# ELECTRICAL SPECIFICATIONS

## ELECTRICAL CONDUCTORS

A. MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:
ALCAN PRODUCTS CORPORATION; ALCAN CABLE DIVISION.
AMERICAN INSULATED WIRE CORP.; A LEVITON COMPANY.
GENERAL CABLE CORPORATION.
SENATOR WIRE & CABLE COMPANY.
SOUTHWIRE COMPANY.
COPPER CONDUCTORS: COMPLY WITH NEMA WC 70.
CONDUCTOR INSULATION: COMPLY WITH NEMA WC 70 FOR TYPES THW, THHN-THWN, XHHW, UF, USE, AND SO.
MULTICONDUCTOR CABLE: COMPLY WITH NEMA WC 70 FOR ARMORED CABLE, TYPE AC, METAL-CLAD CABLE, TYPE MC ,TYPE SO, AND TYPE USE WITH GROUND WIRE.

B. CONDUCTOR MATERIAL APPLICATIONS:
COPPER. SOLID FOR NO. 10 AWG AND SMALLER; STRANDED FOR NO. 8 AWG AND LARGER.

C. CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
1. SERVICE ENTRANCE: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY, TYPE SE OR USE MULTICONDUCTOR CABLE.
2. EXPOSED FEEDERS: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY.
3. FEEDERS CONCEALED IN CEILINGS, WALLS, PARTITIONS, AND CRAWLSPACES: TYPE THHN-THHN, SINGLE CONDUCTORS IN RACEWAY.
4. FEEDERS CONCEALED IN CONCRETE, BELOW SLABS-ON-GRADE, AND UNDERGROUND: YPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY.
5. FEEDERS INSTALLED BELOW RAISED FLOORING: TYPE THHN-THHN, SINGLE CONDUCTORS IN RACEWAY.
6. EXPOSED BRANCH CIRCUITS, INCLUDING IN CRAWLSPACES: TYPE THHN-THHN, SINGLE CONDUCTORS IN RACEWAY, METAL-CLAD CABLE, TYPE MC.
7. BRANCH CIRCUITS CONCEALED IN CEILINGS, WALLS, AND PARTITIONS: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY, ARMORED CABLE, TYPE AC, METAL-CLAD CABLE, TYPE MC.
8. BRANCH CIRCUITS CONCEALED IN CONCRETE, BELOW SLABS-ON-GRADE, AND UNDERGROUND: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY.
9. BRANCH CIRCUITS INSTALLED BELOW RAISED FLOORING: TYPE THHN-THWN, SINGLE CONDUCTORS IN RACEWAY OR ARMORED CABLE, TYPE AC, METAL-CLAD CABLE, TYPE MC.
10. BRANCH CIRCUITS INSTALLED IN PATIENT CARE AREAS: TYPE HCF-MCAP OR AC-HCF WITH ASSEMBLY CERTIFIED AS AN EQUIPMENT GROUNDING CONDUCTOR AND A GREEN INSULATED EQUIPMENT GROUNDING CONDUCTOR CONNECTED TO ALL RECEPTACLES, METALLIC BOXES CONTAINING RECEPTACLES, AND ALL METALLIC EQUIPMENT CASINGS.

## GROUNDING

A. INSULATED CONDUCTORS: COPPER WIRE OR CABLE INSULATED FOR 600 V UNLESS OTHERWISE REQUIRED BY APPLICABLE CODE OR AUTHORITIES HAVING JURISDICTION.

B. BARE COPPER CONDUCTORS:
1. SOLID CONDUCTORS: ASTM B 3.
2. STRANDED CONDUCTORS: ASTM B 8.
3. BONDING CABLE: 28 KCMIL, 14 STRANDS OF NO. 17 AWG CONDUCTOR, 1/4 INCH (6 MM) IN DIAMETER.
4. BONDING CONDUCTOR: NO. 4 OR NO. 6 AWG, STRANDED CONDUCTOR.
5. BONDING JUMPER: COPPER TAPE, BRAIDED CONDUCTORS TERMINATED WITH COPPER FERRULES; 1-5/8 INCHES (41 MM) WIDE AND 1/16 INCH (1.6 MM) THICK.

C. GROUNDING BUS: PREDRILLED RECTANGULAR BARS OF ANNEALED COPPER, 1/4 BY 4 INCHES (6.3 BY 100 MM) IN CROSS SECTION, WITH 9/32-INCH (7.14-MM) HOLES SPACED 1-1/8 INCHES (28 MM) APART. STAND-OFF INSULATORS FOR MOUNTING SHALL COMPLY WITH UL 891 FOR USE IN SWITCHBOARDS, 600 V. LEXAN, IMPULSE TESTED AT 5000 V.

D. CONNECTORS:LISTED AND LABELED BY AN NRTL ACCEPTABLE TO AUTHORITIES HAVING JURISDICTION FOR APPLICATIONS IN WHICH USED AND FOR SPECIFIC TYPES, SIZES, AND COMBINATIONS OF CONDUCTORS AND OTHER ITEMS CONNECTED.

E. BOLTED CONNECTORS FOR CONDUCTORS AND PIPES: COPPER OR COPPER ALLOY, PRESSURE TYPE WITH AT LEAST TWO BOLTS.
PIPE CONNECTORS: CLAMP TYPE, SIZED FOR PIPE.

F. WELDED CONNECTORS: EXOTHERMIC-WELDING KITS OF TYPES RECOMMENDED BY KIT MANUFACTURER FOR MATERIALS BEING JOINED AND INSTALLATION CONDITIONS.

G. BUS-BAR CONNECTORS: MECHANICAL TYPE, CAST SILICON BRONZE, SOLDERLESS COMPRESSION-TYPE WIRE TERMINALS, AND LONG-BARREL, TWO-BOLT CONNECTION TO GROUND BUS BAR.

H. CONDUCTORS: INSTALL SOLID CONDUCTOR FOR NO. 8 AWG AND SMALLER, AND STRANDED CONDUCTORS FOR NO. 6 AWG AND LARGER UNLESS OTHERWISE INDICATED.

I. ISOLATED GROUNDING CONDUCTORS: GREEN-COLORED INSULATION WITH CONTINUOUS YELLOW STRIPE. ON FEEDERS WITH ISOLATED GROUND, IDENTIFY GROUNDING CONDUCTOR WHERE VISIBLE TO NORMAL INSPECTION, WITH ALTERNATING BANDS OF GREEN AND YELLOW TAPE, WITH AT LEAST THREE BANDS OF GREEN AND TWO BANDS OF YELLOW.

J. CONDUCTOR TERMINATIONS AND CONNECTIONS:
PIPE AND EQUIPMENT GROUNDING CONDUCTOR TERMINATIONS: BOLTED CONNECTORS.
UNDERGROUND CONNECTIONS: WELDED CONNECTORS EXCEPT AT TEST WELLS AND AS OTHERWISE INDICATED. CONNECTIONS TO GROUND RODS AT TEST WELLS: BOLTED CONNECTORS. CONNECTIONS TO STRUCTURAL STEEL: WELDED CONNECTORS.

K. EQUIPMENT GROUNDING:
INSTALL INSULATED EQUIPMENT GROUNDING CONDUCTORS TO COMPLY WITH THE NEC AND AS INDICATED ON THE DRAWINGS.

## ELECTRICAL HANGERS AND SUPPORTS

A. COMPLY WITH NECA 1 AND NECA 101 FOR APPLICATION OF HANGERS AND SUPPORTS FOR ELECTRICAL EQUIPMENT AND SYSTEMS EXCEPT IF REQUIREMENTS IN THIS SECTION ARE STRICTER. MAXIMUM SUPPORT SPACING AND MINIMUM HANGER ROD SIZE FOR RACEWAY: SPACE SUPPORTS FOR EMT, IMC, AND RMC AS SCHEDULED IN NECA 1, WHERE ITS TABLE 1 LISTS MAXIMUM SPACINGS LESS THAN STATED IN NFPA 70. MINIMUM ROD SIZE SHALL BE 1/4 INCH (6 MM) IN DIAMETER. MULTIPLE RACEWAYS OR CABLES: INSTALL TRAPEZE-TYPE SUPPORTS FABRICATED WITH STEEL SLOTTED OR OTHER SUPPORT SYSTEM, SIZED SO CAPACITY CAN BE INCREASED BY AT LEAST 25 PERCENT IN FUTURE WITHOUT EXCEEDING SPECIFIED DESIGN LOAD LIMITS. SECURE RACEWAYS AND CABLES TO these SUPPORTS WITH TWO-BOLT CONDUIT CLAMPS. SPRING-STEEL CLAMPS DESIGNED FOR SUPPORTING SINGLE CONDUITS WITHOUT BOLTS MAY BE USED FOR 1-1/2-INCH (38-MM) AND SMALLER RACEWAYS SERVING BRANCH CIRCUITS AND COMMUNICATION SYSTEMS ABOVE SUSPENDED CEILINGS AND FOR FASTENING RACEWAYS TO TRAPEZE SUPPORTS.

B. SUPPORT INSTALLATION: COMPLY WITH NECA 1 AND NECA 101 FOR INSTALLATION REQUIREMENTS EXCEPT AS SPECIFIED IN THIS ARTICLE.

C. RACEWAY SUPPORT METHODS: IN ADDITION TO METHODS DESCRIBED IN NECA 1, EMT, IMC, AND RMC MAY BE SUPPORTED BY OPENINGS THROUGH STRUCTURE MEMBERS, AS PERMITTED IN NFPA 70.

D. STRENGTH OF SUPPORT ASSEMBLIES: WHERE NOT INDICATED, SELECT SIZES OF COMPONENTS SO STRENGTH WILL BE ADEQUATE TO CARRY PRESENT AND FUTURE STATIC LOADS WITHIN SPECIFIED LOADING LIMITS. MINIMUM STATIC DESIGN LOAD USED FOR STRENGTH DETERMINATION SHALL BE WEIGHT OF SUPPORTED COMPONENTS PLUS 200 LB (90 KG).

E. MOUNTING AND ANCHORAGE OF SURFACE-MOUNTED EQUIPMENT AND COMPONENTS: ANCHOR AND FASTEN ELECTRICAL ITEMS AND THEIR SUPPORTS TO BUILDING STRUCTURAL ELEMENTS BY THE FOLLOWING METHODS UNLESS OTHERWISE INDICATED BY CODE:
1. TO WOOD: FASTEN WITH LAG SCREWS OR THROUGH BOLTS.
2. TO NEW CONCRETE: BOLT TO CONCRETE INSERTS.
3. TO MASONRY: APPROVED TOGGLE-TYPE BOLTS ON HOLLOW MASONRY UNITS AND EXPANSION ANCHOR FASTENERS ON SOLID MASONRY UNITS.
4. TO EXISTING CONCRETE: EXPANSION ANCHOR FASTENERS.
5. INSTEAD OF EXPANSION ANCHORS, POWDER-ACTUATED DRIVEN THREADED STUDS PROVIDED WITH LOCK WASHERS AND NUTS MAY BE USED IN EXISTING STANDARD-WEIGHT CONCRETE 4 INCHES (100 MM) THICK OR GREATER. DO NOT USE FOR ANCHORAGE TO LIGHTWEIGHT-AGGREGATE CONCRETE OR FOR SLABS LESS THAN 4 INCHES (100 MM) THICK.
6. TO STEEL: WELDED THREADED STUDS COMPLYING WITH AWS D1.1/D1.1M, WITH LOCK WASHERS AND NUTS OR BEAM CLAMPS (MSS TYPE 19, 21, 23, 25, OR 27) COMPLYING WITH MSS SP-69.
7. TO LIGHT STEEL: SHEET METAL SCREWS.
8. DRILL HOLES FOR EXPANSION ANCHORS IN CONCRETE AT LOCATIONS AND TO DEPTHS THAT AVOID REINFORCING BARS.

## ELECTRICAL CONDUIT

A. METAL CONDUIT AND TUBING
MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:
1. AFC CABLE SYSTEMS, INC.
2. ALFLEX INC.
3. ALLIED TUBE & CONDUIT; A TYCO INTERNATIONAL LTD. CO.
4. ANAMET ELECTRICAL, INC.; ANACONDA METAL HOSE.
5. ELECTRI-FLEX CO.
6. MAVERICK TUBE CORPORATION.
7. O-Z/GEDNEY; A UNIT OF GENERAL SIGNAL.
8. WHEATLAND TUBE COMPANY.

B. RIGID STEEL CONDUIT: ANSI C80.1.
C. ALUMINUM RIGID CONDUIT: ANSI C80.5.
D. IMC: ANSI C80.6.
E. PVC-COATED STEEL CONDUIT: PVC-COATED RIGID STEEL CONDUIT.
F. COMPLY WITH NEMA RN 1.
G. COATING THICKNESS: 0.040 INCH (1 MM), MINIMUM.
H. EMT: ANSI C80.3.
I. FMC: ZINC-COATED STEEL.
J. LFMC: FLEXIBLE STEEL CONDUIT WITH PVC JACKET.
K. FITTINGS FOR CONDUIT (INCLUDING ALL TYPES AND FLEXIBLE AND LIQUIDTIGHT), EMT, AND CABLE: NEMA FB 1; LISTED FOR TYPE AND SIZE RACEWAY WITH WHICH USED, AND FOR APPLICATION AND ENVIRONMENT IN WHICH INSTALLED.
1. FITTINGS FOR EMT: STEEL SET-SCREW OR COMPRESSION TYPE. DIE-CAST IS NOT ACCEPTABLE.
2. COATING FOR FITTINGS FOR PVC-COATED CONDUIT: MINIMUM THICKNESS, 0.040 INCH (1 MM), WITH OVERLAPPING SLEEVES PROTECTING THREADED JOINTS.

L. JOINT COMPOUND FOR RIGID STEEL CONDUIT OR IMC: LISTED FOR USE IN CABLE CONNECTOR ASSEMBLIES, AND COMPOUNDED FOR USE TO LUBRICATE AND PROTECT THREADED RACEWAY JOINTS FROM CORROSION AND ENHANCE THEIR CONDUCTIVITY.

M. SURFACE METAL RACEWAYS: GALVANIZED STEEL WITH SNAP-ON COVERS. MANUFACTURER'S STANDARD ENAMEL FINISH IN COLOR SELECTED BY ARCHITECT.
MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:
1. THOMAS & BETTS CORPORATION.
2. WALKER SYSTEMS, INC.; WIREMOLD COMPANY (THE).
3. WIREMOLD COMPANY (THE); ELECTRICAL SALES DIVISION.

N. BOXES, ENCLOSURES, AND CABINETS:
MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:
1. COOPER CROUSE-HINDS; DIV. OF COOPER INDUSTRIES, INC.
2. EGS/APPLETON ELECTRIC.
3. HOFFMAN.
4. HUBBELL INCORPORATED; KILLARK ELECTRIC MANUFACTURING CO. DIVISION.
5. O-Z/GEDNEY; A UNIT OF GENERAL SIGNAL.
6. RACO; A HUBBELL COMPANY.
7. ROBROY INDUSTRIES, INC.; ENCLOSURE DIVISION.
8. THOMAS & BETTS CORPORATION.
9. WALKER SYSTEMS, INC.; WIREMOLD COMPANY (THE).

O. SHEET METAL OUTLET BOXES: NEMA OS 1.
P. CAST-METAL OUTLET AND DEVICE BOXES: NEMA FB 1, FERROUS ALLOY, TYPE FD, WITH GASKETED COVER.
Q. METAL FLOOR BOXES: CAST METAL, FULLY ADJUSTABLE, RECTANGULAR.
R. SMALL SHEET METAL PULL AND JUNCTION BOXES: NEMA OS 1.
S. CAST-METAL ACCESS, PULL, AND JUNCTION BOXES: NEMA FB 1, GALVANIZED, CAST IRON WITH GASKETED COVER.
T. HINGED-COVER ENCLOSURES: NEMA 250, TYPE 1, WITH CONTINUOUS-HINGE COVER WITH FLUSH LATCH, UNLESS OTHERWISE INDICATED.
1. METAL ENCLOSURES: STEEL, FINISHED INSIDE AND OUT WITH MANUFACTURER'S STANDARD ENAMEL.
A. IN STANDARD PARTITIONS, WHERE 1/2" AND 3/4" CONDUITS ARE EMPLOYED: 4" SQUARE BY 2-1/8" DEEP BOXES WITH 1-GANG OR 2-GANG PLASTER COVERS SHALL BE USED, NO. 4SD-SPL.
B. IN THIN PARTITIONS MEASURING 3-1/2" OR LESS: 4" SQUARE BY 1-1/2" DEEP BOXES WITH 1-GANG OR 2-GANG PLASTER COVERS SHALL BE USED, NO. 4S-SPL.
C. IN STANDARD PARTITIONS, WHERE CONDUITS OF A SIZE GREATER THAN 3/4" ARE EMPLOYED: 4" SQUARE BY 2-1/8" DEEP BOXES WITH 1-GANG OR 2-GANG PLASTER COVERS SHALL BE USED, NO. 4SJD SERIES. THE OUTLET BOXES SHALL BE LOCATED WHEREBY NO TWO (2) OUTLET BOXES ARE INSTALLED CLOSER THAN 24" ON CENTER, AND SECURELY ATTACHED TO THE PARTITION STUDS, WITH AT LEAST ONE (1) PARTITION STUD SEPARATING THE OUTLET BOXES. IT IS NOT ACCEPTABLE TO SECURE OUTLET BOXES ONLY TO DRYWALL PARTITION.

U. CABINETS:
1. NEMA 250, TYPE 1, GALVANIZED-STEEL BOX WITH REMOVABLE INTERIOR PANEL AND REMOVABLE FRONT, FINISHED INSIDE AND OUT WITH MANUFACTURER'S STANDARD ENAMEL.
2. HINGED DOOR IN FRONT COVER WITH FLUSH LATCH AND CONCEALED HINGE.
3. KEY LATCH TO MATCH PANELBOARDS.
4. METAL BARRIERS TO SEPARATE WIRING OF DIFFERENT SYSTEMS AND VOLTAGE.
5. ACCESSORY FELT WHERE REQUIRED FOR FREESTANDING EQUIPMENT.

V. RACEWAY APPLICATION:
OUTDOORS: APPLY RACEWAY PRODUCTS AS SPECIFIED BELOW, UNLESS OTHERWISE INDICATED:
1. EXPOSED CONDUIT: RIGID STEEL CONDUIT.
2. CONCEALED CONDUIT, ABOVEGROUND: RIGID STEEL CONDUIT, EMT, RNC.
3. UNDERGROUND CONDUIT: RNC, TYPE EPC-40-PVC, DIRECT BURIED.
4. CONNECTION TO VIBRATING EQUIPMENT (INCLUDING TRANSFORMERS AND HYDRAULIC, PNEUMATIC, ELECTRIC SOLENOID, OR MOTOR-DRIVEN EQUIPMENT): LFMC.
5. BOXES AND ENCLOSURES, ABOVEGROUND: NEMA 250, TYPE 3R.

W. COMPLY WITH THE FOLLOWING INDOOR APPLICATIONS, UNLESS OTHERWISE INDICATED:
1. EXPOSED, NOT SUBJECT TO PHYSICAL DAMAGE: EMT.
2. EXPOSED, NOT SUBJECT TO SEVERE PHYSICAL DAMAGE: EMT.
3. EXPOSED AND SUBJECT TO SEVERE PHYSICAL DAMAGE: RIGID STEEL CONDUIT. INCLUDES RACEWAYS IN THE FOLLOWING LOCATIONS: LOADING DOCK, CORRIDORS USED FOR TRAFFIC OF MECHANIZED CARTS, FORKLIFTS, AND PALLET-HANDLING UNITS, MECHANICAL ROOMS.
4. CONCEALED IN CEILINGS AND INTERIOR WALLS AND PARTITIONS: EMT.
5. CONNECTION TO VIBRATING EQUIPMENT (INCLUDING TRANSFORMERS AND HYDRAULIC, PNEUMATIC, ELECTRIC SOLENOID, OR MOTOR-DRIVEN EQUIPMENT): FMC, EXCEPT USE LFMC IN DAMP OR WET LOCATIONS.
6. DAMP OR WET LOCATIONS: RIGID STEEL CONDUIT.
7. RACEWAYS FOR OPTICAL FIBER OR COMMUNICATIONS CABLE IN SPACES USED FOR ENVIRONMENTAL AIR: PLENUM-TYPE, OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY, EMT.
8. RACEWAYS FOR OPTICAL FIBER OR COMMUNICATIONS CABLE RISERS IN VERTICAL SHAFTS: RISER-TYPE, OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY, EMT.
9. RACEWAYS FOR CONCEALED GENERAL PURPOSE DISTRIBUTION OF OPTICAL FIBER OR COMMUNICATIONS CABLE: GENERAL-USE, OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY, RISER-TYPE, OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY, PLENUM-TYPE, OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY, EMT.
10. BOXES AND ENCLOSURES: NEMA 250, TYPE 1, EXCEPT USE NEMA 250, TYPE 4X, STAINLESS STEEL IN DAMP OR WET LOCATIONS.

X. MINIMUM RACEWAY SIZE: 1/2-INCH (16-MM) TRADE SIZE.
Y. RACEWAY FITTINGS: COMPATIBLE WITH RACEWAYS AND SUITABLE FOR USE AND LOCATION.
1. RIGID AND INTERMEDIATE STEEL CONDUIT: USE THREADED RIGID STEEL CONDUIT FITTINGS, UNLESS OTHERWISE INDICATED.
2. PVC EXTERNALLY COATED, RIGID STEEL CONDUITS: USE ONLY FITTINGS LISTED FOR USE WITH THAT MATERIAL. PATCH AND SEAL ALL JOINTS, NICKS, AND SCRAPES IN PVC COATING AFTER INSTALLING CONDUITS AND FITTINGS. USE SEALANT RECOMMENDED BY FITTING MANUFACTURER.

Z. INSTALLATION
COMPLY WITH NECA 1 FOR INSTALLATION REQUIREMENTS APPLICABLE TO PRODUCTS SPECIFIED EXCEPT WHERE REQUIREMENTS ON DRAWINGS OR IN THIS ARTICLE ARE STRICTER.

AA. KEEP RACEWAYS AT LEAST 6 INCHES (150 MM) AWAY FROM PARALLEL RUNS OF FLUES AND STEAM OR HOT-WATER PIPES. INSTALL HORIZONTAL RACEWAY RUNS ABOVE WATER AND STEAM PIPING.

AB. COMPLETE RACEWAY INSTALLATION BEFORE STARTING CONDUCTOR INSTALLATION.

AC. SUPPORT RACEWAYS AS SPECIFIED IN "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."

AD. ARRANGE STUB-UPS SO CURVED PORTIONS OF BENDS ARE NOT VISIBLE ABOVE THE FINISHED SLAB.

AE. INSTALL NO MORE THAN THE EQUIVALENT OF THREE 90-DEGREE BENDS IN ANY CONDUIT RUN EXCEPT FOR COMMUNICATIONS CONDUITS, FOR WHICH FEWER BENDS ARE ALLOWED.

AF. CONCEAL CONDUIT AND EMT WITHIN FINISHED WALLS, CEILINGS, AND FLOORS, UNLESS OTHERWISE INDICATED.

AG. RACEWAYS EMBEDDED IN SLABS:
1. RUN CONDUIT LARGER THAN 1-INCH (27-MM) TRADE SIZE, PARALLEL OR AT RIGHT ANGLES TO MAIN REINFORCEMENT. WHERE AT RIGHT ANGLES TO REINFORCEMENT, PLACE CONDUIT CLOSE TO SLAB SURFACE.
2. ARRANGE RACEWAYS TO CROSS BUILDING EXPANSION JOINTS AT RIGHT ANGLES WITH EXPANSION FITTINGS.
3. CHANGE FROM ENT TO RNC, TYPE EPC-40-PVC, RIGID STEEL CONDUIT, OR IMC BEFORE RISING ABOVE THE FLOOR.

AH. THREADED CONDUIT JOINTS, EXPOSED TO WET, DAMP, CORROSIVE, OR OUTDOOR CONDITIONS: APPLY LISTED COMPOUND TO THREADS OF RACEWAY AND FITTINGS BEFORE MAKING UP JOINTS. FOLLOW COMPOUND MANUFACTURER'S WRITTEN INSTRUCTIONS.

AI. RACEWAY TERMINATIONS AT LOCATIONS SUBJECT TO MOISTURE OR VIBRATION: USE INSULATING BUSHINGS TO PROTECT CONDUCTORS, INCLUDING CONDUCTORS SMALLER THAN NO. 4 AWG.

AJ. INSTALL PULL WIRES IN EMPTY RACEWAYS. USE POLYPROPYLENE OR MONOFILAMENT PLASTIC LINE WITH NOT LESS THAN 200-LB (90-KG) TENSILE STRENGTH. LEAVE AT LEAST 12 INCHES (300 MM) OF SLACK AT EACH END OF PULL WIRE.

AK. RACEWAYS FOR OPTICAL FIBER AND COMMUNICATIONS CABLE: INSTALL RACEWAYS, METALLIC AND NONMETALLIC, RIGID AND FLEXIBLE, AS FOLLOWS:
1. 3/4-INCH (19-MM) TRADE SIZE AND SMALLER: INSTALL RACEWAYS IN MAXIMUM LENGTHS OF 50 FEET (15 M).
2. 1-INCH (25-MM) TRADE SIZE AND LARGER: INSTALL RACEWAYS IN MAXIMUM LENGTHS OF 75 FEET (23 M).
3. INSTALL WITH A MAXIMUM OF TWO 90-DEGREE BENDS OR EQUIVALENT FOR EACH LENGTH OF RACEWAY UNLESS DRAWINGS SHOW STRICTER REQUIREMENTS. SEPARATE LENGTHS WITH PULL OR JUNCTION BOXES OR TERMINATIONS AT DISTRIBUTION FRAMES OR CABINETS WHERE NECESSARY TO COMPLY WITH these REQUIREMENTS.

AL. INSTALL RACEWAY SEALING FITTINGS AT SUITABLE, APPROVED, AND ACCESSIBLE LOCATIONS AND FILL THEM WITH LISTED SEALING COMPOUND. FOR CONCEALED RACEWAYS, INSTALL EACH FITTING IN A FLUSH STEEL BOX WITH A BLANK COVER PLATE HAVING A FINISH SIMILAR TO THAT OF ADJACENT PLATES OR SURFACES. INSTALL RACEWAY SEALING FITTINGS AT THE FOLLOWING POINTS:
1. WHERE CONDUITS PASS FROM WARM TO COLD LOCATIONS, SUCH AS BOUNDARIES OF REFRIGERATED SPACES.
2. WHERE OTHERWISE REQUIRED BY NFPA 70.

AP. FLEXIBLE CONDUIT CONNECTIONS: USE MAXIMUM OF 48 INCHES (1219 MM) OF FLEXIBLE CONDUIT FOR RECESSED AND SEMIRECESSED LIGHTING FIXTURES, EQUIPMENT SUBJECT TO VIBRATION, NOISE TRANSMISSION, OR MOVEMENT; AND FOR TRANSFORMERS AND MOTORS.
1. USE LFMC IN DAMP OR WET LOCATIONS.

AQ. RECESSED BOXES IN MASONRY WALLS: SAW-CUT OPENING FOR BOX IN CENTER OF CELL OF MASONRY BLOCK, AND INSTALL BOX FLUSH WITH SURFACE OF WALL.

AR. SET METAL FLOOR BOXES LEVEL AND FLUSH WITH FINISHED FLOOR SURFACE.

AS. FIRESTOPPING
APPLY FIRESTOPPING TO ELECTRICAL PENETRATIONS OF FIRE-RATED FLOOR AND WALL ASSEMBLIES TO RESTORE ORIGINAL FIRE-RESISTANCE RATING OF ASSEMBLY. PROVIDE SLEEVES FOR FLOOR PENETRATIONS EXTENDING 2" ABOVE FLOOR EXCEPT IN FINISHED AREAS WHERE COORDINATED WITH ARCHITECT.

## TRANSFORMERS

A. SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:
ACME ELECTRIC CORPORATION; POWER DISTRIBUTION PRODUCTS DIVISION.
EATON ELECTRICAL INC.; CUTLER-HAMMER PRODUCTS.
GENERAL ELECTRIC COMPANY.
SIEMENS ENERGY & AUTOMATION, INC.
SOLA/HEVI-DUTY.
SQUARE D; SCHNEIDER ELECTRIC.

B. GENERAL TRANSFORMER REQUIREMENTS
DESCRIPTIONS: FACTORY-ASSEMBLED AND -TESTED, AIR-COOLED UNITS FOR 60-HZ SERVICE. GRAIN-ORIENTED, NON-AGING SILICON STEEL.
CONTINUOUS WINDINGS WITHOUT SPLICES EXCEPT FOR TAPS.
INTERNAL COIL CONNECTIONS: BRAZED OR PRESSURE TYPE.
COIL MATERIAL: COPPER.

C. COMPLY WITH NEMA ST 20, AND LIST AND LABEL AS COMPLYING WITH UL 1561. ONE LEG PER PHASE.

D. ENCLOSURE: VENTILATED, NEMA 250, TYPE 2. CORE AND COIL SHALL BE ENCAPSULATED WITHIN RESIN COMPOUND, SEALING OUT MOISTURE AND AIR.

E. ENCLOSURE: VENTILATED, NEMA 250, TYPE 3R. CORE AND COIL SHALL BE ENCAPSULATED WITHIN RESIN COMPOUND, SEALING OUT MOISTURE AND AIR.

F. TRANSFORMER ENCLOSURE FINISH: COMPLY WITH NEMA 250. FINISH COLOR: GRAY.

G. TAPS FOR TRANSFORMERS SMALLER THAN 7.5 KVA: ONE 5 PERCENT TAP ABOVE NORMAL FULL CAPACITY.

H. TAPS FOR TRANSFORMERS 7.5 TO 24 KVA: ONE 5 PERCENT TAP ABOVE AND ONE 5 PERCENT TAP BELOW NORMAL FULL CAPACITY.

I. TAPS FOR TRANSFORMERS 25 KVA AND LARGER: TWO 2.5 PERCENT TAPS ABOVE AND TWO 2.5 PERCENT TAPS BELOW NORMAL FULL CAPACITY.

J. INSULATION CLASS: 220 DEG C, UL-COMPONENT-RECOGNIZED INSULATION SYSTEM WITH A MAXIMUM OF 115 DEG C RISE ABOVE 40 DEG C AMBIENT TEMPERATURE.

K. ENERGY EFFICIENCY FOR TRANSFORMERS RATED 15 KVA AND LARGER: COMPLYING WITH DOE-2016 10 CFR PART 431.

L. K-FACTOR RATING: TRANSFORMERS INDICATED TO BE K-FACTOR RATED SHALL COMPLY WITH UL 1561 REQUIREMENTS FOR FABRICATION USING FULL-RATED CONDUCTORS SIZED TO THE DEGREE REQUIRED BY DESIGNATED K-FACTOR. UNIT SHALL NOT OVERHEAT WHEN CARRYING FULL-LOAD CURRENT WITH HARMONIC DISTORTION CORRESPONDING TO DESIGNATED K-FACTOR. INDICATE VALUE OF K-FACTOR ON TRANSFORMER NAMEPLATE.

M. ELECTROSTATIC SHIELDING: EACH WINDING SHALL HAVE AN INDEPENDENT, SINGLE, FULL-WIDTH COPPER ELECTROSTATIC SHIELD ARRANGED TO MINIMIZE INTERWINDING CAPACITANCE. ARRANGE COIL LEADS AND TERMINAL STRIPS TO MINIMIZE CAPACITIVE COUPLING BETWEEN INPUT AND OUTPUT TERMINALS. INCLUDE SPECIAL TERMINAL FOR GROUNDING THE SHIELD. SHIELD EFFECTIVENESS: CAPACITANCE BETWEEN PRIMARY AND SECONDARY WINDINGS: NOT TO EXCEED 33 PICOFARADS OVER A FREQUENCY RANGE OF 20 HZ TO 1 MHZ. COMMON-MODE NOISE ATTENUATION: MINIMUM OF MINUS 120 DBA AT 0.5 TO 1.5 KHZ; MINIMUM OF MINUS 65 DBA AT 1.5 TO 100 KHZ. NORMAL-MODE NOISE ATTENUATION: MINIMUM OF MINUS 52 DBA AT 1.5 TO 10 KHZ.

N. FUNGUS PROOFING: PERMANENT FUNGICIDAL TREATMENT FOR COIL AND CORE.

O. LUG RATING: ALL LUG CONNECTIONS SHALL BE RATED FOR CONNECTION OF 75 DEG C INSULATION CONDUCTORS.

## PANELBOARDS

A. ENCLOSURES: FLUSH- AND SURFACE-MOUNTED CABINETS. RATED FOR ENVIRONMENTAL CONDITIONS AT INSTALLED LOCATION. INDOOR DRY AND CLEAN LOCATIONS: NEMA 250, TYPE 1. OUTDOOR LOCATIONS: NEMA 250, TYPE 3R. WET OR DAMP INDOOR LOCATIONS: NEMA 250, TYPE 4X STAINLESS STEEL.

B. FRONT: SECURED TO BOX WITH CONCEALED TRIM CLAMPS. FOR SURFACE-MOUNTED FRONTS, MATCH BOX DIMENSIONS; FOR FLUSH-MOUNTED FRONTS, OVERLAP BOX.

C. HINGED FRONT COVER: ENTIRE FRONT TRIM HINGED TO BOX AND WITH STANDARD DOOR WITHIN HINGED TRIM COVER.

D. FINISHES:
PANELS AND TRIM: GALVANIZED STEEL, FACTORY FINISHED IMMEDIATELY AFTER CLEANING AND PRETREATING WITH MANUFACTURER'S STANDARD TWO-COAT, BAKED-ON FINISH CONSISTING OF PRIME COAT AND THERMOSETTING TOPCOAT.

E. BACK BOXES: GALVANIZED STEEL.

F. FUNGUS PROOFING: PERMANENT FUNGICIDAL TREATMENT FOR OVERCURRENT PROTECTIVE DEVICES AND OTHER COMPONENTS.

G. DIRECTORY CARD: INSIDE PANELBOARD DOOR, MOUNTED IN TRANSPARENT CARD HOLDER.

H. INCOMING MAINS LOCATION: TOP AND BOTTOM.

I. PHASE, NEUTRAL AND GROUND BUSES:
MATERIAL: TIN-PLATED ALUMINUM OR HARD-DRAWN COPPER, 98 PERCENT CONDUCTIVITY.
EQUIPMENT GROUND BUS: ADEQUATE FOR FEEDER AND BRANCH-CIRCUIT EQUIPMENT GROUNDING CONDUCTORS; BONDED TO BOX.

J. CONDUCTOR CONNECTORS: SUITABLE FOR USE WITH CONDUCTOR MATERIAL AND SIZES.
MATERIAL: TIN-PLATED ALUMINUM OR HARD-DRAWN COPPER, 98 PERCENT CONDUCTIVITY.
MAIN AND NEUTRAL LUGS: COMPRESSION TYPE. GROUND LUGS AND BUS-CONFIGURED TERMINATORS: COMPRESSION TYPE. FEED-THROUGH LUGS: COMPRESSION TYPE, SUITABLE FOR USE WITH CONDUCTOR MATERIAL. LOCATE AT OPPOSITE END OF BUS FROM INCOMING LUGS OR MAIN DEVICE. RATED FOR CONNECTION OF 75 DEG C INSULATED CONDUCTORS.

K. PANELBOARD SHORT-CIRCUIT CURRENT RATING: FULLY RATED TO INTERRUPT SYMMETRICAL SHORT-CIRCUIT CURRENT AVAILABLE AT TERMINALS.

L. LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE FOLLOWING:
EATON ELECTRICAL INC.; CUTLER-HAMMER BUSINESS UNIT.
GENERAL ELECTRIC COMPANY; GE CONSUMER & INDUSTRIAL
SIEMENS ENERGY & AUTOMATION, INC.
SQUARE D; A BRAND OF SCHNEIDER ELECTRIC.
PANELBOARDS: NEMA PB 1, LIGHTING AND APPLIANCE BRANCH-CIRCUIT TYPE.
MAINS: CIRCUIT BREAKER OR LUGS ONLY.
BRANCH OVERCURRENT PROTECTIVE DEVICES: BOLT-ON CIRCUIT BREAKERS, REPLACEABLE WITHOUT DISTURBING ADJACENT UNITS.
DOORS: CONCEALED HINGES; SECURED WITH FLUSH LATCH WITH TUMBLER LOCK; KEYED ALIKE.

## LIGHTING FIXTURES

A. GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS.
1. RECESSED FIXTURES: COMPLY WITH NEMA LE 4 FOR CEILING COMPATIBILITY FOR RECESSED FIXTURES.
2. INCANDESCENT FIXTURES: COMPL