

SECTION 16B BASIC ELECTRICAL MATERIALS AND METHODS:

16B-1 METHODS

16B-1-1 RACEWAYS

METALLIC CONDUIT AND TUBING:

- 1. ELECTRICAL METALLIC TUBING AND FITTINGS (EMT): ANSI C80.3, UL 797.
2. FLEXIBLE METAL CONDUIT (FMC): ZINC-COATED STEEL OR ALUMINUM UL 7.
3. INTERMEDIATE METAL CONDUIT (IMC): HOT-DIP GALVANIZED RIGID STEEL CONDUIT. ANSI C80.6, UL 724.
4. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC): FLEXIBLE STEEL CONDUIT WITH PVC JACKET. UL 360.
5. RIGID METAL CONDUIT (RMC): HOT-DIP GALVANIZED RIGID STEEL CONDUIT (GRS): ANSI C80.1, UL 6.
6. PLASTIC-COATED IMC, RMC, AND FITTINGS: NEMA RN 1, UL LISTED.
7. IMC AND RMC FITTINGS: NEMA FB 7, COMPATIBLE WITH CONDUIT TYPE AND MATERIAL, UL LISTED.

NON-METALLIC CONDUIT AND TUBING:

- 1. RIGID NONMETALLIC CONDUIT (RNC): SCHEDULE 40 PVC, 90 DEG C RATED, NEMA TC-2, UL 651, FITTINGS: NEMA TC 3, TC 6, UL 574, COMPATIBLE WITH CONDUIT/TUBING TYPE AND MATERIAL, UL LISTED.
2. EMT AND LFMC FITTINGS: COMPATIBLE WITH CONDUIT/TUBING TYPE AND MATERIAL, UL LISTED.

16B-1-2 RACEWAY INSTALLATION

INSTALL ALL CIRCULAR RACEWAYS CONCEALED ABOVE SUSPENDED CEILING OR CONCEALED IN WALLS OR FLOORS WHEREVER POSSIBLE EXCEPT WHERE OTHERWISE INDICATED.

PROVIDE GRS FOR ALL CONDUITS RUN UNDERGROUND, EXPOSED TO WEATHER, OR EXPOSED TO OTHER HAZARDOUS CONDITIONS. PROVIDE GRS INSTALLED BELOW GRADE WITH AN CORROSION RESISTANT BONDED-PLASTIC OR APPROVED MASTIC COATING. THIS SHALL INCLUDE THE 90-DEGREE ELBOW BELOW GRADE AND THE ENTIRE VERTICAL TRANSITION TO ABOVE GRADE.

ALL OTHER RACEWAY MAY BE EMT WHERE APPROVED BY LOCAL CODE. USE COMPRESSION TYPE FITTINGS FOR EMT, WITH ALL FITTINGS UL LISTED FOR THE ENVIRONMENT IN WHICH THEY ARE USED.

AT CONTRACTOR'S OPTION, PVC CONDUIT MAY BE USED UNDERGROUND WITH OWNER'S APPROVAL, WHERE PERMITTED BY LOCAL CODE AND WHERE NOT SPECIFICALLY RESTRICTED BY THESE DOCUMENTS. WHEN USED, PROVIDE COATED GRS, AS SPECIFIED ABOVE, FOR ALL BENDS GREATER THAN 30 DEGREES, INCLUDING THE 90-DEGREE ELBOWS BELOW GRADE AND THE ENTIRE VERTICAL TRANSITION FOR TRANSITIONS FROM BELOW TO ABOVE GRADE OR ABOVE-SLAB.

USE FMC FOR FINAL CONNECTION TO EACH MOTOR AND TRANSFORMER, AND TO ANY DEVICE THAT WOULD OTHERWISE TRANSMIT MOTION, VIBRATION, OR NOISE. USE LFMC WHERE EXPOSED TO LIQUIDS, VAPORS OR SUNLIGHT, AND TO CONNECTION TO KITCHEN AND FOOD SERVICE EQUIPMENT. PROVIDE ALL FMC AND LFMC WITH AN INSULATED BONDING CONDUCTOR.

INSTALL RACEWAYS PARALLEL AND PERPENDICULAR TO BUILDING LINES.

INSTALL RACEWAYS TO REQUIREMENTS OF STRUCTURE AND TO REQUIREMENTS OF ALL OTHER WORK ON THIS PROJECT. INSTALL RACEWAY TO CLEAR ALL OPENINGS, DEPRESSIONS, PIPES, DUCTS, REINFORCING STEEL, AND OTHER IMMovable OBSTACLES. INSTALL RACEWAYS SET IN FORMS FOR CONCRETE STRUCTURE IN SUCH A MANNER THAT INSTALLATION WILL NOT AFFECT THE STRENGTH OF THE STRUCTURE. EXCEPT WHERE APPROVED IN WRITING BY THE ENGINEER, INSTALL NO RACEWAY IN A SLAB-ON-GRADE. LOCATE RACEWAY IN OR BELOW GRANULAR FILL BELOW SLABS-ON-GRADE.

INSTALL RACEWAYS CONTINUOUS BETWEEN CONNECTIONS TO OUTLETS, BOXES AND CABINETS WITH A MINIMUM POSSIBLE NUMBER OF BENDS AND NOT MORE THAN THE EQUIVALENT OF FOUR 90-DEGREE BENDS BETWEEN CONNECTIONS. USE MANUFACTURED ELBOWS FOR ALL 45- AND 90-DEGREE BENDS, UNLESS APPROVED BY THE ENGINEER IN ADVANCE. MAKE OTHER BENDS SMOOTH AND EVEN AND WITHOUT FLATTENING RACEWAY OR FLAKING GALVANIZING OR ENAMEL. RADII OF BENDS SHALL BE AS LONG AS POSSIBLE AND NEVER SHORTER THAN THE CORRESPONDING TRADE ELBOW. USE LONG RADIIUS ELBOWS WHERE NECESSARY, INDICATED, OR BOTH.

SECURELY FASTEN RACEWAYS IN PLACE WITH APPROVED STRAPS, HANGERS AND STEEL SUPPORTS AS REQUIRED. ATTACH RACEWAY SUPPORTS TO THE BUILDING STRUCTURE. HANG SINGLE RACEWAYS FROM FEEDERS WITH MALLEABLE SPLIT RING HANGERS WITH ROD AND TURNBUCKLE SUSPENSION FROM INSERTS SPACED NOT OVER 10 FEET APART IN CONSTRUCTION ABOVE. CLAMP GROUPS OF HORIZONTAL FEEDER RACEWAYS TO STEEL CHANNELS THAT ARE SUSPENDED FROM INSERTS SPACED NOT OVER 10 FEET APART IN CONSTRUCTION ABOVE. SECURELY CLAMP VERTICAL FEEDER RACEWAYS TO STRUCTURAL STEEL MEMBERS ATTACHED TO STRUCTURE. INSTALL CABLE CLAMPS FOR SUPPORT OF VERTICAL FEEDERS WHERE REQUIRED. ADD RACEWAY SUPPORTS WITHIN 12 INCHES OF ALL BENDS, ON BOTH SIDES OF THE BENDS. DO NOT SUPPORT RACEWAYS FROM SUSPENDED CEILING COMPONENTS.

REAM RACEWAY ENDS, THOROUGHLY CLEAN RACEWAYS BEFORE INSTALLATION, AND KEEP CLEAN AFTER INSTALLATION. PLUG OR COVER OPENINGS AND BOXES AS REQUIRED TO KEEP RACEWAYS CLEAN DURING CONSTRUCTION AND FISH ALL RACEWAYS CLEAR OF OBSTRUCTIONS BEFORE PULLING CONDUCTORS WIRES. PROVIDE RACEWAYS OF AMPLE SIZE FOR PULLING OF WIRE AND NOT SMALLER THAN CODE REQUIREMENTS AND NOT LESS THAN 1/2-INCH IN SIZE, UNLESS INDICATED OTHERWISE ON DRAWINGS.

PROTECT ALL RACEWAY INSTALLATIONS AGAINST DAMAGE DURING CONSTRUCTION. REPAIR ALL RACEWAYS DAMAGED OR MOVED OUT OF LINE AFTER ROUGHING-IN TO MEET ENGINEER'S APPROVAL WITHOUT ADDITIONAL COST TO THE OWNER.

ALIGN AND INSTALL TRUE AND PLUMB ALL RACEWAY TERMINATIONS AT PANELBOARDS, SWITCHBOARDS, MOTOR EQUIPMENT AND JUNCTION BOXES.

INSTALL APPROVED EXPANSION/DEFLECTION FITTINGS WHERE RACEWAYS PASS THROUGH (IF EMBEDDED) OR ACROSS (IF EXPOSED) EXPANSION JOINTS.

INSTALL A PULL WIRE IN EACH EMPTY RACEWAY THAT IS LEFT FOR INSTALLATION OF CONDUCTORS OR CABLES UNDER OTHER DIVISIONS OR CONTRACTS. USE POLYPROPYLENE OR MONOPLAMENT PLASTIC LINE WITH NOT LESS THAN 200-LB TENSILE STRENGTH. LEAVE AT LEAST 24 INCHES OF SLACK AT EACH END OF PULL WIRE.

MAKE ALL JOINTS AND CONNECTIONS IN A MANNER THAT WILL ENSURE MECHANICAL STRENGTH AND ELECTRICAL CONTINUITY.

EFFECTIVELY SEAL RACEWAYS, BY INSTALLING A CONDUIT FITTING AT THE BOUNDARY OF THE TWO SPACES, AND FILLING IT WITH AN APPROVED PLIABLE MATERIAL, AFTER CONDUCTORS OR CABLES HAVE BEEN INSTALLED AND TESTED, WHEN EVER:
1. RACEWAYS PASS FROM NON-COOLED TO COOLED SPACES.
2. RACEWAYS TRANSITION FROM OUTSIDE A FACILITY OR ENCLOSURE TO INSIDE, WHETHER BURIED OR EXPOSED.

16B-1-3 BUSHINGS AND LOCKNUTS

RIGIDLY TERMINATE CONDUITS ENTERING SHEET METAL ENCLOSURES TO THE ENCLOSURE WITH A BUSHING AND LOCKNUT ON THE INSIDE AND A LOCKNUT OR AN APPROVED NUB ON THE OUTSIDE. CONDUIT SHALL ENTER THE ENCLOSURE SQUARELY.

PROVIDE BUSHINGS AND LOCKNUTS MADE OF GALVANIZED MALLEABLE IRON WITH STEEL LOCKNUT THREADS.

WHERE EMT ENTERS A BOX, PROVIDE APPROVED EMT COMPRESSION CONNECTIONS.

USE INSULATED, GROUNDING, OR COMBINATION BUSHINGS WHERE THE CONNECTION IS SUBJECT TO VIBRATION OR MOISTURE, WHEN REQUIRED BY NFPA 70, OR BOTH.

16B-1-4 CONDUCTORS AND CABLES

CONDUCTOR MATERIAL:
1. ANNEALED (SOFT) COPPER COMPLYING WITH 90-DEGREE C-RATED, TYPE THHN/THWN-2 OR XHHW-2 COMPLYING WITH IECA 5-95-658/8 NEMA WC70.

2. SOLID CONDUCTOR FOR NO. 10 AWG AND SMALLER, UNSTRANDED, COMPRESSED STRANDED FOR NO. 8 AWG AND LARGER.

3. STRANDED FOR ALL FLEXIBLE CORDS, CABLES, AND CONTROL WIRING] OR AS OTHERWISE INDICATED.

- 2. CONDUCTOR INSULATION TYPES: 90-DEGREE C-RATED, TYPE THHN/THWN-2 OR XHHW-2 COMPLYING WITH IECA 5-95-658/8 NEMA WC70.
3. SIZES OF CONDUCTORS AND CABLES INDICATED OR SPECIFIED ARE IN AMERICAN WIRE GAGE (AWG - BROWN AND SHARPE).
4. UNLESS INDICATED OTHERWISE, SPECIAL PURPOSE CONDUCTORS AND CABLES, SUCH AS LOW VOLTAGE CONTROL AND SHIELDED INSTRUMENT WIRING, SHALL BE AS RECOMMENDED BY THE SYSTEM EQUIPMENT MANUFACTURER.
5. ALUMINUM WIRING: NOT ALLOWED.

ALL FEEDER AND BRANCH CIRCUIT CONDUCTORS NO. 8 AWG AND LARGER: STRANDED, TYPE THWN-2 OR XHHW-2 INSULATION.

ALL CONDUCTORS, NO. 10 AWG AND SMALLER, USED FOR POWER AND LIGHTING CIRCUITS: SOLID COPPER, TYPE THWN-2 (WET OR DAMP LOCATIONS, OR IN CONDUIT BELOW GRADE OR SLAB), TYPE THHN (DRY LOCATIONS ONLY AND ABOVE GRADE) INSULATION, OR DUAL-RATED TYPE THHN/THWN-2.

ALL BRANCH CIRCUIT WIRING: NOT SMALLER THAN NO. 12 AWG. IF NO CONDUCTOR SIZE IS INDICATED ON THE DRAWINGS FOR A BRANCH CIRCUIT, PROVIDE CONDUCTORS AND CONDUIT SIZED PER NFPA 70 AND BASED ON THE INDICATED BRANCH CIRCUIT OVERCURRENT PROTECTIVE DEVICE (OCPD) RATING AND NUMBER OF POLES. WHERE NO CIRCUIT SIZE (I.E. LOAD AND OCPD) IS INDICATED ON THE DRAWINGS FOR A BRANCH CIRCUIT, PROVIDE THREE NO. 12 AWG CONDUCTORS, IN 3/4-INCH RACEWAY, AND A 20A CIRCUIT BREAKER.

CONDUCTORS FIELD-INSTALLED WITHIN FLOURESCENT LIGHT FIXTURE CHANNELS: TYPE THHN.

CONTROL WIRING: STRANDED COPPER CONDUCTORS, 600V INSULATION, OF THE PROPER TYPE, SIZE AND NUMBER AS REQUIRED TO ACCOMPLISH SPECIFIED FUNCTION. MINIMUM SIZE: NO. 14 AWG, UNLESS NOTED OTHERWISE.

TYPE MC CABLE: 600V, UNMARKETED; ANSI E179 AND E174, UL STANDARDS #4 OR #3 (AS APPLICABLE), AND 1569, NFPA 70 ARTICLE 336; ALUMINUM OR GALVANIZED STEEL INTERLOCKED ARMOR, THIN-OR XHHW-INSULATED CONDUCTORS; COLOR CODE: IECA METHOD 1, WITH GREEN INSULATED GROUNDING CONDUCTOR. NOT ALLOWED IN GARAGE AREA.

16B-1-5 INSTALLATION OF CONDUCTORS AND CABLES

INSTALL ALL WIRING IN APPROVED RACEWAY AND ENCLOSURES, EXCEPT WHERE SPECIFIED OR INDICATED, FOR LOW-VOLTAGE WIRING OR, WHERE TYPE MC CABLE IS INDICATED, SPECIFIED AS ACCEPTABLE, OR BOTH.

SUPPORT ALL CONDUCTORS AND CABLES IN VERTICAL INSTALLATIONS, AS REQUIRED BY NFPA 70, BY INSTALLING CABLE SUPPORTS OR PLUG-TYPE CONDUIT RISER SUPPORTS, OR WIRE-MESH SAFETY GRIPS.

INSTALL ALL CONDUCTORS AND CABLE IN RACEWAYS CONTINUOUS WITHOUT TAPS OR SPLICES. SPLICE OR TAP ONLY IN APPROVED BOXES AND ENCLOSURES WITH APPROVED SOLDERLESS CONNECTORS, OR CLAMP CONNECTORS AND TERMINAL BLOCKS FOR CONTROL WIRING, AND KEEP TO THE MINIMUM REQUIRED. INSULATE ALL SPLICES, TAPS, AND JOINTS AS REQUIRED BY CODES.

ALL MATERIALS USED TO TERMINATE, SPLICE OR TAP CONDUCTORS: DESIGNED, PROPERLY SIZED, AND UL LISTED FOR THE SPECIFIC APPLICATION AND CONDUCTORS INVOLVED, AND INSTALLED IN STRICT ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS, USING THE MANUFACTURER'S RECOMMENDED TOOLS.

WHERE WIRING IS INDICATED AS INSTALLED, BUT THE CONNECTION IS INDICATED "FUTURE" OR "BY OTHER DIVISION, TRADE, OR CONTRACT," LEAVE A MINIMUM 3-FOOT "PIGTAIL" AT THE BOX, TAPE THE ENDS OF THE CONDUCTORS, AND COVER THE BOX.

THE NUMBER OF CONDUCTORS IN A SPECIFIC RACEWAY "HOME RUN" IS INDICATED WITH CROSS LINES (TICK MARKS) ON EACH "CIRCUIT RUN" ON THE DRAWINGS. IN GENERAL, THE DIRECTION OF BRANCH CIRCUIT "HOME RUN" ROUTING IS INDICATED ON THE DRAWINGS, COMPLETE WITH CIRCUIT NUMBERS AND PANELBOARD DESIGNATION. CONTINUE ALL SUCH "HOME RUN" WIRING TO THE DESIGNATED PANELBOARD, AS THOUGH "CIRCUIT RUNS" WERE INDICATED IN THEIR ENTIRETY.

WHEN MULTIPLE HOME RUNS ARE COMBINED INTO A SINGLE RACEWAY SUCH THAT THE NUMBER OF CONDUCTORS EXCEEDS FOUR, CONDUCTOR COUNT IS MADE UP OF ANY COMBINATION OF PHASE AND NEUTRAL CONDUCTORS), THE FOLLOWING RESTRICTIONS APPLY, WHICH ARE IN ADDITION TO THOSE IN NFPA 70:

- 1. NORMAL OR NON-ESSENTIAL CIRCUITS:
A. MAXIMUM OF 16 CONDUCTORS IN A SINGLE RACEWAY. FOR UP TO EIGHT CONDUCTORS IN A RACEWAY, MINIMUM RACEWAY SIZE: 3/4-INCH. FOR GREATER THAN EIGHT CONDUCTORS, MINIMUM RACEWAY SIZE: 1-INCH. DO NOT INSTALL ANY OTHER TYPE OF CIRCUIT IN THIS RACEWAY.
B. THE MINIMUM WIRE SIZE FOR ALL CONDUCTORS IN THIS RACEWAY: NO. 10 AWG.
C. ONLY 15A AND 20A BRANCH CIRCUIT HOMERUNS MAY BE COMBINED INTO ONE RACEWAY.
2. GFCI CIRCUITS:
A. DO NOT USE MULTI-CONDUCTOR CIRCUITS, WITH A SHARED NEUTRAL, FOR ANY GFCI CIRCUIT BREAKER OR RECEPTACLE CIRCUIT.

FOR BRANCH CIRCUITS FED FROM GFCI CIRCUIT BREAKERS, LIMIT THE ONE-WAY CONDUCTOR LENGTH TO 100 FEET BETWEEN THE PANELBOARD AND THE MOST REMOTE RECEPTACLE OR LOAD OF THE GFCI CIRCUIT.

WIRING SHALL HAVE INSULATION OF THE PROPER COLOR TO MATCH COLOR CODE SYSTEM IN THE TABLE BELOW. IN LARGER SIZES, WHERE PROPERLY COLORED INSULATION IS NOT AVAILABLE, USE WHITE PLASTIC ELECTRICAL TAPE OF THE APPROPRIATE COLOR AROUND EACH CONDUCTOR AT ALL TERMINATION POINTS, JUNCTION AND PULL BOXES.

Table with 3 columns: System Voltage, Conductor Type, Color. Row 1: 200V/120, Phase A, Black. Row 2: Phase B, Red. Row 3: Phase C, Blue. Row 4: Neutral, White. Row 5: Equipment Ground, Green w/yellow stripe.

- TYPE MC CABLE ONLY USED:
1. IN CASE OF FLEXIBLE CONDUIT, FROM LIGHT FIXTURES IN ACCESSIBLE CEILING TO JUNCTION BOXES ATTACHED TO BUILDING STRUCTURE ABOVE THE CEILING. PROVIDE CABLE WHIPS OF SUFFICIENT LENGTHS TO ALLOW FOR RELOCATING EACH LIGHT FIXTURE WITHIN A 5-FOOT RADIUS OF ITS INSTALLED LOCATION, NOT EXCEEDING 6 FEET IN UNSUPPORTED LENGTHS.
2. FOR VERTICAL DROPS IN STUD WALLS.
3. IN LIEU OF #1 ONLY FOR 15A AND 20A BRANCH CIRCUITS (WITH UP TO FOUR (4) CONDUCTORS, NOT INCLUDING GROUND CONDUCTOR), AND ONLY IN DRY CONCEALED LOCATIONS ABOVE GRADE, EXCEPT WHERE SPECIFICALLY NOT PERMITTED BY NFPA 70.

- DO NOT USE MC CABLE FOR THE FOLLOWING:
A. HOMERUNS TO PANELBOARDS.
B. WHERE EXPOSED TO VIEW.
C. WHERE EXPOSED TO DAMAGE.
D. HAZARDOUS LOCATIONS.
E. WET LOCATIONS.
F. WHEN RESTRICTED OTHERWISE ABOVE, AND WHEN SPECIFICALLY DISALLOWED BY THE LOCAL AHA, OWNER, OR BOTH.

PROPERLY IDENTIFY ALL TERMINAL BLOCKS AND WIRE TERMINALS FOR CONTROL WIRING WITH VINYL STICK-ON MARKERS OR EQUIVALENT. PROVIDE ENGINEER WITH A LIST OF PROPOSED IDENTIFYING NUMBERS FOR REVIEW PRIOR TO INSTALLING MARKERS.

PROVIDE AN EQUIPMENT-GROUNDING CONDUCTOR, OR BONDING JUMPER, AS APPLICABLE, IN ALL FEEDER AND NON-LIGHTING BRANCH CIRCUITS, SIZED IN ACCORDANCE WITH NFPA 70 TABLES 250.66 OR 250.122, AS APPLICABLE, UNLESS INDICATED AS LARGER ON THE DRAWINGS.

PROVIDE AN EQUIPMENT-GROUNDING CONDUCTOR, OR BONDING JUMPER, AS APPLICABLE, IN ALL BRANCH CIRCUITS AND FEEDERS, SIZED IN ACCORDANCE WITH NFPA 70 TABLES 250.66 OR 250.122, AS APPLICABLE, UNLESS INDICATED AS LARGER ON THE DRAWINGS.

VOLTAGE DROP IN BRANCH CIRCUITS SHALL NOT EXCEED 3 PERCENT.

16B-1-6 JUNCTION BOXES, PULL BOXES, CABINETS AND WIREWAYS

PROVIDE JUNCTION BOXES, PULL BOXES, CABINETS AND WIREWAYS WHEREVER NECESSARY FOR PROPER INSTALLATION OF VARIOUS ELECTRICAL SYSTEMS ACCORDING TO NFPA 70 AND WHERE INDICATED ON THE DRAWINGS. SIZE AS REQUIRED FOR THE SPECIFIC FUNCTION OR AS REQUIRED BY NFPA 70, WHICHEVER IS LARGER. CONSTRUCTION SHALL BE OF A NEMA DESIGN SUITABLE FOR THE ENVIRONMENT INSTALLED.

HORIZONTALLY MOUNT JUNCTION BOXES UNDER CENTER FIXTURES (AND CASES), HANDY BOXES OR 4-INCH SQUARE BOXES WITH TOPS OF BOXES NOT MORE THAN 3-1/2 INCHES ABOVE THE FLOOR. SIZE JUNCTION BOXES TO ADEQUATELY CONTAIN ALL REQUIRED CONDUCTORS AND SPLICES.

16B-1-7 OUTLET BOXES

ALL OUTLETS INCLUDING LIGHT FIXTURE, SWITCH, RECEPTACLE, AND SIMILAR OUTLETS: NATIONAL ELECTRICAL, APPLETON, STEEL CITY, RACO, OR APPROVED EQUAL, GALVANIZED STEEL AND/OR WROUGHT IRON BOXES, SUITABLE IN DESIGN TO THE PURPOSE THEY SERVE AND THE SPACE THEY OCCUPY. SIZE AS REQUIRED FOR THE SPECIFIC FUNCTION OR AS REQUIRED BY NFPA 70, WHICHEVER IS LARGER. SET ALL OUTLET BOXES IN WALLS, COLUMNS, FLOORS, OR CEILING SO THEY ARE FLUSH WITH THE FINISHED SURFACE, ACCURATELY SET, AND RIGIDLY SECURED IN POSITION. PROVIDE PLASTER RINGS, EXTENSION RINGS AND/OR MASONRY RINGS AS REQUIRED FOR FLUSH MOUNTING. PROVIDE APPROVED CAST OUTLET BOXES, WITH HOBS AND WEATHERPROOF COVERS, IN ALL AREAS SUBJECT TO DAMP, WET, OR HARSH CONDITIONS.

16B-1-8 OUTLET LOCATIONS

COORDINATE LOCATIONS OF OUTLET BOXES. OUTLETS ARE ONLY APPROXIMATELY LOCATED ON THE SMALL SCALE DRAWINGS. USE GREAT CARE IN THE ACTUAL LOCATION BY CONSULTING THE VARIOUS LARGE SCALE DETAILED DRAWINGS USED BY OTHER DIVISION TRADES, AND BY SECURING DEFINITE LOCATIONS FROM THE ARCHITECT.

16B-1-9 MOUNTING HEIGHTS

REFER TO THE CONSTRUCTION DRAWINGS FOR MOUNTING HEIGHTS OF WIRING DEVICES AND SWITCHES.

16B-1-10 WIRING DEVICES

RECEPTACLES SHALL BE LEVITON 120-VOLT, 20 AMP, SERIES 76382-W DECORATOR STYLE, BACK WIRED, WALL SWITCHES SHALL BE LEVITON #3827-2W OR #3823-2W. WHERE 15A RATED DEVICES ARE INDICATED ON THE DRAWINGS OR REQUIRED FOR CIRCUIT RATING LIMITATIONS, PROVIDE WIRING DEVICES EQUIVALENT TO THOSE INDICATED ABOVE FOR 20A, BUT RATED FOR 15A.

PROVIDE THE WIRING DEVICES WHERE SHOWN ON DRAWINGS OR REQUIRED. MINOR CHANGES RELATIVE TO THE LOCATION OF ELECTRICAL EQUIPMENT MAY BE MADE TO COMPLY WITH STRUCTURAL AND BUILDING REQUIREMENTS AS DETERMINED IN THE COURSE OF CONSTRUCTION. PROVIDE ALL WIRING DEVICES OF THE SAME MANUFACTURER AND NOT MIXED IN THE PROJECT, TO THE MAXIMUM EXTENT POSSIBLE. PROVIDE WHITE TOGGLES AND RECEPTACLES UNLESS OTHERWISE REQUESTED BY THE ARCHITECT.

16B-1-11 SWITCH AND OUTLET COVER PLATES

SWITCH AND OUTLET PLATES: COLORED, SMOOTH NYLON, BY THE SAME MANUFACTURER AS THE WIRING DEVICES, WHEREVER POSSIBLE. VERIFY DESIRED MATERIALS AND FINISHES WITH ARCHITECT BEFORE INSTALLATION. SWITCH PLATES IN UNFINISHED AREAS AND 2-AND 3-POLE BREAKERS: INSTALL GROUPS OF SWITCHES UNDER ONE CAPITAL LETTER, SMALLER THAN 1/2 INCH OR, WHERE REQUIRED BY DETAILS, VERTICALLY. SET ALL COVER PLATES, SWITCHES, SMALLER AND FINISHED FLUSH WITH THE WALL.

16B-1-12 WEATHERPROOF COVER PLATES

PROVIDE GFCI RECEPTACLES FOR PROTECTED WEATHERPROOF RECEPTACLES, UNLESS INDICATED OTHERWISE ON THE DRAWINGS. FOR UNATTENDED, WET LOCATIONS: IN-USE NON-3/4-INCH-THICK PLATES MOLDED FROM A CLEAR HIGH IMPACT ULTRAVIOLET STABILIZED POLYCARBONATE MATERIAL FOR EASY VERIFICATION PROCEDURES ARE BULGED IN AND THE GFCI IS FUNCTIONING. FOR ATTENDED WET LOCATIONS: WEATHERPROOF COVER PLATES, UL-LISTED FOR WET LOCATIONS WITH GFCI NOT USED; BLACK IN COLOR FOR SWITCHES AND VERTICALLY MOUNTED RECEPTACLES DOUBLE COVER FOR HORIZONTALLY MOUNTED RECEPTACLES; SELF-CLOSING TYPE.

COVER PLATES: BY THE SAME MANUFACTURER AS THE WIRING DEVICES; COMPLYING WITH NFPA 70 406.8 (A) OR (B) REQUIREMENTS FOR ATTENDED OR UNATTENDED USE AS APPLICABLE.

16B-2 ELECTRICAL SERVICE AND GROUNDING

16B-2-1 ELECTRICAL SERVICE

SEE DRAWINGS FOR TYPE, SIZE, VOLTAGE, PHASE, AND OTHER REQUIREMENTS. PROVIDE, OR ARRANGE WITH THE SERVING UTILITY FOR INSTALLATION TO PROVIDE, A RECORDING VOLTMETER AT THE SERVICE POINT, ON THE FIRST DAY THE FACILITY IS OPEN FOR BUSINESS, FOR A 24-HOUR VOLTAGE TEST. IF VOLTAGE AND REGULATION ARE NOT WITHIN ACCEPTABLE LIMITS, ARRANGE WITH THE UTILITY FOR PROPER VOLTAGE. SUBMIT TO THE OWNER A REPORT OF MAXIMUM AND MINIMUM VOLTAGE AND A COPY OF THE RECORDING.

PROVIDE WEATHER PROTECTION TO SERVING UTILITIES.

PROVIDE RACEWAYS, TERMINATIONS, METERING PROVISIONS, AND MISCELLANEOUS EQUIPMENT, AS REQUIRED, FOR ELECTRICAL AND TELEPHONE SERVICES FOR CONNECTION BY THE SERVING UTILITY, IN STRICT COMPLIANCE WITH THE REQUIREMENTS OF ALL APPLICABLE CODES AND OF THE SERVING UTILITY INVOLVED. VERIFY ALL SERVICE TERMINATIONS AND CONNECTION POINTS IN THE FIELD AND WORK IN CONJUNCTION WITH THE UTILITY INVOLVED IN THE INSTALLATION OF ALL SERVICES. PROVIDE ALL MATERIALS AND EQUIPMENT REQUIRED FOR COMPLETE UTILITY CONNECTION BUT NOT FURNISHED BY THE SERVING UTILITY. NOTIFY THE UTILITY COMPANIES INVOLVED WITHIN TWO WEEKS AFTER NOTICE TO PROCEED, OF ALL REQUIRED INFORMATION NECESSARY FOR THE UTILITY TO SUPPLY THE PROJECT WITHOUT DELAY. PAY ALL CHARGES OF THE SERVING UTILITY FOR THE ELECTRICAL SERVICE(S).

16B-2-2 GROUNDING

PERMANENTLY AND EFFECTIVELY GROUND AND BOND THE ELECTRICAL INSTALLATION IN A THOROUGH AND EFFICIENT MANNER, AND IN CONFORMANCE, AT A MINIMUM, WITH NFPA 70, OR THESE DOCUMENTS, WHERE THEY EXCEED CODE REQUIREMENTS. USE BARE OR INSULATED CONDUCTORS, AS SPECIFIED HEREIN, AND OTHER MATERIALS INDICATED ON THE DRAWINGS.

16B-3 DISTRIBUTION AND CONTROL EQUIPMENT

16B-3-1 LIGHTING AND APPLIANCE PANELBOARDS

PANELBOARDS: GENERAL ELECTRIC TYPE AE OR AG, AS APPLICABLE, BASED ON VOLTAGE AND AMPERE RATINGS RATED AND REQUIRED SHORT-CIRCUIT INTERRUPTING RATINGS AS SCHEDULED ON THE DRAWINGS UNLESS OTHERWISE INDICATED. COMPLETE WITH BUILT-IN THERMAL MAGNETIC, MOLDED CASE CIRCUIT BREAKERS ASSEMBLED IN A DEAD-FRONT FINISHED CABINET CONTAINING A TYPEWRITTEN CARD DIRECTORY INDICATING EXACTLY WHAT EACH CIRCUIT BREAKER CONTROLS; FULLY-OR SERIES RATED AND WITH THE INTEGRATED SHORT CIRCUIT CURRENT RATINGS INDICATED ON THE DRAWINGS. PLOG-IN TYPE BREAKERS WILL NOT BE ACCEPTABLE. ALL TWO AND THREE-POLE BREAKERS: COMMON TRIP TYPE. BREAKERS USED AS SWITCHES FOR 120V OR 277V LIGHTING CIRCUITS: APPROVED FOR THE PURPOSE AND MARKED "SW". BREAKERS USED FOR THE PROTECTION OF HVAC AND REFRIGERATION EQUIPMENT: HACK TYPE.

16B-3-2 SERIES RATINGS ON PANELBOARDS

LABEL PANELBOARDS WITH A UL INTEGRATED SHORT CIRCUIT CURRENT RATING. WHEN SERIES RATINGS ARE APPLIED WITH INTEGRAL OR REMOTE UPSTREAM DEVICES, PROVIDE LABELS COMPLYING WITH NFPA 70 ARTICLES 240.86 AND 240.122. IN ADDITION TO THE WARNING LABEL, INCLUDE, AT A MINIMUM, THE FOLLOWING CONDITIONS OF THE UL 67 SERIES RATINGS:

- 1. SIZE AND TYPE OF UPSTREAM DEVICE.
2. BRANCH DEVICES THAT CAN BE USED.
3. UL SERIES SHORT CIRCUIT CURRENT RATING.

WHEN THERE IS NOT ENOUGH ROOM IN THE EQUIPMENT TO SHOW ALL THE LEGITIMATE SERIES RATED COMBINATIONS, REFERENCE A BULLETIN SUPPLIED WITH THE PANELBOARD, PER UL 67.

SERIES RATINGS SHALL COVER ALL TRIP RATINGS OF INSTALLED FRAMES.

16B-3-3 DISCONNECT (SAFETY) SWITCHES

DISCONNECT (SAFETY) SWITCHES: GENERAL ELECTRIC FUSED OR NON-FUSED TYPE THD (AS INDICATED ON DRAWINGS OR REQUIRED); NEMA KS1, HEAVY DUTY, EXTERNALLY OPERATED, VISIBLE-BLADE SAFETY SWITCHES; NEMA ENCLOSURE TYPE INDICATED ON THE DRAWINGS OR SUITABLE FOR THE ENVIRONMENT IN WHICH INSTALLED. BASED ON FUSIBLE SWITCH AND FUSE SIZES INDICATED, INCLUDE CLASS R, J, OR L FUSE PROVISIONS AS APPLICABLE.

WHERE INDICATED, PROVIDE FUSIBLE SWITCHES PERMANENTLY LABELED AS SUITABLE FOR USE AS SERVICE ENTRANCE EQUIPMENT, WITH INTEGRAL AND SEPARATE NEUTRAL AND GROUND ASSEMBLIES, SUITABLE FOR THE SIZES OF CONDUCTORS INDICATED. DO NOT DOUBLE-LOC ANY TERMINATIONS NOT SPECIFICALLY LISTED AS SUITABLE FOR MORE THAN ONE CONDUCTOR.

PROVIDE SWITCHES WHERE NOT FURNISHED WITH THE STARTING EQUIPMENT, AT ALL OTHER POINTS REQUIRED BY NFPA 70, AND WHERE INDICATED ON THE DRAWINGS.

16B-3-4 FUSES

FURNISH THREE SPARE FUSES OF EACH SIZE AND TYPE USED ON THE PROJECT (EXCEPT MAIN SWITCH FUSES, FURNISH ONE SPARE), NEATLY CONTAINED IN A PROPERLY LABELED CABINET. PROVIDE EACH CIRCUIT AND SET OF FUSE CLIPS THROUGHOUT THE WORK WITH BUSSMANN, FERRAZ SHAWMUT, OR LITTLEFUSE FUSES, SIZES AND TYPES AS REQUIRED OR INDICATED. ALL FUSES LARGER THAN CLASS 1, SIMILAR TO TYPE KERS, BUSSMANN LOW PEAR OR EQUAL. FUSES USED TO PROTECT MOTORS: UL CLASS KMS, BUSSMANN FUSETRON OR EQUAL. FUSES USED TO PROTECT ALL OTHER ELECTRICAL EQUIPMENT: UL CLASS RK1, DUAL ELEMENT, BUSSMANN LPS/LPN OR EQUAL. ALL FUSED DEVICES SHALL BE LABELED AS TO TYPE AND SIZE OF FUSE REQUIRED.

16B-3-5 PHOTO CONTROL

PHOTO CONTROL SHALL:
1. PROVIDE AUTOMATIC SWITCHING FOR LIGHTING LOADS USING A THERMAL DESIGN WITH BUILT-IN DELAY TO ENSURE THAT THE CONTROLLED LIGHTING DOES NOT SWITCH OFF DUE TO AMBIENT LIGHT OR LIGHTNING STRIKING THE PHOTOCELL.
2. HAVE A RATING BASED ON UL TESTING AT 50% POWER FACTOR FOR BALLAST LOADS, BE UL LISTED, AND MEET ALL APPLICABLE AGENCY REQUIREMENTS.
3. BE STEM-MOUNTING TYPE WITH ALL NECESSARY MOUNTING HARDWARE AND INSTRUCTIONS; HAVE A HOUSING CONSTRUCTED OF HIGH IMPACT POLYCARBONATE; PHOTO CONTROL COMPONENTS CONSISTING OF A METAL FILM RESISTOR, DUAL TEMPERATURE COMPENSATING BI-METAL BLADES, SHARP ACTION CONTACT BLADES, CHEMICALLY TREATED/POLYMER ENCAPSULATED CADMIUM SULFIDE PHOTOCELL AND SILVER ALLOY CONTACTS TO ENSURE RELIABLE 5 YEAR MANUFACTURER WARRANTED OPERATION. PHOTO CONTROL SHALL BE 100% FACTORY TESTED FOR FUNCTION WITHIN MANUFACTURER'S SPECIFIED LIGHT LEVELS.
4. BE FROM THE SAME MANUFACTURER OF AND TOTALLY COMPATIBLE WITH THE TIME SWITCHES SPECIFIED ABOVE.

16B-3-6 PHOTO CONTROL

PHOTO CONTROL SHALL:
1. PROVIDE AUTOMATIC SWITCHING FOR LIGHTING LOADS USING A THERMAL DESIGN WITH BUILT-IN DELAY TO ENSURE THAT THE CONTROLLED LIGHTING DOES NOT SWITCH OFF DUE TO AMBIENT LIGHT OR LIGHTNING STRIKING THE PHOTOCELL.
2. HAVE A RATING BASED ON UL TESTING AT 50% POWER FACTOR FOR BALLAST LOADS, BE UL LISTED, AND MEET ALL APPLICABLE AGENCY REQUIREMENTS.
3. BE STEM-MOUNTING TYPE WITH ALL NECESSARY MOUNTING HARDWARE AND INSTRUCTIONS; HAVE A HOUSING CONSTRUCTED OF HIGH IMPACT POLYCARBONATE; PHOTO CONTROL COMPONENTS CONSISTING OF A METAL FILM RESISTOR, DUAL TEMPERATURE COMPENSATING BI-METAL BLADES, SHARP ACTION CONTACT BLADES, CHEMICALLY TREATED/POLYMER ENCAPSULATED CADMIUM SULFIDE PHOTOCELL AND SILVER ALLOY CONTACTS TO ENSURE RELIABLE 5 YEAR MANUFACTURER WARRANTED OPERATION. PHOTO CONTROL SHALL BE 100% FACTORY TESTED FOR FUNCTION WITHIN MANUFACTURER'S SPECIFIED LIGHT LEVELS.
4. BE FROM THE SAME MANUFACTURER OF AND TOTALLY COMPATIBLE WITH THE TIME SWITCHES SPECIFIED ABOVE.

16B-3-7 LIGHTING CONTRACTORS

LIGHTING CONTRACTORS:
1. INDUSTRIAL DUTY TYPE; SILVER ALLOY, DOUBLE BREAK CONTACTS, CONVERTIBLE WITH NO AND NO INDICATORS; CAPABLE OF ADDING POLES IN THE FIELD; NUMBER AND RATING OF POLES AS INDICATED ON THE DRAWINGS OR REQUIRED BY THE LOAD CONTROLLED; TYPED DIRECTORY AFFIXED TO THE INSIDE OF THE ENCLOSURE DOOR LISTING ALL BRANCH CIRCUITS SWITCHED AND THE CONTROL POWER BRANCH CIRCUIT.
2. SHORT CIRCUIT CURRENT RATING:
A. 22,000A AT 240V
B. 10,000A AT 480V
3. ENCL. CLASS:
A. NEMA
4. COOL VOLTAGE:
A. 120V AC

16B-3-8 BALLASTS

FLOURESCENT BALLASTS: LOW HEAT TYPE, THERMALLY PROTECTED AGAINST OVERHEATING; ETL-CRM CLASS P TO MEET ALL REQUIREMENTS OF SECTION #10-73 (E) OF THE NFPA 70 AS A MINIMUM, COMPLY WITH THE NATIONAL BALLAST ENERGY LAW; 90- PERCENT POWER FACTOR OR GREATER; SOUND LEVELS NOT EXCEEDING CLASS A AMBIENT NOISE LEVELS.
1. INDOOR FLOURESCENT BALLASTS: ELECTRONIC TYPE SUITABLE FOR OPERATION OF T8 LAMPS; TOTAL HARMONIC DISTORTION LESS THAN 20 PERCENT; FREQUENCY OF OPERATION OF 20 KHZ OR GREATER WITH NO VISIBLE FLICKER; LINE TRANSIENT WITHSTAND RATINGS AS DEFINED IN ANSI/IEEE C62.41, CATEGORY A. MANUFACTURERS: ADVANCE REL/VEL SERIES OR APPROVED EQUAL BY MAGNETEK, MOTOROLA, OR OSRAM.
2. EXTERIOR AND LOW TEMPERATURE FLOURESCENT BALLASTS: SHALL BE ELECTRONIC TYPE SUITABLE FOR OPERATION OF T8 LAMPS; SHALL HAVE A TOTAL HARMONIC DISTORTION LESS THAN 20 PERCENT; SHALL HAVE A FREQUENCY OF OPERATION OF 20 KHZ OR GREATER AND OPERATE WITH NO VISIBLE FLICKER; SHALL WITHSTAND LINE TRANSIENTS AS DEFINED IN ANSI/IEEE C62.41, CATEGORY A. SHALL HAVE A MINIMUM STARTING TEMPERATURE OF -20 DEGREES F; AND SHALL BE ADVANCE REL/VEL SERIES OR EQUAL OF MAGNETEK OR MOTOROLA.
3. COMPACT FLOURESCENT BALLASTS: SHALL BE THERMALLY PROTECTED AGAINST OVERHEATING; SHALL BE CLASS P; SHALL HAVE A MINIMUM 90 PERCENT POWER FACTOR; SOUND LEVELS SHALL NOT EXCEED CLASS A AMBIENT NOISE LEVELS; AND SHALL BE LOW HEAT TYPE. ALL BALLASTS SHALL BE BY ADVANCE. BALLASTS FOR 36W T8/90 55W LAMPS SHALL BE MARK V ELECTRONIC TYPE.
4. HIGH-INTENSITY DISCHARGE (HID) BALLASTS (INCLUDES HIGH PRESSURE SODIUM (HPS) AND METAL HALIDE (MH)): SHALL HAVE A POWER FACTOR GREATER THAN 90 PERCENT; COMPLY WITH UNDERWRITERS LABORATORY (UL) 1023; PROVIDE NORMAL OPERATION AND LIGHT OUTPUT WITH THE INPUT VOLTAGE IS WITHIN 170 PERCENT OF NOMINAL BALLAST RATING (EXCEPT HPS LAMPS SMALLER THAN 250W WHICH MUST HAVE THE INPUT VOLTAGE WITHIN +5 PERCENT); SHALL HAVE A MINIMUM STARTING TEMPERATURE OF -20 DEGREES F. PROVIDE ENCAPSULATED AND REMOTE TYPES WHERE INDICATED ON THE DRAWINGS.

16B-3-9 BALLASTS

EMERGENCY FLOURESCENT BALLASTS: SHALL BE BODINE B50 OR IOTA I-232 FOR FOUR-FOOT FLOURESCENT LAMPS; SHALL BE BODINE B30 OR IOTA I-160 FOR EIGHT-FOOT FLOURESCENT LAMPS. LIGHTING FIXTURES SHALL BE EQUIPPED WITH DISCONNECTING MEANS IN ACCORDANCE WITH NEC 410.73(G).

16B-5 MISCELLANEOUS ELECTRICAL

16B-5-1 WIRING OF MECHANICAL EQUIPMENT

PROVIDE ALL RACEWAYS AND POWER WIRING FOR ALL DIVISION 15 EQUIPMENT REQUIRING ELECTRICAL CONNECTIONS, INCLUDING, BUT NOT LIMITED TO, PUMPS, WATER HEATERS, AND HVAC EQUIPMENT, AND ALL LINE-VOLTAGE CONTROL AND INTERLOCK WIRING NOT PROVIDED UNDER DIVISION 15. CONNECT PER MANUFACTURER'S WIRING DIAGRAMS. COORDINATE WITH DIVISION 15 FOR DISCONNECTS FURNISHED WITH EQUIPMENT, AND PROVIDE ALL DISCONNECT SWITCHES AS REQUIRED. AFTER INSTALLING WIRING, VERIFY THAT EACH MOTOR LOAD HAS THE CORRECT PHASE ROTATION.

VERIFY THE ACTUAL "MAXIMUM OVERCURRENT PROTECTION" (MOCP) DEVICE RATINGS AND "MINIMUM CIRCUIT AMPACITY" (MCA) CONDUCTOR SIZING FOR MECHANICAL EQUIPMENT FROM THE EQUIPMENT NAMEPLATE. BASE ELECTRICAL INSTALLATIONS ON ACTUAL REQUIRED AMPERAGES, WHICH MAY VARY SOMEWHAT FROM THE CONDUCTOR AND EQUIPMENT