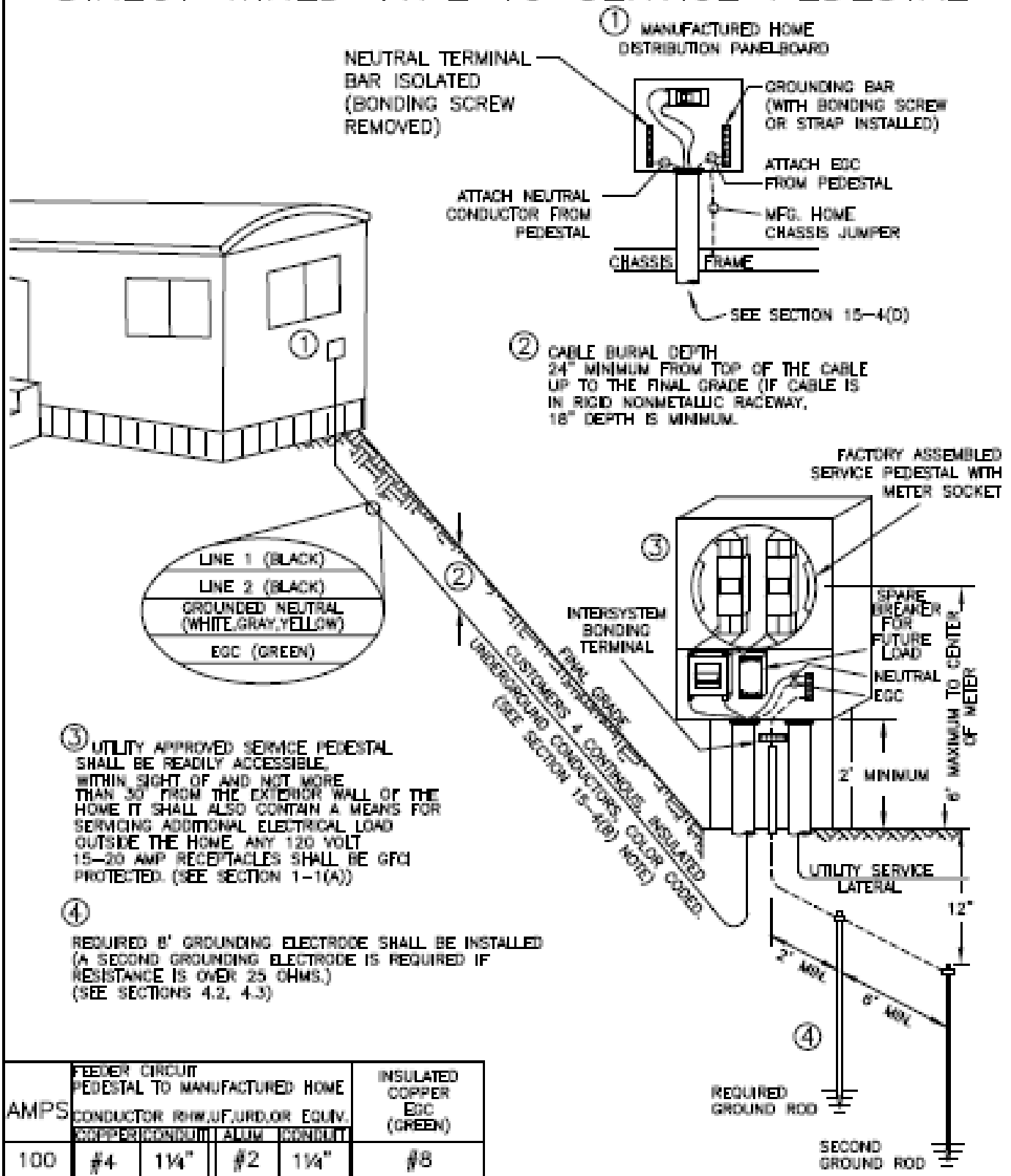


AMPS	SERVICE ENTRANCE WEATHERHEAD TO DISCONNECT CONDUCTOR THW OR EQUIV.			FEEDER CIRCUIT SERVICE POLE TO MANUFACTURED HOME CONDUCTOR RHW, UF, URD, OR EQUIV.				INSULATED COPPER EGC (GREEN)	
	COPPER CONDUIT	ALUM CONDUIT	CONDUIT	COPPER CONDUIT	ALUM CONDUIT	CONDUIT	CONDUIT		
100	#4	1 1/4"	#2	1 1/8"	#4	1 1/4"	#2	1 1/4"	#8
150	#1	1 1/4"	#20	1 1/2"	#1	1 1/2"	#20	1 1/2"	#6
200	#20	1 1/2"	#40	2"	#20	2"	#40	2"	#6

Diagram 15-B

MANUFACTURED HOME SERVICE TERMINATION (NOT DAPIA QUALIFIED)

DIRECT WIRED TYPE TO SERVICE PEDESTAL



AMPS	FEEDER CIRCUIT PEDESTAL TO MANUFACTURED HOME CONDUCTOR (NHW, UF, F, OR EQUIV.)				INSULATED COPPER EGC (GREEN)
	COPPER	ALUM.	CONDUIT	CONDUIT	
100	#4	1 1/4"	#2	1 1/4"	#8
150	#1	1 1/2"	#2/0	1 1/2"	#6
200	#2/0	2"	#4/0	2"	#6

Diagram 15-C

MANUFACTURED HOME (DAPIA QUALIFIED) SERVICE EQUIPMENT MOUNTED ON HOME

WARNING LABEL
(SEE NOTE G BELOW)

ELECTRIC SERVICE
EQUIPMENT
OVERHEAD OR
UNDERGROUND

3 CONDUCTOR
SERVICE SHOWN
FROM POWER PROVIDER
(SEE DIAGRAM 3-D)

GES
(SEE SECTION 4)

**MANUFACTURED HOMES
MEETING 'DAPIA' DESIGN CRITERIA
INCLUDING A PERMANENT FOUNDATION,
MAY QUALIFY FOR ELECTRIC SERVICE EQUIPMENT
TO BE MOUNTED ON THE HOME
(SEE SECTION 15.2(E))**

MANUFACTURED HOMES SERVICE EQUIPMENT SHALL BE PERMITTED TO BE INSTALLED ON THE MANUFACTURED HOME PROVIDED ALL OF THE FOLLOWING CONDITIONS, A THRU G ARE MET:

- (A) MANUFACTURER MUST PROVIDE WRITTEN INSTALLATION INSTRUCTIONS REQUIRING HOME BE SECURED TO A PERMANENT FOUNDATION, OR AN APPROVED ANCHORING SYSTEM.
- (B) SERVICE EQUIPMENT INSTALLATION MUST COMPLY WITH NEC ART 230.
- (C) THE GROUNDING ELECTRODE CONDUCTOR MUST BE ROUTED OUTSIDE THE HOME AND CONNECTION MAKE TO SERVICE EQUIPMENT.
- (D) THE SERVICE EQUIPMENT MUST COMPLY WITH NEC ART 250 GROUNDING AND BONDING.
- (E) THE MANUFACTURER SHALL PROVIDE IN ITS WRITTEN INSTRUCTIONS ON METHOD OF GROUNDING THE SERVICE EQUIPMENT AT THIS SITE, NEC ART 250.
- (F) MANUFACTURER MUST SPECIFY THE MINIMUM SIZE GROUNDING ELECTRODE CONDUCTOR.
- (G) A 'RED' WARNING LABEL SHALL BE MOUNTED ON OR NEXT TO THE SERVICE EQUIPMENT WITH THIS STATEMENT:

"REQUIRED"
LABEL

WARNING

DO NOT PROVIDE ELECTRICAL POWER UNTIL
THE GROUNDING ELECTRODE(S) IS INSTALLED
AND CONNECTED

(SEE INSTALLATION INSTRUCTIONS)

Diagram 15-E



NOTE: Kentucky General Assembly: See KRS 100.348 on manufactured home standards
-Mobile Home (KRS 219.320 and 227.550): Structures manufactured prior to June 15, 1976
-Manufactured Home (KRS 100.348): Single family dwelling manufactured after June 15, 1976

15-8 Kentucky has an inspection system to determine compliance with standards for human habitation and they are as follows:

NOTE: NEW Homes-HUD Code Seal=Certified new home
USED Homes-

- B1 Seal=Habitable, Certified inspection, meets HUD Code performance standards
- B2 Seal=Not Habitable, Certified inspection, **does not** meet HUD Code performance standards. Salvage only, legal for storage or utility use.

16. CUSTOMERS' OUTSIDE WIRING

(NEC Articles 225, 300 and 310)

16-1 OVERHEAD WIRING:

A. INSTALLATION:

1. **OUTSIDE WIRE BETWEEN BUILDINGS** shall be approved outdoor type of sufficient size to carry the connected load but no smaller than No. 10 copper. Span length is limited to 50 feet, unless messenger-supported multi-conductor cable is used.
2. **IN ADDITION** to the foregoing requirements for wire size, all wire shall be of sufficient size to carry the load in order that the voltage drop shall not be over 3 percent when the circuit connected is operating at 80 percent load factor. All outside wiring on member premises shall give proper clearance over driveways, roadways, walks, etc., as previously specified. To accommodate adverse weather conditions, additional clearance may be required.
3. **CONDUCTOR CLEARANCE FROM GROUND:** Open conductors of not over 600 volts, nominal, shall conform to the following:
 - A. **10 feet** above finished grade, sidewalks, or any platform or projection from which they may be reached where the supply conductors (including service drip loop) are limited to 150 volts to ground and accessible to pedestrians only.
 - B. **12 feet** over residential driveways and those commercial areas not subject to truck traffic where the voltage is limited to 300 volts to ground.
 - C. **15 feet** for those areas listed in the 12-foot classification where the voltage exceeds 300 volts to ground.
 - D. **18 feet** over public streets, alleys, roads, parking areas subject to truck traffic, driveways (located on other than residential property,) and other land traversed by vehicles for purposes such as cultivation, grazing, forestry and harvesting.
4. **OUTBUILDINGS WITH POWER** shall have a main disconnecting switch. (See Section 4.)

NOTE: For clearances of conductors of over 600 volts, see NATIONAL ELECTRICAL SAFETY CODE, ANSI C2-2007.

CUSTOMERS' OUTSIDE WIRING (continued)

5. **THE GROUNDING ELECTRODE CONDUCTOR** shall be guarded at least 4 feet up the wall and the wire shall be secured, up the wall, to the point of attachment. (See Diagram 4-B.)
6. **CONDUCTORS** supplying outbuildings shall be connected to approved brackets, insulators, or wire holders, which are substantially fastened to buildings. Service entrance conductors shall be connected to overhead feeders by approved connectors with a 12-inch drip loop on each conductor.

16-2 UNDERGROUND FEEDER AND BRANCH CIRCUIT CABLE:

A. UNDERGROUND FEEDER TYPE AND INSTALLATION:

1. **UNDERGROUND FEEDER AND BRANCH CIRCUIT CABLE SHOULD BE APPROVED** cable in sizes No. 14 to No. 4/0 copper wire inclusive. The conductors shall be Types RHW, UF, USE, or other conductors approved for the purpose. In addition to the insulated conductors, the cable may have an approved size of uninsulated, or bare, grounding conductor. The overall covering shall be flame-retardant, moisture-resistant, fungus-resistant, corrosive-resistant and suitable for direct burial in the earth.
2. **THE CABLE SHALL CARRY DISTINCTIVE MARKERS** on exterior for its entire length, specifying cable type and the name of manufacturing company.
3. **UNDERGROUND FEEDER AND BRANCH CIRCUIT CABLE:** Installations of underground feeder and branch circuit cable (Type UF) shall comply with other applicable versions of this guide. (See NEC 300.)
4. **A MINIMUM BURIAL DEPTH:** A minimum depth of 24 inches shall be maintained for direct buried conductors and cables. This direct burial depth may be reduced to 18 inches, if conductors are in rigid or intermediate metal conduit raceway. The burial depth can be reduced to 6-inches earth cover providing a permanent supplemental, protective covering (i.e. such as a 2 inch concrete covering that extends over the conductors for the full length of circuit with less than 24 inch earth cover.).

EXCEPTION: Residential branch circuits rated 125 volts or less, with GFCI protection and maximum overcurrent protection of 20-amperes, can be reduced to 12 inches minimum depth.

5. **WHERE SINGLE CONDUCTOR CABLES ARE INSTALLED,** all cables of the feeder circuit, subfeeder circuit or branch circuit; including the grounded neutral conductor if any; shall be run together in the same trench or raceway.

NOTE: See Section 3-5 regarding location of warning ribbon in trench.

CUSTOMERS' OUTSIDE WIRING (continued)

TABLE 16-B

Minimum Cover Requirements, 0 to 600 Volts, Nominal	
(Cover is defined as the distance between the top surface of direct buried cable, conduit, or other raceways and the finished grade.)	
Wiring Method	Minimum Burial (inches)
Direct Burial Cables	24
Rigid Metal Conduit	6
Intermediate Metal Conduit	6
Rigid Nonmetallic Conduit Approved for Direct Burial without concrete Encasement	18
Other approved Raceways	18
Residential Branch Circuits	
Rated 125 volts or less on 20-Amp Circuit (GFCI)	12
Low Voltage Circuits	
Rated 30 volts or less (UF Cable)	6

NOTE: UTILITY UNDERGROUND SERVICE LATERAL DEPTH SHALL BE DETERMINED BY LOCAL UTILITY'S POLICY.

6. **WHERE BURIED DIRECTLY IN THE EARTH**, supplementary mechanical protection such as a covering board, concrete pad, raceway, etc., when considered necessary, may be required by the Authority Having Jurisdiction.
7. **TYPE UF CABLE** may be used for interior wiring in wet, dry, or corrosive locations under the recognized wiring methods of this guide, and when installed as nonmetallic-sheathed cable, it shall be the multiple conductor type. This type of cable shall not be used: (1) as service entrance cable, (2) in commercial garages, (3) in theaters except as provided in Section 520-4, NEC (4) in motion picture studios, (5) in storage battery rooms, (6) in hoist ways, (7) in any hazardous location, and (8) embedded in poured cement, concrete, or aggregate.
8. **AMPACITY:** See Tables 8-C, 8-D, and 16-E.
9. **SERVICE ENTRANCE CABLES:** Service entrance cables shall be type USE, recognized for underground use and have a moisture resistant covering. Service entrance cables are not required to have a flame-retardant covering or inherent protection against mechanical abuse. Single conductor cables having rubber insulation specifically approved for the purpose do not require an outer covering.

NOTE: Sections 16-1 and 16-2 do not apply to service entrances with the exception of 16-2 (A)9.

TABLE 16-C - COPPER CONDUCTORS, 120 VOLTS, SINGLE PHASE, 3 PERCENT VOLTAGE DROP

		Minimum Allowable Size of Conductor																		
		In Cable, Conduit, Earth								Overhead in Air										
Load In Amps	Types UF	Types RH, RHW, THW THHN	Types RH, RHW, THW THHN	Covered Conductors	50	60	75	100	125	150	175	200	225	250	275	300	350	400	450	500
					Compare size shown below with size shown to left of double line. Use the larger size.															
5	14	14	14	10	14	14	14	14	14	12	12	12	10	10	10	10	8	8	8	8
7	14	14	14	10	14	14	12	12	12	12	10	10	8	8	8	8	8	6	6	6
10	14	14	14	10	14	12	12	10	10	10	8	8	8	8	6	6	6	6	6	4
15	14	14	14	10	12	12	10	8	8	8	8	6	6	6	6	4	4	4	4	3
20	12	12	12	10	10	10	8	8	8	6	6	6	6	4	4	4	4	3	2	2
25	10	10	10	10	10	8	8	6	6	6	6	4	4	4	4	3	3	2	2	1
30	10	10	10	10	10	8	6	6	6	4	4	4	4	3	3	2	2	1	1	1/0
35	8	8	8	10	10	8	6	6	6	4	4	4	3	3	2	2	1	1	1/0	1/0
40	8	8	8	10	8	6	6	4	4	4	4	3	2	2	2	1	1	1/0	1/0	2/0
45	6	8	8	10	8	6	6	4	4	4	3	2	2	2	1	1	1/0	1/0	2/0	2/0
50	6	6	6	10	6	6	4	4	4	3	3	2	2	1	1	1/0	1/0	2/0	2/0	3/0
60	4	6	6	8	6	6	4	3	2	2	2	1	1	1/0	1/0	2/0	2/0	3/0	3/0	4/0
70	4	4	4	8	6	4	4	3	2	2	1	1	1/0	1/0	2/0	2/0	3/0	3/0	4/0	4/0
80	2	4	4	6	4	4	3	2	1	1	1	1/0	1/0	2/0	2/0	3/0	3/0	4/0	4/0	250
90	2	3	3	6	4	4	2	2	1	1	1/0	1/0	2/0	2/0	3/0	3/0	4/0	4/0	250	300
100	1	3	3	6	4	3	2	1	1/0	1/0	1/0	2/0	2/0	3/0	3/0	4/0	4/0	250	300	300
115	1/0	2	2	4	4	2	1	1/0	1/0	1/0	2/0	3/0	3/0	4/0	4/0	4/0	250	300	350	350
130	2/0	1	1	4	2	2	1	1/0	2/0	2/0	3/0	3/0	4/0	4/0	250	250	300	350	400	400
150	3/0	1/0	1/0	2	2	2	1/0	2/0	2/0	2/0	3/0	4/0	4/0	250	250	300	350	400	500	500
175	4/0	2/0	2/0	1	2	1	1/0	2/0	3/0	3/0	4/0	250	250	300	350	350	400	500	600	600
200	250	3/0	3/0	1	1	1/0	2/0	3/0	4/0	4/0	4/0	250	300	300	350	350	500	500	600	600

TABLE 16-D - COPPER CONDUCTORS, 240 VOLTS, SINGLE-PHASE, 3 PERCENT VOLTAGE DROP

Minimum Allowable Size of Conductor		Length of Run in Feet																				
Load in Amps	Types UF	Types RH, RHW, THW, THHN	Types Covered Conductors	Compare size shown below with size shown to left of double line. Use the larger size																		
				50	60	75	100	125	150	175	200	225	250	300	350	400	450	500	550	600	650	700	800
5	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
7	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
10	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
15	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
20	12	12	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
25	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
30	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
35	8	8	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
40	8	8	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
45	6	8	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
50	6	6	10	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
60	4	6	8	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
70	4	4	8	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
80	2	4	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
90	2	3	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
100	1	3	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
115	1/0	2	4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
130	2/0	1	4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
150	3/0	1/0	2	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
175	4/0	2/0	2	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
200	250	3/0	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
225	300	4/0	1/0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
250	350	250	2/0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
275	400	300	2/0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
300	500	350	3/0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
325	600	400	4/0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
350	600	500	4/0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
375	700	500	250	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8
400	750	600	250	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	10	10	8

TABLE 16-E - OUTDOOR OVERHEAD SUPPLY CONDUCTOR

(QUADRIPLEX 125/250 VOLT SUPPLY CABLE)

NOTE 1: Insulated conductors shall have individual identification,; i.e.one conductor (L1) one ridge; one conductor (L2) two ridges; one conductor (neutral) plain. The uninsulated (support messenger) shall serve as the equipment grounding conductor (EGC).

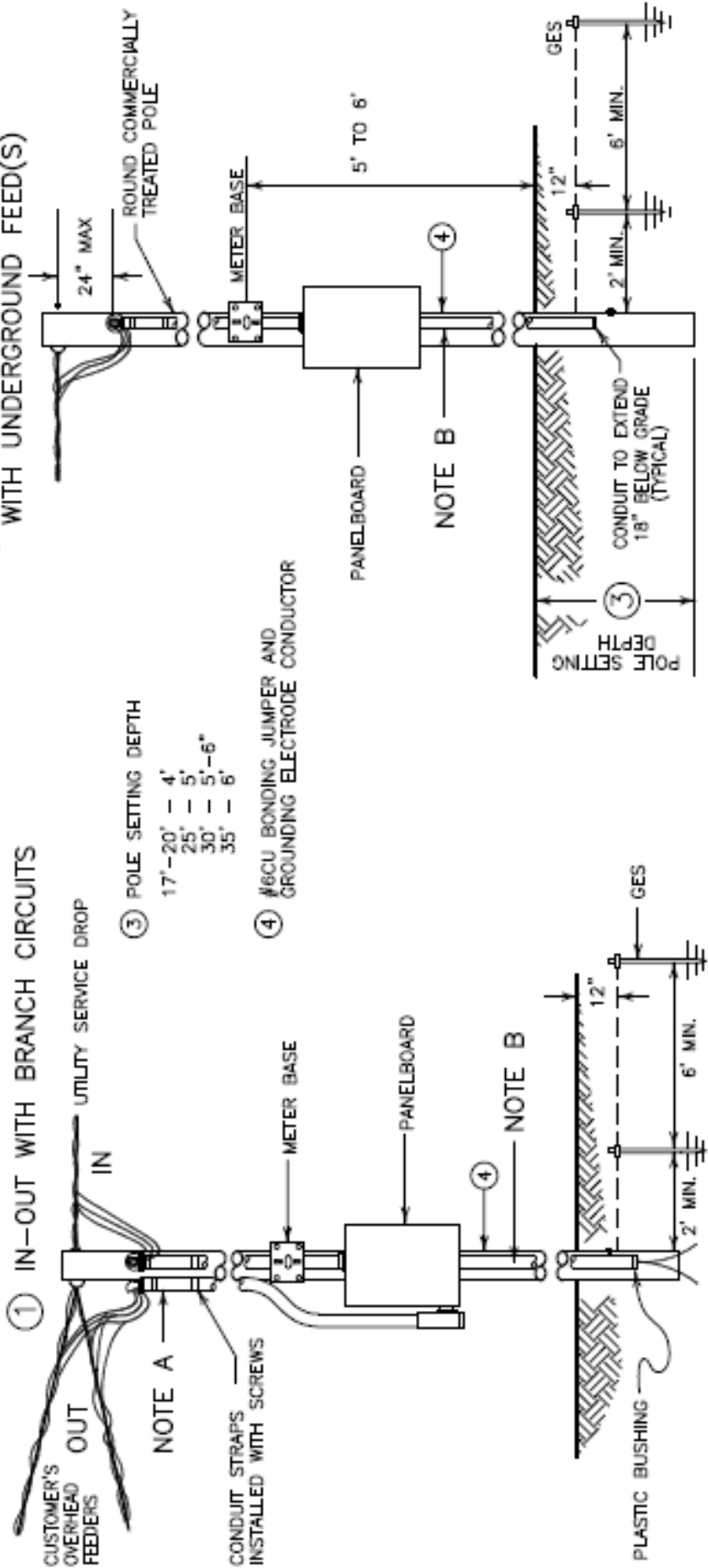
NOTE 2: Triplex **shall not** be used for 125/250 volt service

OVERHEAD QUADRUPLEX SUPPLY CABLE

Supply Conductors or Neutral Conductors			Bare Messenger (EGC)			Weight	Ampacity (Amps)		
						Per 1000 Feet (lbs.)			
Size		Insulation	Size		Rated				
(AWG)	Stranding	Thickness	(AWG)	Stranding	Strength	XLP or Poly	XLP	Poly	
		(Mils)			(lbs.)				
Aluminum Quadruplex Conductor Specifications									
6	7	45	6	6/1	1,190	153	75	60	
4	7	45	4	6/1	1,860	229	100	80	
2	7	45	2	6/1	2,850	349	135	105	
1/0	9	60	1/0	6/1	4,380	549	180	140	
2/0	11	60	2/0	6/1	5,310	677	205	160	
3/0	17	60	3/0	6/1	6,620	837	235	185	
4/0	18	60	4/0	6/1	8,350	1038	275	210	

METERING INSTALLATION

(SINGLE-PHASE, 3 WIRE 125/250, POLE TYPE) CONTACT UTILITY FOR OTHER SERVICE VOLTAGE APPLICATIONS



SERVICES ILLUSTRATED ABOVE EMPLOY CONVENTIONAL METER POLES WITH WEATHERPROOF BREAKER OR FUSED DISCONNECT.

DISCONNECTS ARE REQUIRED FOR EACH SERVICE. WHERE MORE THAN ONE BUILDING OR OTHER STRUCTURE IS ON THE SAME METER, EACH SHALL BE PROVIDED WITH THE MEANS FOR DISCONNECTING ALL UNGROUNDED CONDUCTORS.

ALL GROUNDING, BONDING, AND CLEARANCES SHALL COMPLY WITH THE 2011 NEC (NATIONAL ELECTRIC CODE.) THE GROUNDED NEUTRAL CONDUCTOR BROUGHT TO EACH SERVICE EQUIPMENT SHALL BE LARGE ENOUGH TO CARRY THE UNBALANCED CURRENT AND SHALL NOT BE SMALLER THAN SPECIFIED BY TABLE 250-66 OF THE NEC.

NOTE A: CONDUIT ABOVE PANELBOARD MAY BE RIGID METAL CONDUIT, INTERMEDIATE METAL CONDUIT, RIGID NONMETALLIC CONDUIT OR ELECTRICAL METALLIC TUBING (NEC 230-43).

NOTE B: CONDUIT EMERGING FROM GROUND SHALL BE RIGID METAL CONDUIT, INTERMEDIATE METAL OR SCHEDULE 80 RIGID NONMETALLIC CONDUIT. (NEC 300-5(0))

CLEARANCES 12 FEET OVER RESIDENTIAL PROPERTY AND THOSE COMMERCIAL AREAS NOT SUBJECT TO TRUCK TRAFFIC WHERE VOLTAGE IS LIMITED TO 300 VOLTS TO GROUND; 15 FEET WHERE SUBJECT TO NON-ROUTINE VEHICULAR TRAFFIC AND 18 FEET OVER PUBLIC STREETS, ALLEYS, ROADS, PARKING AREAS SUBJECT TO TRUCK TRAFFIC; DRIVEWAYS ON OTHER THAN RESIDENTIAL PROPERTY AND OTHER LAND TRAVERSED BY VEHICLES SUCH AS CULTIVATED, GRAZING, FOREST AND ORCHARD (NEC 230-24).

Diagram 16-A

17. SWIMMING POOLS, HOT TUBS OR SPAS

(NEC Article 680)

17-1 **GENERAL:** Before Installation **contact the power supplier** to get advice on proper clearances needed to meet Life Safety Code requirements for overhead and underground service/feeder conductors.

17-2 **DEFINITIONS:**

- A. **EQUIPOTENTIAL BONDING GRID:** This required bonding grid is embedded in the concrete pool and surrounding walking surface to reduce voltage gradients in the pool area. The bonding of all metal pool structural components, all pool electrical system components, and all metallic pool accessories, (i.e. diving board structures, ladders, etc.) shall be interconnected in a manner to reduce objectionable voltage gradients within protected area.
- B. **FORMING SHELL:** A structure designed to support a wet-niche lighting fixture assembly, usually for mounting in pool walls.
- C. **HYDROMASSAGE BATHTUB:** A permanently installed bathtub equipped with a recirculating piping system, pump, and associated equipment. It is designed so it can accept, circulate, and discharge water upon each use.
- D. **PERMANENTLY INSTALLED SWIMMING POOL:** A pool that is constructed in the ground, on the ground, or in a building in such a manner that the pool cannot be readily disassembled for storage.
- E. **SPA OR HOT TUB:** A hydromassage pool, or tub for recreational or therapeutic use, usually having a filter, heater, and motor-driven blower. It may be installed indoors or outdoors. Generally, a spa or hot tub is not designed or intended to have its contents drained or discharged after each use.
- F. **STORABLE SWIMMING OR WADING POOL:** A pool with a maximum diameter of 18 feet and a maximum wall height of 42 inches and constructed such that it may be readily dis-assembled for storage and reassembled to its original integrity. A pool with inflatable nonmetallic walls, regardless of dimensions, is considered to be a storable pool. **All 125, 15-and 20-amperes receptacles located within 20 feet of the inside of the storable pool shall be GFCI protected (See NEC 680-32). Low-voltage lighting (30 volts or less) shall not be located within 10 feet horizontally of the inside of the pool (See NEC 411-4(B)).**

See Section 17-5 for pump motors.

SWIMMING POOLS, HOT TUBS OR SPAS (continued)

17-3 TRANSFORMERS AND GROUND-FAULT CIRCUIT INTERRUPTERS:

- A. **TRANSFORMERS:** Transformers used for the supply of underwater lighting fixtures, together with the transformer enclosure, shall be identified for the purpose. Transformers must be an isolated-winding type with an ungrounded secondary, that has a metal barrier between the primary and secondary windings which is grounded. The branch circuit supplying the primary shall include a grounded circuit conductor, and the branch circuit shall be protected by a ground-fault circuit interrupter.
- B. **WIRING:** Conductors on the load side of a ground-fault circuit interrupter or of a transformer shall not occupy raceway, boxes, or enclosures containing other conductors that are not protected by a ground-fault circuit interrupter.

17-4 RECEPTACLES, LIGHTING FIXTURES, CEILING FANS AND SWITCHING DEVICES:

- A. **RECEPTACLES:**
 - 1. Receptacles for other than circulation and sanitation systems shall be located at least 6 feet from the inside walls of a pool.
 - 2. At dwelling units where a permanently installed pool is installed, at least one 125-volt, 15- or 20-ampere convenience receptacle shall be located a minimum of 6 feet, but not more than 20 feet, from the inside wall of the pool. The receptacle shall not be located more than 6 feet, 6 inches above grade level. All 125-volt receptacles located within 20 feet of the inside walls of a pool shall be protected by a ground-fault circuit interrupter.
- B. **LIGHTING FIXTURES AND CEILING FANS:** Lighting fixtures and ceiling fans shall not be installed over the pool or over the area extending 5 feet horizontally from the inside walls of a pool unless no part of the lighting fixture or ceiling fan is less than 12 feet above the maximum water level.
- C. **SWITCHING DEVICES:** Switching devices shall be located at least 5 feet horizontally from the inside walls of a pool.

17-5 PUMP MOTORS: Fixed or stationary equipment rated 20 amperes or less, other than underwater lighting fixture for a permanently installed pool, shall be permitted to be connected with a flexible cord. For other than storable pools, the flexible cord shall not exceed 3 feet in length and shall have a copper equipment grounding conductor not smaller than No. 12 with a 3-wire grounding-type attachment plug.

- A. Receptacles that supply circulation or sanitation equipment shall be located at least 10 feet from the inside walls of the pool or not less than 6 feet from the inside walls of the pool if the following conditions are met.
 - 1. Single receptacle
 - 2. Locking type plug and receptacle
 - 3. Grounding type
 - 4. Protected by ground-fault circuit interrupter

SWIMMING POOLS, HOT TUBS OR SPAS (continued)

- B. **GROUND-FAULT PROTECTION:** All pump motors supplied by branch circuits rated 15- or 20-amperes, 125-volt or 240-volt single phase; whether direct wired or cord and plug connected; shall be GFCI protected.

17-6 PERMANENTLY INSTALLED POOLS:

A. UNDERWATER LIGHTING FIXTURES FOR PERMANENTLY INSTALLED POOLS:

1. GENERAL:

- (a.) A ground-fault circuit interrupter shall be installed in the branch circuit supplying fixtures operating at more than 15 volts. (See Section 17-3 if supplied by a transformer.)
- (b.) No lighting fixture shall be installed for operation on supply circuits over 150 volts between conductors.
- (c.) Lighting fixtures mounted in walls shall be installed with the top of the fixture lens at least 18 inches below the normal water level of the pool.

EXCEPTION: Lighting fixtures shall be permitted at a depth of not less than 4 inches when identified for such use.

2. **WET-NICHE FIXTURES:** A listed forming shell shall be used with all wet-niche underwater fixtures. Rigid metal, intermediate metal, liquid-tight flexible non-metallic or rigid nonmetallic conduit shall extend from the forming shell to a suitable junction box or other listed enclosure. Metal conduit shall be of brass or other approved corrosion-resistant metal. Where rigid nonmetallic conduit is used, a No. 8 green insulated copper conductor shall be installed in this conduit with provisions for terminating in the forming shell, junction box or other approved enclosure. The No. 8 grounding conductor terminal in the forming shell must be covered or encapsulated with a listed compound.

B. JUNCTION BOXES:

A JUNCTION BOX CONNECTED TO CONDUIT that extends directly to a forming shell shall be:

1. A listed type for swimming pools
2. Located not less than 4 inches above the ground level or pool deck, measured from the inside of the bottom of the box, or not less than 8 inches above the maximum pool water level, whichever provides the greatest elevation
3. Located not less than 4 feet from the inside wall of the pool.

All entries shall be threaded or hubs or nonmetallic hub. All metal conduits must have electrical continuity through integral corrosion resistant means to bonding terminals.

On lighting systems of 15 volts or less, a listed flush deck box shall be permitted, provided an approved compound is used to fill the box and the flush deck box is located not less than 4 feet from the inside wall of the pool.

SWIMMING POOLS, HOT TUBS OR SPAS (continued)

2. **PROTECTION FROM PHYSICAL DAMAGE:** Junction boxes and enclosures mounted above the grade of the finished walkway around the pool shall not be located in the walkway unless additional protection is had, such as by location under diving boards or adjacent to fixed structures.
- C. **BONDING:** To reduce voltage gradients in the pool area, it is recommended an equipotential bonding grid of 12x12 inch square spacing be installed for pools that have a conductive pool shell and have perimeter surface bonding grid around the pool.
1. **CONDUCTIVE POOL SHELLS:** Pool shell constructed of concrete or masonry blocks are considered conductive shells and require a bonding grid to be installed within the conductive walls and flooring consisting of unencapsulated structural reinforcing welded wire mesh. The structural reinforcing welded wire mesh shall be bonded together using wire ties or the equivalent. If structural reinforcing welded wire mesh is not available, a copper grounding grid shall be installed. The grid shall be constructed of No. 8 minimum copper bare solid conductors. The copper grid shall be arranged in a network of a 12 X 12 inch square spacing (+4 or -4 inches) pattern with a listed bonding connection at each crossing point (NEC 250.8). This copper grid shall follow the contour of the pool shell and be secured within or under and no more than 6 inches from the pool shell. Fiberglass shell and vinyl liners are considered to be non-conductive material.
2. **PERIMETER SURFACES:**
- (a.) Perimeter Surfaces: The perimeter surface measured from inside wall of the pool should have an equipotential bonding grid, 3 feet in width, installed. This bonding grid shall be the unencapsulated structural reinforcing welded wire mesh or reinforcing mesh within the paved surface.
 - (b.) If reinforcing steel equipotential grid is not installed then a No. 8 minimum copper bare solid conductor shall be installed as an alternate method. The bare No. 8 copper solid conductor shall follow the contour of the pool at a distance of 18 to 24 inches from the inside walls of the pool. The conductor shall be secured within the paved surface or 4 to 6 inches below the perimeter subgrade. The perimeter bonding conductor shall also be bonded to the pool shell structural reinforcing welded wire mesh or the copper grid at four evenly spaced points around the pools perimeter. For nonconductive pool shells, the four point perimeter bonding is not required.
3. **POOL WATER:** An intentional bonding surface of 9 square inches or more must be in contact with the pool water. Metallic pool lighting surface or other metallic surfaces in contact with the pool water that provides the minimum 9 square inches of surface area shall be permitted to be included as the intentional bonding.
 4. **BONDING ELECTRICAL EQUIPMENT:** All metal parts of the swimming pools electrical system shall be bonded together by a No. 8 copper conductor. Listed double insulated water pump motors are not required to be bonded to the other metal parts of the pool. However, a No. 8 copper conductor from the pools bonding system is required to be routed to the pump motor location with sufficient length to make a bonding connection.

SWIMMING POOLS, HOT TUBS OR SPAS (continued)

- D. **METHODS OF GROUNDING:** The following provisions shall apply to the grounding of underwater lighting fixtures, junction boxes, metal transformer enclosures, panelboards, motors, and other electrical enclosures and equipment.
1. **POOL LIGHTING FIXTURES:** Underwater lighting fixtures shall be connected to an equipment-grounding conductor sized in accordance with Table 4-B but not smaller than No. 12. It shall be a green insulated copper conductor and shall be installed with the circuit conductors in rigid metal conduit, intermediate metal conduit, or rigid non metallic conduit.
 2. **MOTORS:** Pool associated motors shall be connected to an equipment grounding conductor sized in accordance with Table 4-B but not smaller than No. 12. It shall be a green insulated copper conductor and shall be installed with the circuit conductors in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or type MC cable listed for the application.

When necessary to employ flexible connections at or adjacent to the motor, liquid tight flexible metal or nonmetallic flexible conduit with approved fittings shall be permitted.

3. **PANELBOARDS:** A panelboard, not part of the service equipment, shall have an equipment-grounding conductor installed between its grounding terminal and the grounding terminal of the service equipment. This conductor shall be sized in accordance with Table 4-B but no smaller than No. 12. It shall be a green insulated copper conductor and shall be installed with the feeder conductors in rigid metal conduit, intermediate metal conduit or rigid nonmetallic conduit. The equipment-grounding conductor shall be connected to an equipment-grounding terminal within the panelboard.
- E. **EQUIPMENT DISCONNECTING MEANS FOR MAINTENANCE:** A disconnecting means to simultaneously open all ungrounded conductors shall be provided for all pool, spa or hot tub equipment. The disconnecting means shall be located at least 5 feet from the inside wall of the pool, spa or hot tub, but not more than 50 feet from and within sight of the equipment that the disconnecting means disconnects.

17-7 STORABLE POOLS:

- A. **GROUND-FAULT:** All electric equipment, including power supply cords, used with storable pools shall be protected by ground-fault circuit interrupters.

17-8 SPAS AND HOT TUBS:

- A. **PROTECTION:** Spas and hot tubs and associated electrical components shall be protected by ground-fault circuit interrupters.

SWIMMING POOLS, HOT TUBS OR SPAS (continued)

C. INDOOR INSTALLATIONS:

1. **RECEPTACLES:** At least one convenience receptacle shall be located a minimum of 6 feet but not more than 10 feet from the inside wall of the spa or hot tub.
 - (a.) Receptacles shall be located at least 5 feet from the inside walls of a spa or hot tub.
 - (b.) 125-volt receptacles located within 10 feet of the inside walls of a spa or hot tub shall be protected by a ground-fault circuit interrupter.
 - (c.) Receptacles that provide power for a spa or hot tub shall be ground-fault circuit interrupter protected.
2. **LIGHTING FIXTURES, LIGHTING OUTLETS, AND CEILING FANS:** Lighting fixtures, lighting outlets, and ceiling fans located over or within 5 feet from the inside walls of the spa or hot tub shall be a minimum of 7 feet 6 inches above the maximum water level and shall be protected by a ground-fault circuit interrupter.

EXCEPTION: Lighting fixtures meeting the requirements of Notes 1 and 2 below and protected by a ground-fault circuit interrupter shall be permitted to be installed less than 7 feet 6 inches over the spa or hot tub.

NOTE 1: Recessed fixtures shall have a glass or plastic lens, a nonmetallic or electrically isolated metal trim, and identified as suitable for use in damp locations.

NOTE 2: Surface-mounted fixtures shall have a glass or plastic lens, globe, a nonmetallic body or a metallic body isolated from contact, and identified as suitable for use in damp locations.
3. **WALL SWITCHES:** Wall switches shall be located at least 5 feet, measured horizontally, from the inside walls of the spa or hot tub.

17-9 HYDROMASSAGE BATHTUBS:

- A. **PROTECTION:** Hydromassage bathtubs and their associated electric components shall be on a **readily accessible**, dedicated GFCI protected circuit. **Hydromassage bathtub supply receptacle shall be installed such that the face is within direct view from the service access opening and located not more than 1 foot from the opening. The GFCI devices shall be horsepower rated for the motor being served.**

NOTE 1: Motor shall be accessible for replacement or maintenance and have a means of disconnection.

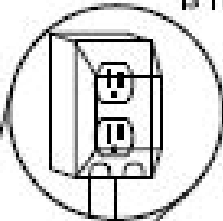
NOTE 2: See Section 17-6C for proper bonding methods and 17-6D for proper grounding methods.

NOTE 3: All metal piping systems, metal enclosures, and pump motor(s) associated with the hydromassage tub shall be bonded together with a No.8 solid copper conductor or larger. (Bond to the lug on top of the non-double insulated motor. If double-insulated motor is installed, you shall provide a pigtail for future bonding.)

SWIMMING POOLS

BONDING ALL METALLIC PARTS

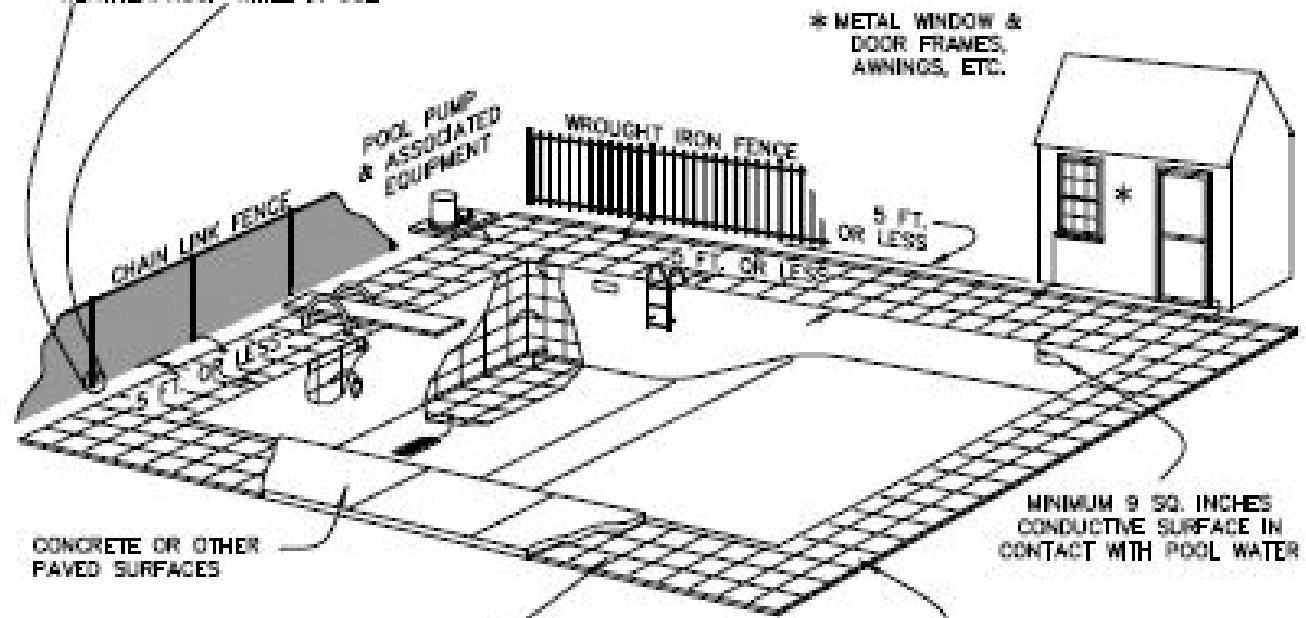
A 125 VOLT 15 OR 20 AMP GFCI PROTECTED RECEPTACLE MUST BE LOCATED WITHIN 20 FT., BUT NOT LESS THAN 6 FT. THIS MEASUREMENT IS FROM INSIDE WALL OF POOL. SEE SECTION 17-4(A).



WEATHERPROOF WHILE IN USE

BOND ALL FIXED METAL PARTS/METAL STRUCTURES WITH A NO. 8 OR LARGER SOLID COPPER CONDUCTOR TO FORM A SOLID BONDING GRID. SEE SECTION 17.8(C)2 AND 17-2(A).

DEFINITION 2-35



CONCRETE OR OTHER PAVED SURFACES

AN EQUIPOTENTIAL STRUCTURAL REINFORCING WIRE MESH SHALL BE INSTALLED TO REDUCE VOLTAGE GRADIENTS IN THE POOL AREA AND ADJACENT PAVED WALKING SURFACES. (SEE SECTION 17.6(C)1)

THE STRUCTURAL REINFORCING WIRE MESH SHALL BE INSTALLED TO ACCOMPLISH THE INTENT OF NEC ART 680.26

ALTERNATE METHOD FOR PERIMETER BONDING SEE 17.6 (C) (2) (B) IF STRUCTURAL STEEL IS NOT INSTALLED.

EQUIPOTENTIAL PLANE (BONDING GRID) COVERING THE CONTOUR OF THE POOL AND AT LEAST 3 FT. WALKING SURFACE AROUND PERIMETER.

* ALL FIXED METAL PARTS WITHIN 5 FT. HORIZONTALLY AND 12 FT. VERTICALLY FROM INSIDE WALL OF PERMANENT POOL SHALL BE BONDED TO EQUIPOTENTIAL GRID.

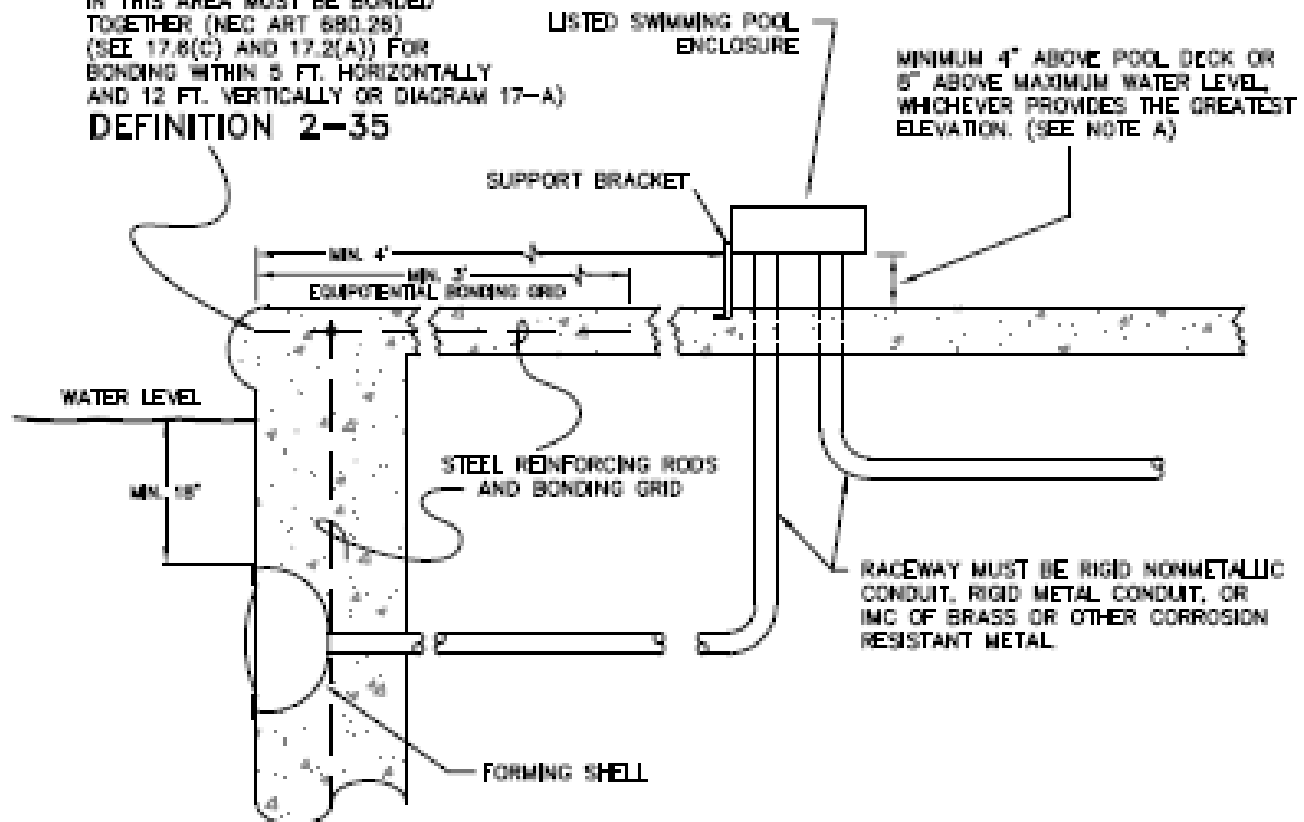
Diagram 17-A

SWIMMING POOLS

SUBMERSED LIGHTING

POOLS WITH CONCRETE WALKING SURFACES MUST HAVE AN EQUIPOTENTIAL BONDING GRID EMBEDDED IN THE CONCRETE AT LEAST 3 FT. AROUND THE POOL EXTENDING FROM THE INSIDE POOL WALL. ALL METALLIC STRUCTURES IN THIS AREA MUST BE BONDED TOGETHER (NEC ART 680.26) (SEE 17.8(C) AND 17.2(A)) FOR BONDING WITHIN 5 FT. HORIZONTALLY AND 12 FT. VERTICALLY OR DIAGRAM 17-A)

DEFINITION 2-35



NOTE A:

A FLUSH DECK BOX MAY BE USED FOR A FIXTURE OPERATING AT 15 VOLTS OR LESS WHEN A LISTED AND APPROVED POTTING COMPOUND IS USED TO FILL THE BOX TO PREVENT MOISTURE FROM ENTERING.

Diagram 17-B

18. NATURAL AND ARTIFICIALLY MADE BODIES OF WATER

(NEC Article 682)

18-1 **GENERAL:** This section addresses installation of electrical wiring for equipment in and adjacent to natural or artificially made bodies of water such as fish farm ponds, aeration ponds, storm retention basins, etc. (See AHJ for electrical service details)

18-2 **DEFINITIONS:**

A. ELECTRICAL DATUM PLANE: The expected, or designed, highest water level that may occur during normal, seasonal, or storm driven circumstances will constitute a benchmark. A horizontal plane located 2 feet above established benchmark shall be the electrical datum plane. Electrical equipment, transformers and their enclosures shall not be located below the electrical datum plane unless specifically listed for operation while submerged. (See NEC 682.2; 682.10; 682.11)

B. EQUIPOTENTIAL PLANE: An equipotential plane shall be installed adjacent to all outdoor service equipment or disconnecting means controlling equipment located in or on the water and may become energized. The equipotential plane shall encompass the area around the equipment extending out not less than 36 inches in all directions from which a person could come in contact with equipment. The equipotential plane is the area where wire mesh or other conductive elements are;

-placed on,

-embedded in

-placed no more than 3 inches under the walking surface

The conductive elements shall be bonded to all metal structures, and other fixed non-electrical equipment that may become energized. These conductive elements shall be connected to the electrical grounding system with a solid copper bonding conductor not smaller than 8 AWG.

19. AGRICULTURAL BUILDINGS

(NEC Article 547)

19-1 **GENERAL:** Agricultural buildings must be properly wired to promote safety and to adequately serve the electrical loads connected to the service panelboard. Those buildings where particular attention should be given to ensure that minimum standards of safety are met including the following:

- Those buildings where excessive dust and dust with water may accumulate (i.e. poultry, livestock, and fish confinement systems)
- Buildings where a corrosive atmosphere exists, such as where poultry and animal excrement may cause corrosive vapors, corrosive particles may combine with water
- The area is wet and damp by reason of periodic washing for cleaning, should be given particular attention to ensure that minimum standards of safety are met.

Stray voltage affecting animal confinement areas require a combination of resources to manage the problem. On-farm or off-farm interconnection of electrical, communications, metal pipelines, conductive non-current-carrying materials (like concrete floors, etc.) can create a complex “voltage web” allowing irregularities to affect animals and personnel. Good wiring practices, electrical insulation, balanced electrical loads, and proper neutral size are essential to solving or minimizing the problem of stray voltage, also know as contact voltage.

NOTE: Contact your local power supplier for more information.

19-2 **DEFINITIONS:**

- A. **EQUIPOTENTIAL PLANE (GRID):** An equipotential plane is an area where all metallic objects, like a milking parlor or livestock holding area, are bonded together mechanically so that, if energized, there is little or no voltage between any two pieces of metal in that area, regardless of voltage source. A grid in the concrete slab floor SHALL be bonded to the electrical system grounding bus and all metal objects in the area SHALL be bonded to the grid with solid copper, No. 8 or larger, conductor. Equipotential grid must be installed in ALL concrete floors which are livestock (not poultry) confinement areas, indoors or outdoors, having metallic equipment installed or attached that may become energized and accessible to the livestock. (See Diagram 19-A.)

A more comforting voltage transition for livestock between equipotential grid and surrounding areas can be achieved through the use of voltage gradient ramp. This is done at animal entrances and exits. Use ground rods driven outward and downward at a 45-degree angle to the surface, spaced every 12 inches horizontally across the entrance and exit ramps and connected to the equipotential grid.

AGRICULTURAL BUILDINGS (continued)

NOTE: For information on equipotential plane (grid) and grounding, contact power supplier before starting construction, or consult the American Society of Agricultural Engineers (ASAE), reference number EP473-2001.

- 19-3 **RECEPTACLES:** All 125-volt, single-phase, 15- and 20-ampere general purpose receptacles shall be GFCI protected.
- 19-4 **LUMINAIRES:** Luminaires shall be installed to minimize the entrance of dust, moisture, corrosive material, or other foreign matter. A suitable guard shall be installed to provide protection to luminaires exposed to physical damage. Luminaires shall be watertight where exposed to water and cleaning liquid and shall be listed for use in wet locations.
- 19-5 **FARM WIRING: Contact power supplier** about farmstead wiring, served overhead or underground, including site-isolating device when more than one farm building is served from one distribution point.

Farm owners, managers or employees observing power lines damaged by storms, farm equipment, etc. must notify serving utility immediately for inspection and or repair.

- 19-6 **WIRING SYSTEMS:** The wiring methods employed shall be Type UF, NMC, copper SE cables, jacketed MC cables, nonmetallic conduit, liquidtight flexible conduit, or other cables or raceways suitable and approved for farm applications.
- 19-7 **NEW CONSTRUCTION:** See Diagram 19-A.
- 19-8 **PHYSICAL PROTECTION:** All electrical wiring and equipment shall be protected from physical and corrosive damage in the areas where there is excessive dust, dust with moisture, or corrosive vapors.
- 19-9 **PREVENTING OBJECTIONABLE CURRENT:** Grounding and bonding of electrical systems, communication systems, circuit conductors, surge arrestors, **conductive non-current carrying materials** (like concrete floors) and equipment shall be installed and arranged in a manner to prevent objectionable current over the equipment grounding conductors or grounding paths. (See NEC 250.6 (A) & (B).)

In addition, all metal devices within the structure, (i.e. metal stanchions, gates, metal pipes, feeders, etc.), shall be bonded to the service panelboard using a No. 8 bare copper conductor.

A common practice for detecting objectionable current is through voltage measurements.

AGRICULTURAL BUILDINGS (continued)

Common farm voltage measurements are as follows:

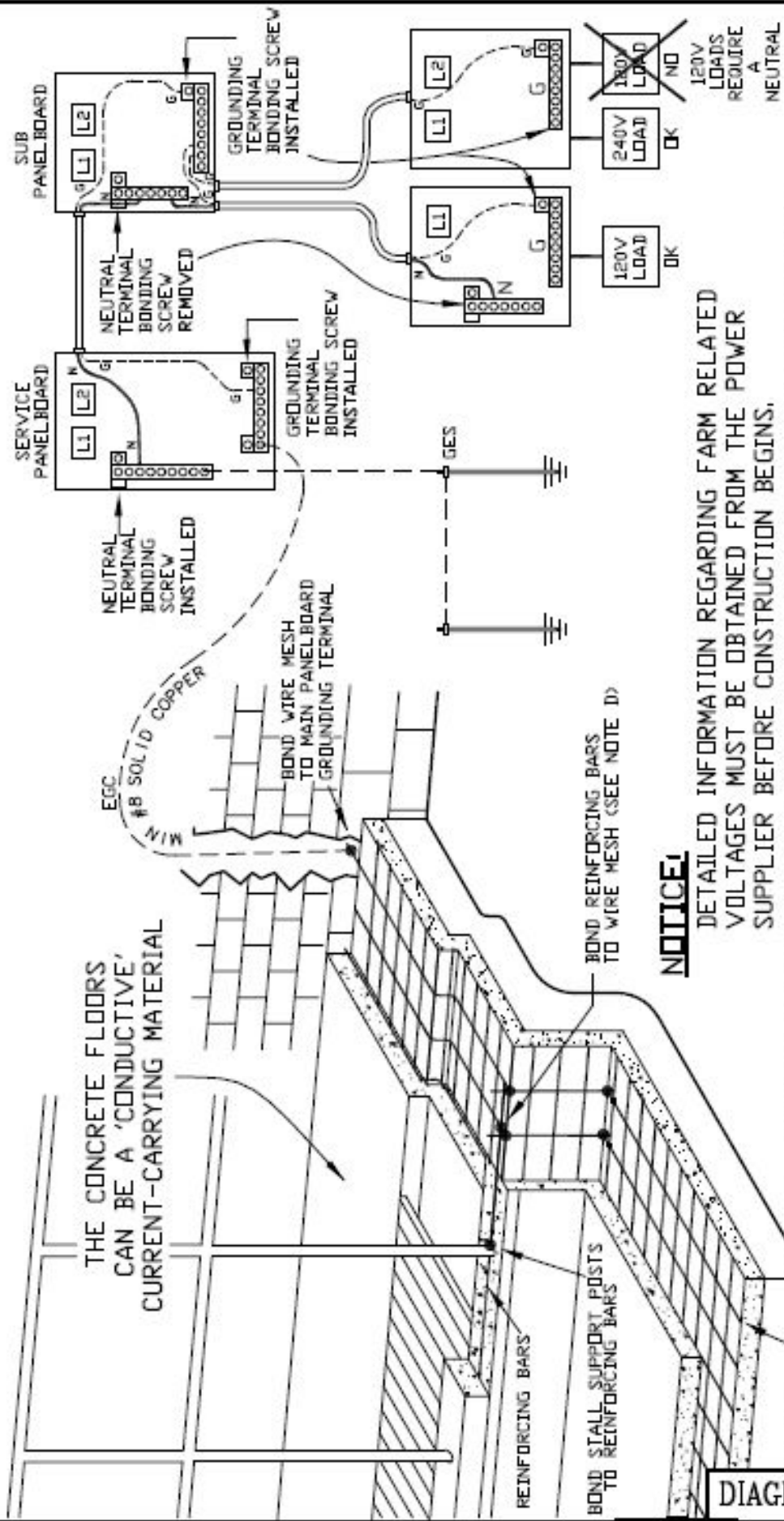
-Contact voltage: Is measured between 2 points that can be simultaneously contacted (touched) by an animal.

-Stray voltage: Is measured between 2 points that normally would not have any significant voltage present.

-Neutral-to-earth voltage: Is measured between the primary distribution circuits grounded (neutral) conductor and a referenced remote/independent ground rod driven into the earth nearby.

NOTE: A neutral conductor is a current-carrying conductor and MUST NEVER be used as a grounding conductor; likewise, a grounding conductor should never carry current, except under circuit fault conditions. These two conductors are distinctly different and can only be intentionally bonded together at the service panelboard. These conductors shall be isolated from each other at all subpanelboards. (See Diagram 19-A.)

ANIMAL CONFINEMENT AREAS



NOTICE!

DETAILED INFORMATION REGARDING FARM RELATED VOLTAGES MUST BE OBTAINED FROM THE POWER SUPPLIER BEFORE CONSTRUCTION BEGINS.

- A. ALL METALLIC EQUIPMENT IN THE AREA SHALL BE INTERCONNECTED (BONDED) TO THE REINFORCING RODS & MESH IN THE FLOOR AREA BEFORE THE CONCRETE IS POURED CREATING AN EQUIPOTENTIAL PLANE.
- B. THE GROUNDED CONDUCTOR (NEUTRAL) SHALL NOT BE INTERCONNECTED WITH THE EGG (BARE OR GREEN) AT ANY POINT BEYOND THE MAIN PANELBOARD.
- C. 120 VOLT ELECTRICAL LOADS THAT OPERATE SIMULTANEOUSLY, SHALL BE EQUALLY DIVIDED BETWEEN PHASE L1 AND PHASE L2 TO REDUCE NEUTRAL CURRENTS.
- D. BONDING CONDUCTORS EMBEDDED IN CONCRETE SHALL BE WITH LISTED BI-METALLIC CONNECTORS.

DIAGRAM 19-A

20. OPTIONAL STAND-BY POWER SYSTEMS

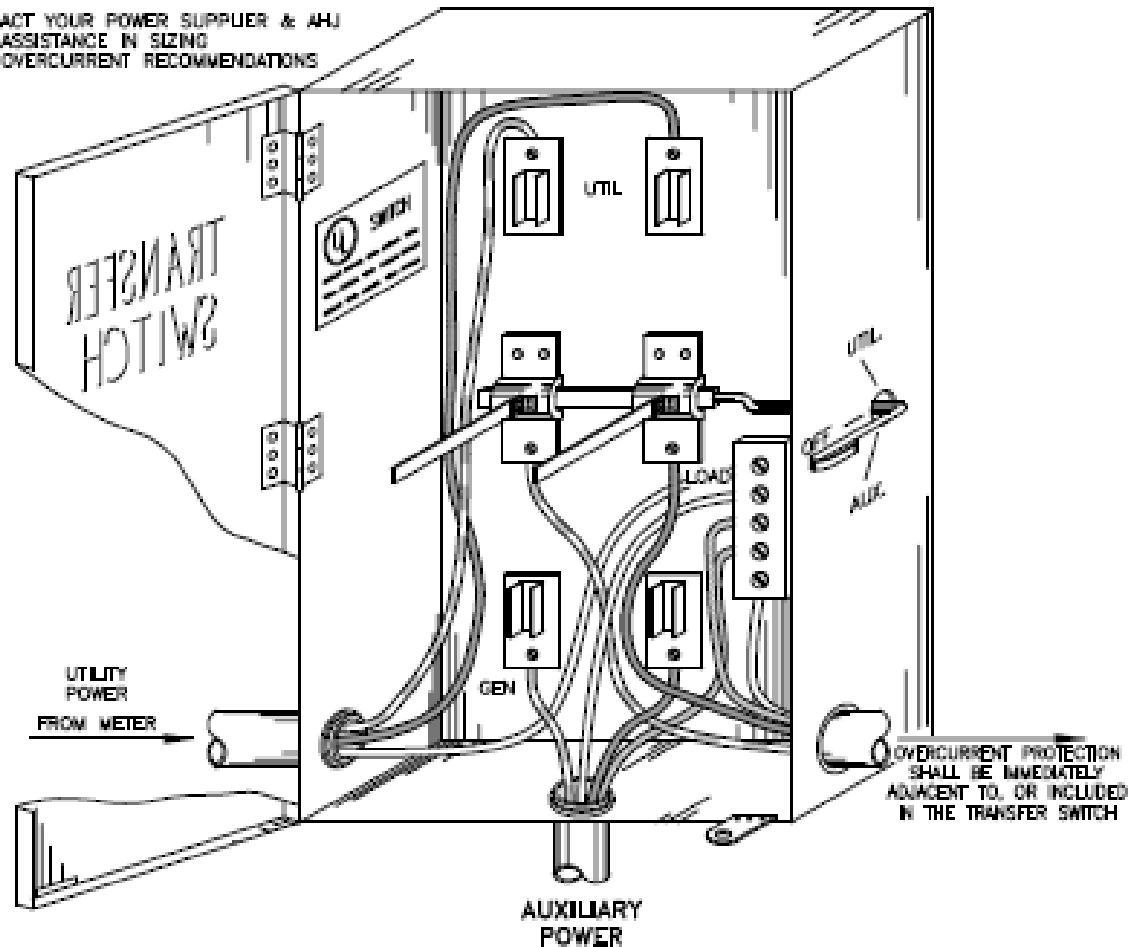
(NEC Article 702)

20-1 INSTALLATIONS:

- A. **GENERATOR UNITS** are available in two types:
1. **Engine driven** portable standby units are very popular with homeowners and farm operations.
 2. **Tractor driven** (power take-off) units are the most common types found on the farm.
- B. **TRANSFER SWITCH:** It is **absolutely** essential that the standby power system connected to any part of your electrical system (normally served by your electric utility) **must** have a transfer switch making it impossible to have both standby power system and the electric utility service connected at the same time. (See Diagram 20-A & B.)
- C. **AUTOMATIC TRANSFER SWITCH:** An automatic transfer switch and the standby power system shall be sized for the connected load.
- D. **INTERCONNECTION:** No matter how small the generator output, that power is potentially very dangerous if not properly connected. Contact the electric utility serving the area of the proposed generator location for their rules, regulations and specifications concerning the installation and connection of the generator and associated equipment to their served customers.
- E. **SIZE AND LOCATION:** Contact power supplier or qualified electrical contractor for information in sizing and location.

TYPICAL TRANSFER SWITCH SUITABLE FOR USE AS SERVICE EQUIPMENT FOR NON-SEPARATELY DERIVED SYSTEM

CONTACT YOUR POWER SUPPLIER & AHJ
FOR ASSISTANCE IN SIZING
AND OVERCURRENT RECOMMENDATIONS



TO INSURE A GENERATOR CANNOT BE INADVERTANTLY CONNECTED TO ANOTHER ELECTRIC SYSTEM, A DOUBLE-POLE, DOUBLE-THROW TRANSFER SWITCH MUST BE INSTALLED ON THE LOAD SIDE OF THE POWER SUPPLIER'S ELECTRIC METER.

THE TRANSFER SWITCH MUST PREVENT STAND-BY GENERATED POWER FROM FEEDING BACK INTO THE POWER SUPPLIER'S SYSTEM AND ENDANGERING THE LIVES OF LINEMEN, NEIGHBORS, PETS, LIVESTOCK, ETC.

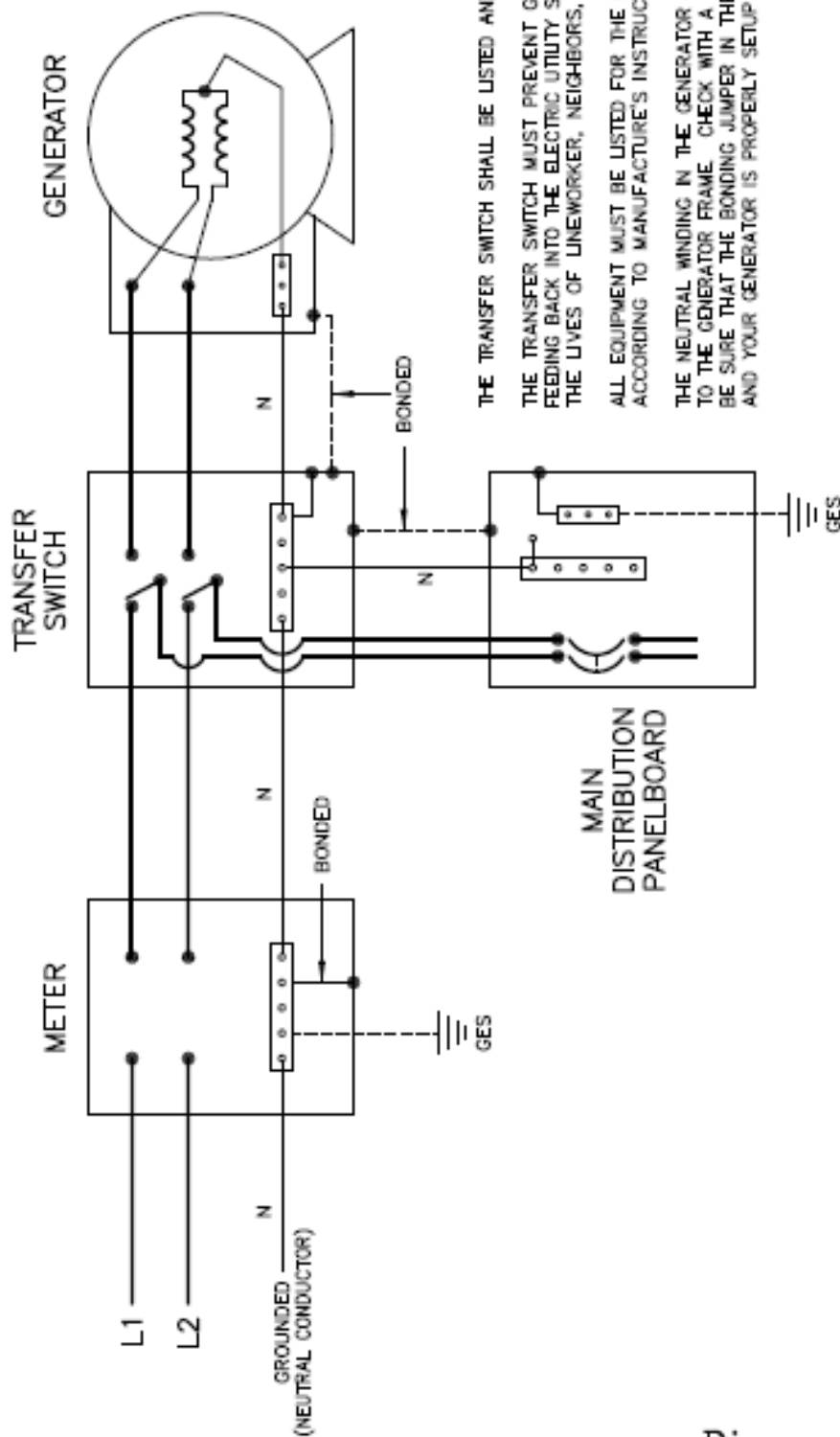
ALL EQUIPMENT MUST BE LISTED FOR THE PURPOSE, SIZE COORDINATED WITH MAIN PANEL, AND INSTALLED ACCORDING TO MANUFACTURER'S INSTRUCTIONS.

TRANSFER SWITCH/METER COMBINATIONS ARE ALSO AVAILABLE IN SEVERAL SIZES AND COMBINATIONS.

Diagram 20-A

TYPICAL TRANSFER SWITCH

FOR NON-SEPARATELY DERIVED SYSTEMS



THE TRANSFER SWITCH SHALL BE LISTED AND HAVE AN OFF POSITION.

THE TRANSFER SWITCH MUST PREVENT GENERATED POWER FROM FEEDING BACK INTO THE ELECTRIC UTILITY SYSTEM AND ENDANGERING THE LIVES OF LINEWORKER, NEIGHBORS, PETS, LIVESTOCK, ETC.

ALL EQUIPMENT MUST BE LISTED FOR THE PURPOSE AND INSTALLED ACCORDING TO MANUFACTURE'S INSTRUCTIONS.

THE NEUTRAL WINDING IN THE GENERATOR SHOULD NOT BE BONDED TO THE GENERATOR FRAME. CHECK WITH A QUALIFIED ELECTRICIAN TO BE SURE THAT THE BONDING JUMPER IN THE GENERATOR IS REMOVED AND YOUR GENERATOR IS PROPERLY SETUP FOR YOUR INSTALLATION.

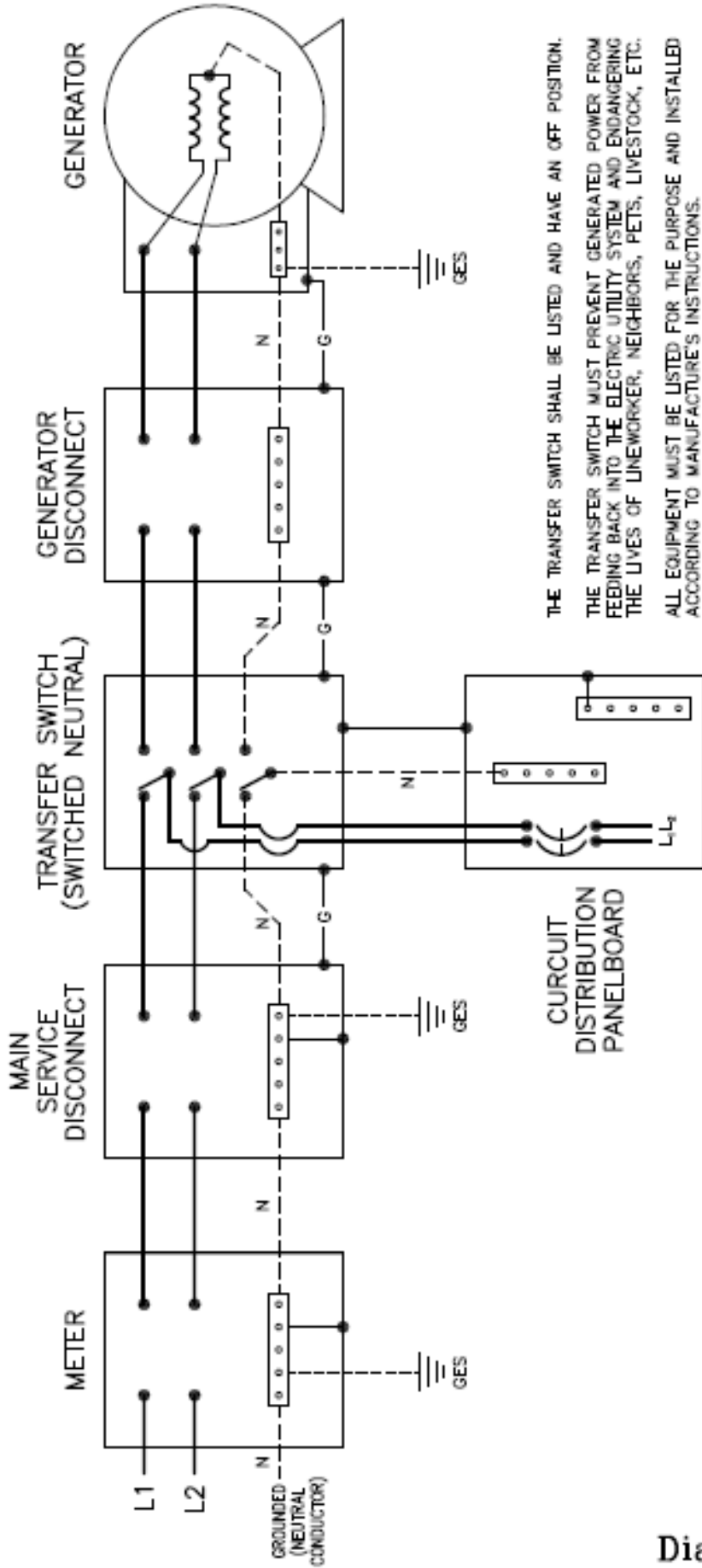
NOTE: FOR ASSISTANCE IN SIZING AND RECOMMENDATIONS CONTACT YOUR LOCAL UTILITY AND AHJ.

TRANSFER SWITCH SHALL BE INSTALLED BY QUALIFIED PERSON (SEE DEFINITION 2-68)

Diagram 20-B

TYPICAL TRANSFER SWITCH

FOR SEPARATELY DERIVED SYSTEMS



THE TRANSFER SWITCH SHALL BE LISTED AND HAVE AN OFF POSITION.

THE TRANSFER SWITCH MUST PREVENT GENERATED POWER FROM FEEDING BACK INTO THE ELECTRIC UTILITY SYSTEM AND ENDANGERING THE LIVES OF LINEWORKER, NEIGHBORS, PETS, LIVESTOCK, ETC.

ALL EQUIPMENT MUST BE LISTED FOR THE PURPOSE AND INSTALLED ACCORDING TO MANUFACTURE'S INSTRUCTIONS.

THE NEUTRAL WINDING IN THE GENERATOR SHOULD NOT BE BONDED TO THE GENERATOR FRAME. CHECK WITH A QUALIFIED ELECTRICIAN TO BE SURE THAT THE BONDING JUMPER IN THE GENERATOR IS REMOVED AND YOUR GENERATOR IS PROPERLY SETUP FOR YOUR INSTALLATION.

GENERATOR MUST BE ADEQUATELY SIZED TO SERVE ALL LOADS CONNECTED TO IT.

NOTE:
FOR ASSISTANCE IN SIZING AND RECOMMENDATIONS
CONTACT YOUR LOCAL UTILITY AND AHJ.

Diagram 20-C

21. RENEWABLE ENERGY

NEC 690 and 694

21-1 General: Renewable energy is becoming a more reliable energy source because of advancement of the technologies required to collect, transform and deliver electricity in a useful and cost effective way. Wind, solar, biomass, biogas and other energy sources are being converted to supply electrical needs to the extent they can be relied upon. Economics and conservation are important factors in assessing the viability of renewable energy.

21-2 Two basic categories:

A.) Non-Interactive System: Independent electric generating system which is totally separate (not interconnected to utility source system) and delivers electric energy to an independent electrical load; i.e. electric fence charger, etc. Special electric utility rates do not apply to this type of electric supply.

Interactive Systems: Interactive systems are distributed generation systems that are interconnected and operating in parallel with, and suitable for, delivering 60Hz Alternating Current (AC) to an electric primary source system. **Contact your local utility first for specific policies and system interconnection guidelines.**

Note: Investigate the feasibility of this system before final decisions are made to its practical application for your short- or long-term goals. Some key points to be aware of with every project are:

-Cost/Return on investment

-Isolation/Separation of system for maintenance

-Consult with serving utility on policies

-Utility electric rate structures; i.e. Renewable Energy (RE) rates, Feed-in-Tariffs (FIT) etc.

-Additional electric energy metering; i.e. net metering, dedicated generation metering, etc.

-Authority Having Jurisdiction (AHJ) Electrical Inspector

-Local, state and federal regulations

-Commissioning plan and operational testing approved by involved parties

-Each specific design may have many more important points to consider

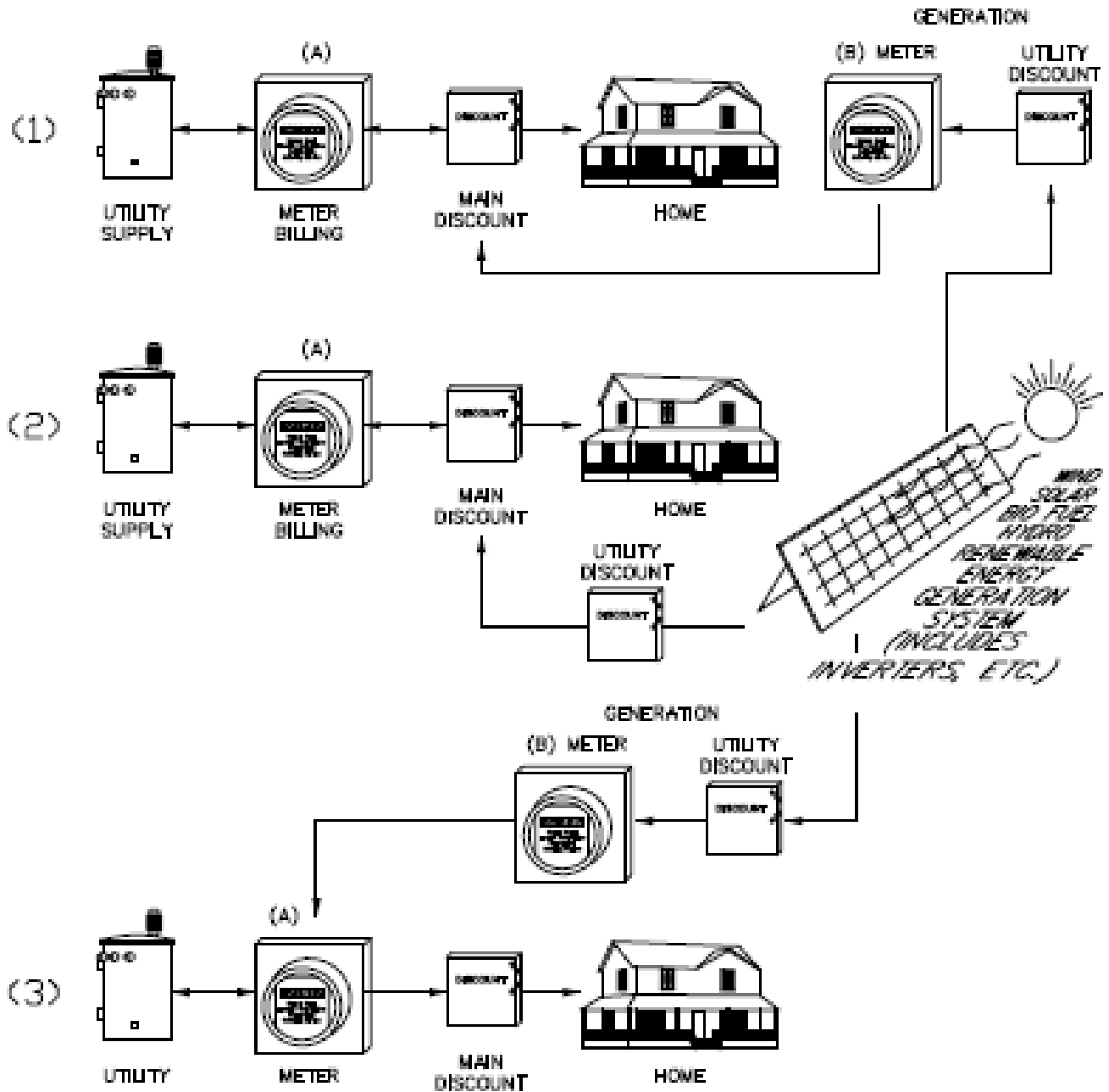
B.) Energy, especially electric energy, is the power that keeps our society working and healthy as well as providing recreation and many other important services. It's an 'ever-ready servant' and we will participate in a rapid evolutionary process of energy priorities. We must be willing and vigilant to keep our electrical systems, codes and safety regulations revised in a timely manner.

See Diagram 21-A for a sample wiring format to connect an Interactive System with appropriate metering scheme.

NOTE: Contact serving utility for their specific requirements.

RENEWABLE ENERGY

METERING AND CONNECTION DESIGN ALTERNATIVES FOR INTERACTIVE SYSTEMS (NEC 690-694)



NOTE: BEFORE FINALIZING RENEWABLE ENERGY AGREEMENTS/CONTRACTS OR EQUIPMENT PURCHASE FROM SUPPLIERS, CONTACT SERVING UTILITY AND AHJ.

METERING (METERING SHALL BE DETERMINED BY LOCAL POWER SUPPLIER):

(A) UTILITY BILLING METER

(B) UTILITY RENEWABLE ENERGY METER

Diagram 21-A

2011 Uniform Wiring Guide Errata Sheet

Issued May 2011

The 2011 Uniform Electrical Wiring Guide has been revised, printed and distributed across the state of Kentucky. The extensive revision of the 2011 Uniform Wiring Guide in editing and printing the document brings the volunteers back together to verify its accuracy.

The 2011 Uniform Wiring Guide Erratum listing follows:

Page vi	omit Tables 8E & 8F
Page 4	2-5 B TABLE should be PORTABLE (cord and plug)
Page 34	6-2 G 3 note: for unfinished basements, See Diagram 6-C
Page 35	6-2 I 3 note: See Sections 2-58 and 2-90
Page 40	Remove all non -references to GFCI from Diagram 6-C. Corrected Diagram 6-C attached.
Page 51	8-3 B The grounded neutral conductor shall be of such ampacity to be able to carry the maximum unbalanced load between the neutral and ungrounded conductor....
Page 53	(Notice) Corrected Table 8-B attached
Page 55	Omit Table 8-E
Page 56	Omit Table 8-F
Page 65	14-5 E- Service Equipment
Page 69	15-1 Note 4 (Diagram 15F) (page 79)
Page 70	15-3 B Service Equipment
Page 103	Diagram 20-C Separately Derived System Generator neutral shall be bonded to the generator frame. Qualified electrician should verify this bonding jumper is properly installed. (Notice) Corrected Diagram 20-C is attached.
Page 104	Biogas and other energy sources are being converted....

TABLE 8-B

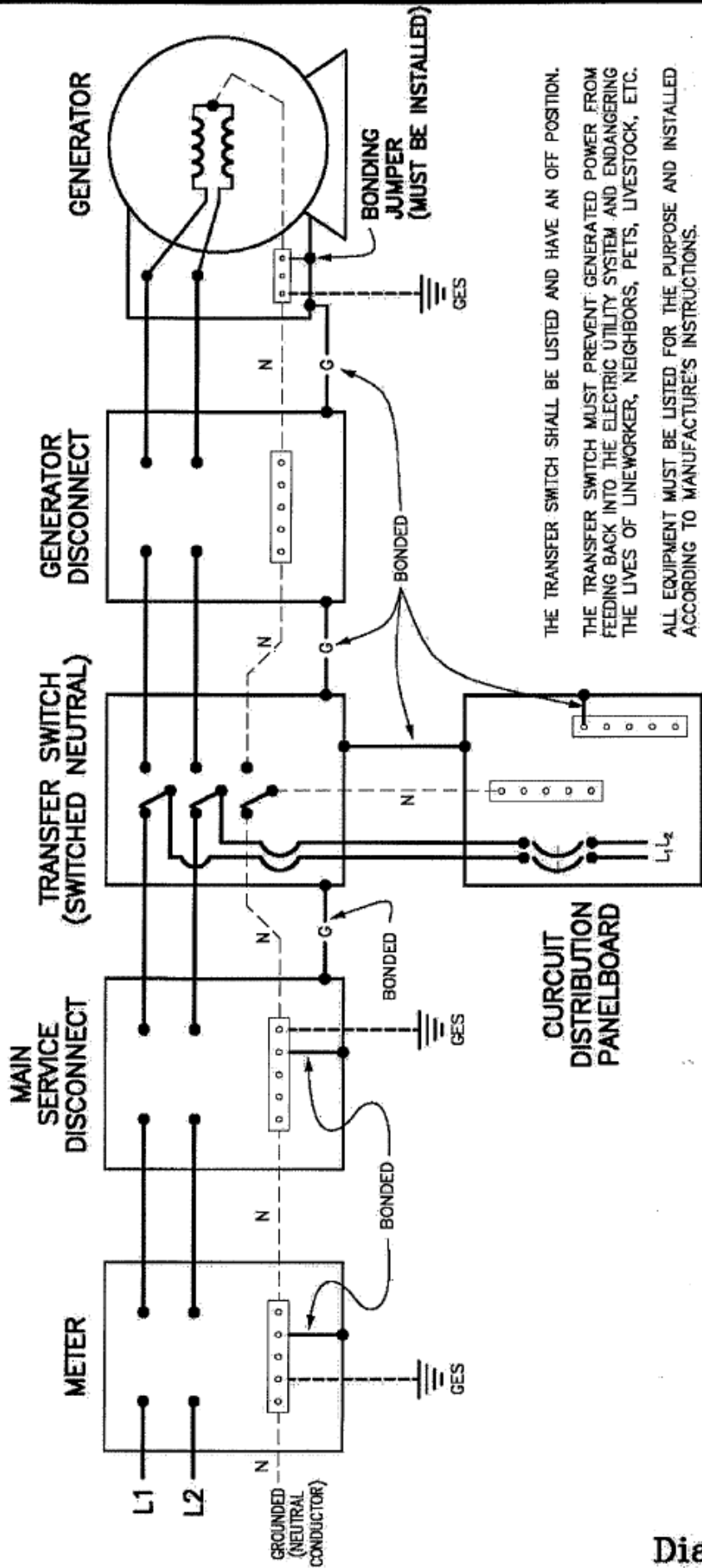
Box Dimension, Inches Trade Size or Type	Min. Cu. In. Capacity	Maximum Conductor Count (See Note)						
		No. 18	No. 16	No. 14	No. 12	No. 10	No. 8	No. 6
4 x 1 1/4 Round or Octagonal	12.5	8	7	6	5	5	5	2
4 x 1 1/2 Round or Octagonal	15.5	10	8	7	6	6	5	3
4 x 2 1/8 Round or Octagonal	21.5	14	12	10	9	8	7	4
4 x 1 1/4 Square	18.0	12	10	9	8	7	6	3
4 x 1 1/2 Square	21.0	14	12	10	9	8	7	4
4 x 2 1/8 Square	30.3	20	17	15	13	12	10	6
4 11/16 x 1 1/4 Square	25.5	17	14	12	11	10	8	5
4 11/16 x 1 1/2 Square	29.5	19	16	14	13	11	9	5
4 11/16 x 2 1/8 Square	42.0	28	24	21	18	16	14	8
3 x 2 x 1 1/2 Device	7.5	5	4	3	3	3	2	1
3 x 2 x 2 Device	10.0	6	5	5	4	4	3	2
3 x 2 x 2 1/4 Device	10.5	7	6	5	4	4	3	2
3 x 2 x 2 1/2 Device	12.5	8	7	6	5	5	4	2
3 x 2 x 2 3/4 Device	14.0	9	8	7	6	5	4	2
3 x 2 x 3 1/2 Device	18.0	12	10	9	8	7	6	3
4 x 2 1/8 x 1 1/2 Device	10.3	6	5	5	4	4	3	2
4 x 2 1/8 x 1 7/8 Device	13.0	8	7	6	5	5	4	2
4 x 2 1/8 x 2 1/8 Device	14.5	9	8	7	6	5	4	2
3 3/4 x 2 x 2 1/2 Masonry Box/Gang	14.0	9	8	7	6	5	4	2
3 3/4 x 2 x 3 1/2 Masonry Box/Gang	21.0	14	12	10	9	8	7	4
FS--Minimum Internal Depth 1 3/4 Single Cover/Gang	13.5	9	7	6	6	5	4	2
FD--Minimum Internal Depth 2 3/8 Single Cover/Gang	18.0	12	10	9	8	7	6	3
FS--Minimum Internal Depth 1 3/4 Multiple Cover/Gang	18.0	12	10	9	8	7	6	3
FD--Minimum Internal Depth 2 3/8 Multiple Cover/Gang	24.0	16	13	12	10	9	8	4

Note: For combinations of conductor sizes shown in this table, the maximum number of conductors permitted in a box shall be computed using the volume per conductor listed in Table 8-A*.

*See Section 8-1A for Table 8-A.

TYPICAL TRANSFER SWITCH

FOR SEPARATELY DERIVED SYSTEMS



THE TRANSFER SWITCH SHALL BE LISTED AND HAVE AN OFF POSITION.
 THE TRANSFER SWITCH MUST PREVENT GENERATED POWER FROM FEEDING BACK INTO THE ELECTRIC UTILITY SYSTEM AND ENDANGERING THE LIVES OF LINEWORKER, NEIGHBORS, PETS, LIVESTOCK, ETC.
 ALL EQUIPMENT MUST BE LISTED FOR THE PURPOSE AND INSTALLED ACCORDING TO MANUFACTURE'S INSTRUCTIONS.

THE NEUTRAL WINDING IN THE GENERATOR SHALL BE BONDED TO THE GENERATOR FRAME. CHECK WITH A QUALIFIED ELECTRICIAN TO BE SURE THAT THE BONDING JUMPER IN THE GENERATOR IS INSTALLED AND YOUR GENERATOR IS PROPERLY SETUP FOR YOUR INSTALLATION.
 GENERATOR MUST BE ADEQUATELY SIZED TO SERVE ALL LOADS CONNECTED TO IT.

NOTE:
 FOR ASSISTANCE IN SIZING AND RECOMMENDATIONS CONTACT YOUR LOCAL UTILITY AND AHJ.

Diagram 20-C