SOME REVIEW - QUESTIONS
2011 NATIONAL ELECTRICAL CODE

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What is the Code rule regarding neutral conductors at switches?

Switches controlling line-to-neutral lighting loads must have a neutral provided at the switch location [404.2(C)].

Exception: The neutral conductor isn’t required at the switch location if:
1. The conductors for switches enter the device box through a raceway that has sufficient cross-sectional area to accommodate a neutral conductor.
2. Cable assemblies for switches enter the box through a framing cavity that’s open at the top or bottom on the same floor level, or switches enter the box through a wall, floor, or ceiling that is unfinished on one side.
One of my guys put two uninsulated conductors under a single screw on the bonding bus. The inspector said that was a code violation. Where is this in the NEC?

110.14 Electrical Connections
(A) Terminals. Connection of conductors to terminal parts shall ensure a thoroughly good connection without damaging the conductors and shall be made by means of pressure Connectors (including set-screw type), solder lugs, or splices to flexible leads. Connection by means of wire-binding screws or studs and nuts that have upturned lugs or the equivalent shall be permitted for 10 AWG or smaller conductors. Terminals for more than one conductor and terminals used to connect aluminum shall be so identified.
Can flexible metal conduit or surface metal raceways be used for branch circuits in patient care areas where wiring must be provided with a ground path for fault current?

**Hint 517.18**

Flexible metal conduit in lengths not exceeding 6 ft can be used for branch circuit wiring in patient care areas of a health care facility if the circuit conductors contained in the raceway are protected by overcurrent devices rated at 20A or less. A redundant equipment grounding conductor is also necessary. In addition, 250.118(6)c points out that where the flexible metal conduit is part of the ground return path, the total combined length of the flexible metal conduit in that run cannot exceed 6 ft.

Surface metal raceways are also considered suitable for grounding unless they have some marking – like UL information – that would prohibit its use as a sole grounding path.
Can someone tell me if the National Electrical Code (NEC) limits running flexible metal conduit to any particular length? I ask this because I understand Greenfield for a light fixture shall not be longer than 6 ft. I would like to know if I can extend a 7-ft run of flexible metal conduit to a motor.

Hint 604.6(2)
The NEC does restrict the length of flexible metal conduit for lighting fixtures to 6 ft to limit the ground return path. Sec. 430.223 restricts the length of the motor leads between the motor and required junction box to a maximum of 6 ft, regardless of what type of conduit they are contained in—this pertains to the motor leads only. The length of flexible metal conduit for other uses isn’t restricted, while a grounding conductor is included with the circuit conductors. In response, the author may run any length of flexible conduit from the disconnect to the motor junction box, provided he also meets the requirements for support of the flexible conduit and location of the disconnecting means.

Several other comments

If over 6 ft must have grounding conductor.
I'm installing 3-in. intermediate metal conduit (IMC) with an extended run length of about 300 ft to 350 ft. My coworkers told me I have to install a pull box about every 100 ft, but I can't find a reference to this in the NEC. Is there a rule in the Code that specifies the maximum distance between pull points?

Hint 314

No. The Code does not specify when a pull box is required, but 314.28 does specify how to properly size a pull box. You can run the raceway as long as you want, but the Code does not permit more than the equivalent of four quarter bends (360° total) between pull points [Secs. 362.26, 342.26, 344.26, 352.46, 358.26, 348.26, 350.26, and 356.26].
I just set a service on a new house where I used ½-in. Electrical metallic tubing (EMT) to encase the grounding electrode conductor (GEC) from the meter base to the ground rod. The inspector said I have to bond both ends of the metal raceway to the GEC. He also said I should use nonmetallic conduit in the future. Is he correct?
Yes. According to 250.64(E), you can use a metal enclosure to encase the GEC, but you must maintain electrical continuity between the point of attachment to cabinets or equipment and the grounding electrode. You must also securely fasten it to the ground clamp or fitting and make metal enclosures that are not physically continuous from cabinets or equipment to the grounding electrode electrically continuous by bonding each end to the GEC Sec. 250.92. This ensures they will be in parallel with each other. Failure to bond both ends could create a condition where the reactance of the raceway becomes so high that it creates an “inductive choke” that would limit the GEC's ability to carry current. If you used nonmetallic conduit to encase the GEC, you don't have to worry about maintaining the electrical continuity of the metal raceway.
I'm working on a project that includes hooking up a listed kiln in a ceramics classroom. The kiln is rated 100A at 208V. The flexible metal raceway from the kiln to the 100A disconnect includes two 1 AWG conductors, one 6 AWG grounded (neutral) conductor, and one 12 AWG equipment ground. I can’t find a section of the NEC that allows the grounded (neutral) conductor to be reduced in size as it is. Am I missing something?
Yes. There are no Code rules that specifically tell us how to size the grounded (neutral) conductor for branch circuits, but there is one for feeders (220.61(B)). You only need to size the grounded (neutral) conductor to carry the maximum unbalanced load between it and any ungrounded conductor. Because this is a listed product, you only need to wire the appliance according to the instructions. However, the size of the equipment grounding conductor in the flexible metal raceway is cause for concern. This equipment grounding conductor may not be smaller than shown in Table 250.122, based on the rating of the circuit overcurrent protection device. For a 100A protection device, the equipment grounding conductor may not be smaller than 8 AWG.
I've heard an insulated equipment grounding conductor for an isolated grounding circuit installation should float from the electrical system. I've also heard it must terminate at the neutral point of a transformer or at the neutral-to-case connection point at service equipment. Which way is correct?
Isolated (insulated) equipment grounding circuits must provide an effective ground-fault current path in addition to providing a clean grounding connection for the equipment. Essentially the isolated (insulated) equipment grounding conductor serves both purposes. The required equipment grounding conductors must always be in place and effective in addition to any desired isolated (insulated) equipment grounding conductor. Where designs call for more specialized equipment grounding means for reducing unwanted electromagnetic interference on the grounding circuit, usually an additional insulated equipment grounding conductor path is installed. In the patient care areas of health care facilities, where isolated (insulated) equipment grounding circuits are installed with the branch circuits, there will be three equipment grounding conductor paths. Remember to meet the requirements in 517.13(A) and (B) in addition to any desired isolated (insulated) equipment grounding that may be desired. A good way to approach these installations is to always strive to satisfy what is required by the minimum requirements of the NEC before applying any desired isolated (insulated) equipment grounding circuits. Safety must not be compromised.
Neither. The NEC doesn't require the isolated equipment grounding conductor for electronic equipment to terminate to the neutral point of a transformer or at the neutral-to-case connection point at service equipment — nor does it permit you to float the equipment grounding conductor from the electrical system [250.96(B) and 250.146(D)]. The equipment grounding conductor from electronic equipment may not be “floated, lifted, or isolated” from the electrical source. If the metal parts of an electrical system were truly isolated or floated from the electrical source, a line-to-case fault could not be cleared — there would be no path for electrons to return to the power supply — and the metal parts of the equipment would remain energized with dangerous touch voltage.

To ensure a safe electrical system, you must bond all metal parts of the electrical system together and to the utility grounded (neutral) conductor at service equipment or the neutral point of a separately derived system [Sec. 250.4(A)(4)].

According to several industry standards, the insulated equipment grounding conductor should originate at the neutral point at the transformer or neutral-to-case connection point of service equipment, and it should remain insulated from the metallic raceway and all other metal parts through its length. To maintain isolation from the metal parts of the electrical system, the isolated equipment grounding conductor may pass through metal enclosures [Secs. 250.146(D) and 408.20 Exception].

Real world experience demonstrates that the difference in ground potential between electronic equipment (which causes the problems with digital equipment) can be reduced to a satisfactory level by simply terminating all insulated equipment grounding conductors to a “single point” at the panelboard where all the circuits originate.
Does the NEC require you to measure (test) the resistance of the grounding electrode to validate the ground resistance?

No. The rules in 250-50 specify that a metal underground water pipe, the metal frame of a building or structure, a concrete-encased electrode, or a ground ring can be used as the required grounding electrode for services (250-24), separately derived systems (250-30), and remote buildings and structures (250-32). The NEC does not require any of these electrodes have a resistance of 25 ohms or less (contrary to what many think), nor does it require you to measure their ground resistance.
What size copper equipment grounding conductor is necessary for a 5 hp Design Letter B, 208V, 3-phase motor protected by an inverse time circuit breaker, assuming no more than three current-carrying conductors in a raceway, ambient temperature of 30°C (86°F), and a circuit conductor length of 50 ft?
Number 12. According to 250-122, the equipment grounding conductors shall not be smaller than shown in Table 250-122, based on the rating of the circuit overcurrent protection device. But it does not have to be larger than the circuit conductors supplying the equipment. Follow these steps to determine the size:

**Step 1.** Size the circuit protection device (circuit breaker) per Sec. 430-52.
Motor FLC = 16.7A [Table 430-250]
Protection device size = 16.7A x 250%
   = 41.75A.
The next size up permitted is 45A [Secs. 240-6(a) and 430-52(c)(1) Exception No. 1].
Step 2. Size the motor-circuit conductors per Sec. 430-22(a).
Conductor size = 16.7A x 125%
= 20.9A
The 75°C column in Table 310-15(B)(16), calls for No. 12
[Sec. 110-14(c)(1)(a)].
Step 3. Size the equipment grounding conductor per
Sec. 250-122(a) and (d).
The copper equipment grounding conductor required by
Table 250-122 is No. 10, but the equipment grounding conductor
does not have to be larger than the No. 12 circuit conductors.
I'm a contractor in California with a limited specialty license relating to swimming pools and spas. I continually run into electricians who have a different interpretation of the GFCI protection requirements of motors for spas and hot tubs. When is GFCI protection required?

According to Sec. 680.21(C), GFCI protection is required for motors of 15 – 20 Amp at 120 through 240 Volts. Many other GFCIs are needed at pools.
Does the NEC have any requirements about where a 120V smoke detector must be installed?

No. The NEC does not cover the location of smoke detectors. This is covered in other NFPA documents such as NFPA 72 Fire Alarm Code or NFPA 101 — Life Safety Code.
I understand there’s a provision in the Code prohibiting the "daisy-chain" feed-through connections of conductors on receptacles and switches. In other words, all wiring at receptacles and switches must be pigtailed. Supposedly, the rule was intended to prevent the removal of a wiring device, such as a receptacle, may not interrupt the continuity of the grounded (neutral) conductor [300.13(B)]. Therefore, the grounded (neutral) conductors must be spliced together and a pigtail must be provided for device terminations. The opening of the ungrounded (hot) or grounded (neutral) conductor of a two-wire circuit during the replacement of a device doesn’t cause a safety hazard, so pigtailing these conductors isn’t required by the NEC. Be careful - if the continuity of the grounded (neutral) conductor of a multiwire circuit is interrupted (open), the resultant over- or undervoltage could cause a fire and/or destruction to electrical equipment.
I’m working on a job that includes a raceway with nine 12 AWG current-carrying conductors. What’s the ampacity of these conductors—after conductor ampacity adjustment—as required by Table 310.15(B)(2)(a) in the Code? It’s my understanding that you must take the amperage of 12 THHN as listed in Table 310.15(B)(16) under the 90°C column, which is 30A. I multiplied this value by 70%, yielding an ampacity of 21A, which may be placed on a 20A breaker.

My boss instructed me to use the 20A rating of the circuit breaker, which results in the conductor having an ampacity of 14A. Based on this interpretation, this conductor can’t be placed on a 20A circuit. Who is correct?
You are. The ampacity after conductor adjustment for 12 AWG THHN conductors in a dry location is based on 30A rating as listed in Table 310.15(B)(16) under the 90ºC column [110.14(C)]. Therefore, you can place this 21A conductor on a 20A protection device.
What is the maximum ground resistance required by the NEC for the grounding electrode system?

There is no maximum ground resistance specified for the grounding electrode system. However, if a single ground rod is used as the required grounding electrode system, and it’s resistance exceeds 25 ohms, then it must be augmented by one additional electrode located no less than 6 ft from the original ground rod (250.53).

Example: If the first ground rod has a ground resistance of 100 ohms, you only need to add one additional ground rod, regardless of the resistance of the two ground rods.
Is it a violation of the Code to protect temporary lighting circuit switch a GFCI? I’ve seen exposed temporary lighting wire (wire nuts fell off or were missing) touching metal studs, thereby presenting a potentially deadly work environment.
The NEC is silent on this issue, so this means it’s okay to GFCI-protect temporary lighting circuit conductors. However, to prevent a construction site from being placed in the dark by a ground fault, temporary lighting shall not be installed on the branch circuit that supplies receptacles [590.4(D)(1)]

*Note:* Receptacles rated 15A or 20A, 125V used to supply temporary power for construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities shall be GFCI protected [590.6(A)].
Are hospital grade receptacles required in doctor, chiropractic, or dentist examination rooms? What about isolated ground receptacles?
Oh good! An easy one. No and No. Hospital grade receptacles are only required for patient bed locations, defined in 517.18(B) as an inpatient sleeping bed; or the bed or procedure table used in critical patient care area.

Isolated ground receptacles, or receptacles that incorporate an isolated grounding connection intended for the reduction of electrical noise [250.146(D)], are never required by the NEC. An isolated ground receptacle isn't actually isolated from the system ground. This type of device has its grounding contacts insulated from the metal mounting yoke. Art. 517 properly calls an “isolated ground receptacle” an “insulated ground receptacle.” In fact, the FPN to 517.16 cautions against the indiscriminate use of receptacles with insulated grounding terminals since such a practice forfeits the benefit of parallel grounding paths that otherwise would occur.
I'm an electrical designer in Greensboro, N.C. I recently worked on a new car dealership project. The engineer and I decided that to power the vehicle lifts, the contractor would have to provide an SO cord from a junction box above to the lift motor. The contractor says that the inspector told him that the cord must have a twist-lock connection and receptacle. I've searched the NEC but can't find where this is required. Can you help?

Hint 400.7

A twist-lock connector (locking type) isn't required for a cord used for this purpose. However, 400.7(B) requires an attachment plug and receptacle (twist-lock not required) for any flexible cord used for the connection of utilization equipment to facilitate frequent interchange [400.7(A)(6)]. However, if the manufacturer's installation instructions call for a twist-lock plug and receptacle, then it must be provided, per 110.3(B).
I have a 1,600A switchboard that is protected with ground-fault protection in accordance with 230.95. The only neutral load on the switchboard is from two 225A lighting panelboards.

What size feeder, neutral, and bond wires are required for this installation if we use rigid nonmetallic conduit (RNC)?
Ungrounded conductor. According to 240.4(C), the ungrounded conductors must have an ampacity not less than 1,600A. This can be accomplished by any of the following parallel sets (conductors rated at least 75°C):

Six sets of 300kcmil = 285A × 6 = 1,710A

Five sets of 400kcmil = 335A × 5 = 1,675A

Four sets of 600kcmil = 420A × 4 = 1,680A

Note: You can't use four sets of 500 kcmil, because they would only be rated 1,520A (380A × 4).
Neutral conductor. Sec. 220.61(A) states that the neutral demand load shall be “the maximum unbalance computed load between the neutral and any one ungrounded conductor.” I will assume that all of the loads on the two 225A panelboards are nonlinear line-to-neutral loads. Based on this worst-case assumption, you can't apply the “over 200A, 70% demand factor” contained in 220.61(B). Therefore the neutral must be sized at 100% of the line-to-neutral loads, which in this case is 450A. Assuming that we parallel the feeder in four raceways, the neutral conductor in each raceway must have an ampacity of no less than about 113A (450A÷4). According to Table 310.15(B)(16), 2 AWG has a rating of 460A (115A×4). But the parallel rules contained in 310.10(H) require each parallel neutral conductor to be sized no smaller than 1/0 AWG.
Fine Print Note No. 2 of 220.61(C)(2) states “a 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads may necessitate that the power system design allows for the possibility of high harmonic neutral currents.” This means that “good design” dictates that you should consider “up-sizing” the neutral conductor to accommodate the odd triplen harmonic currents, which don't cancel. By following the industry practice of “doubling the neutral,” the neutral conductor would then be sized based on $450A \times 2 = 900A$. You can accommodate this by installing a 4/0 AWG neutral conductor in each of the four parallel raceways. 

*Equipment grounding (bonding) conductor*. An equipment grounding (bonding) conductor must be installed in each of the rigid nonmetallic conduits. Each shall be sized to the circuit's overcurrent device protecting rating, in accordance with Table 250.122. For a 1,600A-protected feeder, this would require a 4/0 AWG bond wire in each of the raceways.
I thought that all raceway and cable support fittings must be listed for the purpose. I keep telling my boss that we can only use listed nonmetallic sheath cable staples. Am I correct?

Nope. The NEC doesn't require support systems — including cable trays — to be listed. However, the NEC requires all equipment to be approved by the AHJ (110.2). In addition, 90.4 specifies that the AHJ has the responsibility for deciding on the approval of equipment and materials, which, according to Art. 100, means acceptable to the AHJ.

According to UL, metal cable trays can be classified as to their suitability as an equipment grounding conductor in accordance with 392. Nonmetallic cable trays are listed and tested in accordance with the performance and construction requirements of NEMA FG 1-1993.
Some 480V-120/208V, 3-phase transformers come shipped with a bonding strap that connects the XO terminal to the case of the transformer. My boss told me to install a bonding jumper sized to Table 250.66 and based on the secondary conductors and leave this factory-bonding strap in place. Is this really required by the NEC?

No. You're not required to add an additional bonding jumper if the transformer is listed by a qualified electrical testing laboratory (90.7). It's true that 250.30(A)(1) requires a bonding jumper sized in accordance with Table 250.66 to bond the XO terminal to the case. But if the manufacturer has installed one, then there's no need for you to add an additional bonding connection.
What is the minimum size branch circuit conductor to a motor, and what is the largest breaker I can use to protect these conductors?

Motor circuit conductors must be sized no smaller than 125% of the motor full-load current rating listed in Tables 430.247 -- 250. The maximum size inverse time circuit breaker for short-circuit ground-fault protection must not exceed 250% of the motor full-load current rating [430.52(C)(1)].

Example: A 10-hp, 230V, 3-phase motor with a Service Factor 1.15 used for continuous duty application has a FLC rating of 28A [Table 430.250]. Its terminals are rated 75°C.

*Branch circuit conductors.* 28A×1.25=35A. Typically this would be 10 AWG THHN/THWN.

*Branch short-circuit and ground-fault protection.* 28A×2.5=70A

Yes, it's OK to protect the 10 AWG conductors with a 70A protection device [240.4(G)] because the motor is protected by an overload protection device (heaters) no larger than 125% of the motor nameplate rating [430.6(A)(1) and 430.32].
Can I use one single-pole 15A, 125V AFCI breaker and one 15A, 125V non-AFCI circuit breaker with 14/3 nonmetallic sheath cable to supply an AFCI-protected dwelling unit bedroom circuit and another circuit that isn't AFCI protected?

No. A single-pole AFCI circuit breaker, just like a single-pole GFCI circuit breaker, isn't designed to operate on a multiwire branch circuit. I suggest you use the new 14/4 NM cable that is manufactured for this purpose.
What is the proper way to replace two-prong receptacles with a grounding type receptacle in an older house where no ground wire is located in the outlet box?

Where no grounding means exists in the outlet box, a nongrounding-type receptacle can be replaced with a GFCI receptacle, if marked “No Equipment Ground,” or a grounding type receptacle, if GFCI protected and marked “GFCI Protected” and “No Equipment Ground.” See 406.4(D)(2)(a-c) for details.

In Addition:

406.4(D)(4-6) Where a receptacle outlet is supplied by a branch circuit that requires arc-fault circuit interrupter, tamper resistant and weather resistant protection as specified elsewhere in this Code.
We recently designed an upgrade to an existing imaging center that has 208V, 3-phase service. We're adding additional equipment that requires 480V, 3-phase, and we designed a separate service to supply the new 480V equipment. The permit plan reviewer, stating that the NEC didn't allow two services to the same building, rejected the plans. It's my belief that 230.2(D) permits this design for differing voltages. What's your opinion?

You're correct. Per 230.2(D), “additional services shall be permitted for different voltages.” You also need to comply with 230.2(E), which requires a building supplied by more than one service to have a permanent plaque or directory at each service disconnect location denoting all other services supplying that building and the area served by each. In addition, be sure you use the same grounding electrode for both services (250.58).
How do you size the conductor and protection device for a 15 kVA, 240V, 3-phase space heater?

Conductors and protection devices for electric space heating equipment must be sized no smaller than 125% of the ampere rating of the equipment [424.3(B)].

Equipment Ampere Rating = \( \frac{kVA}{\text{Volts} \times 1.732} = \frac{15,000}{(240 \times 1.732)} \)

Equipment Ampere Rating = 36A

Conductor and Protection not Less Than = 36A \times 1.25 = 45A

Conductor = 6 AWG for 60°C terminals or 8 AWG for 75°C terminals [110.14(C)]

Protection = 45 or 50A device [240.6(A)]
Is there an NEC requirement that an equipment grounding conductor be installed in PVC conduits?

Kind of. Sec. 352.60 states that where equipment grounding (bonding) is required by Art. 250, a separate equipment grounding (bonding) conductor must be installed in the conduit.

So if equipment grounding (bonding) is required by Art. 250, and the installation is nonmetallic conduit, then an equipment grounding (bonding) conductor must be installed. But the exceptions to 352.60 permit the grounded (neutral) conductor to be used for bonding at the following locations [250.142(A)]:

On the supply side or within the enclosure of the service disconnecting means [250.24(B), 350.60 Exception 2] (Fig. 1).

On the supply side or within the enclosure of the disconnecting means for separate buildings [250.32(B)].

On the supply side or within the enclosure of the disconnecting means of separately derived systems [250.30(A)(1)].
What are the working space requirements for 120V industrial machinery?

Where maintenance and supervision conditions ensure that only qualified persons will service the installation, the working space from live parts for 120V circuits must be at least 3 ft (670.1). However, where it's necessary to use a tool to open the enclosure, and where only diagnostic and troubleshooting testing is involved, the clearances can be less than 3 ft. How much less is a judgment call for the AHJ to make. The 2.5-ft working space rule only applies to 120V circuits. If the equipment is rated 208V, 240V, 277V, or 480V, then the working space requirements must comply with the more stringent requirements contained in Table 110.26(A)1.
The luminaires in the men's bathroom in my building are controlled by occupancy sensors that don't have a manual override switch. When there's no motion for 3 min or more, the luminaires shut off — even if the stalls are occupied — and the room goes dark. Trust me, I know. Because the motion sensor is located so far from the stalls, an occupant must leave the stall for the sensor to “see” movement before the luminaire will turn back on. Does the NEC permit this installation?
Yes. This is a design issue [90.1(C)]. The NEC doesn't require habitable rooms in commercial occupancies to have lighting, receptacles, or switches. Therefore the bathroom occupancy sensor need not be equipped with a manual override switch. However, if this were a dwelling unit bathroom, the installation would violate of 210.70(A)(1), which requires the bathroom wall switch to be equipped with a manual override that would allow the sensor to function as a wall switch.

Ultrasonic sensors are “volumetric” in that they send out sound waves to “fill” a space and then use the Doppler Effect to detect any motion that causes a shift in the returning sound waves. This permits detection behind stall walls in bathrooms. In contrast, passive infrared or PIR sensors are line-of-sight and need to “see” the area that's being detected. Therefore, they don't work if there's a barrier — in this case, a stall wall — between the sensor and what is being detected.
Can you install a 3-phase main breaker panel for a single-phase service and a 3-phase breaker for a single-phase panel?

There's nothing in the NEC that would prohibit this installation. However, 110.3(B) requires electrical equipment to be installed and used in accordance with any instructions included in the listing or labeling.
Does the Code require a local disconnect on the primary side of a transformer?

No, just overcurrent protection in accordance with 450.3(B). However, transformers rated greater than 600V installed in tunnels must have a switch or circuit breaker that simultaneously opens all ungrounded conductors of the circuit within sight of each transformer.
I think 120V outdoor receptacles for sump pump equipment and drinking fountains in commercial/industrial settings should be GFCI-protected. Is there an NEC article that addresses this situation directly or indirectly?

Sorry, but the NEC doesn't require GFCI protection for any of these applications. 210.8(B)(5) Sinks
I'm handling an automobile claim for an insurance company in which one of its customers was driving a truck and struck an electrical wire that was attached to a building. The tractor-trailer was 13 ft 6 in. tall. I'm trying to determine if the NEC lists the height requirement for electrical wiring above parking lot and streets. It's my opinion that I can deny this loss based upon the fact the height of the wire was below the standard.

If the wiring is a service drop owned by the utility, then the heights given in the National Electric Safety Code (NESC) apply. Per the NEC, the minimum height of overhead conductor spans not owned by the electric utility over public streets, alleys, roads, and parking areas subject to truck traffic may not be less than 18 ft 225.18(4).
As an engineer, I was taught that good wiring practices meant keeping the phase circuit conductors and control conductors (120V) separated. I agree that in many circumstances that's the ideal condition, but what does the NEC require?

The NEC permits Class 1 remote and power supply circuit conductors to occupy the same cable, enclosure, or raceway, but only where the equipment powered is functionally associated with the conductors 725.48. Your engineering instinct may tell you to always keep phase circuit conductors and control conductors separate, but the Code will allow it in some instances.
There's an ongoing practice among electrical contractors in my area to connect a short piece of 14 AWG wire to the 12 AWG in a receptacle box to facilitate the use of the push-in connectors on the back of 15A receptacles installed on a 20A circuit. When I ask how this could be permitted, they cite the fact that the device is rated 15A and that therefore the practice is allowed according to the branch-circuit tap rules. Is this true?

No. The minimum size conductor for a 20A circuit is 12 AWG [240.4(D)], and a 15A duplex receptacle is permitted on a 20A circuit [Table 210.21(B)(3)]. Also, 210.19(A)(4) Ex. 1(c) doesn't permit 15A tap (14 AWG) conductors for a receptacle outlet on a 20A circuit.
I work in a chemical laboratory and have been trying to get GFCI-protected outlets installed in the vicinity of any apparatus that uses running water (for cooling, for instance). I finally managed to convince my management to do it, but then when the electrician came, he insisted that it isn't necessary. Who's right?

The electrician's correct on this one. In commercial and industrial occupancies, GFCI protection is only required for receptacles in bathrooms, sinks, kitchens, rooftops, and outdoors [210.8(B)]. Exception No. 2 to (4): In industrial establishments only, where the conditions of maintenance and supervision ensure that only qualified personnel are involved, an assured equipment grounding conductor program as specified in 590.6(B)(2) shall be permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power is interrupted or having a design that is not compatible with GFCI protection.
We put out a drawing with a detail showing the removal of the tabs on a 20A, 125V duplex receptacle, thus creating two single 20A devices. A separate 20A circuit supplies each receptacle, but the inspector rejected the installation, citing that it's against the Code. Is the inspector right?

Your design is fine. Each receptacle is individually rated 20A, 125V, so there's no problem. But where more than one branch circuit supplies more than one receptacle on the same yoke, a means to simultaneously disconnect the ungrounded conductors that supply those receptacles shall be provided at the panelboard where the branch circuits originated 210.7.
The NEC requires receptacle outlets to be located so no point measured horizontally along the floor line in any wall space is more than 6 feet from a receptacle outlet. Is there a similar requirement for receptacles in a commercial occupancy?

The NEC doesn't require receptacle outlets in the wall space of commercial or industrial occupancies. Simply locate receptacles per the plan.
What are the Code rules for using floor receptacles to meet the receptacle wall outlet requirements in a dwelling wall space?

Floor receptacle outlets are not counted as the required receptacle wall outlet, if they are located more than 18 in. from the wall [210.52(A)(3)].
What are the NEC rules on placing receptacles for countertops in a dwelling unit kitchen?

A receptacle outlet must be installed for each kitchen and dining area countertop wall space 1 ft or wider, and receptacles must be placed so that no point along the countertop wall space is more than 2 ft (measured horizontally) from a receptacle outlet [210.52(C)(1)].
What are the GFCI protection requirements for a receptacle installed in a non-dwelling location if it is under a counter with a sink above it?

All 15A and 20A, 125V receptacles installed within 6 ft of the outside edge of a sink in non-dwelling occupancies must be GFCI protected 210.8(B)(5).

*Exception No. 1:* In industrial laboratories, receptacles used to supply equipment where removal of power would introduce a greater hazard aren’t required to be GFCI protected.

*Exception No. 2:* Receptacles located in patient bed locations of general care or critical care areas of health care facilities are not required to be GFCI-protected.
When mounting receptacles in boxes that are set back from the finished surface as permitted in 314.20, the receptacles shall be installed so that the mounting yoke or strap of the receptacle is _________.
A. tight against the box, which is set back no more than ¼ in.
B. secured by a self-grounding clip
C. held rigidly at the finished surface
D. secured by sheet metal screws

Answer: C
As noted in 406.5(A) of the 2011 NEC, "When mounting receptacles in boxes that are set back from the finished surface as permitted in 314.20, the receptacles shall be installed so that the mounting yoke or strap of the receptacle is held rigidly at the finished surface."
For field-fabricated installations using equipment operating at more than 600V, the minimum air separation between live conductors and between such conductors and adjacent grounded surfaces shall be a minimum of ______ in. for an indoor, phase-to-phase application of 13.8kV.

A. 12  
B. 7.5  
C. 7  
D. 5

Answer: B
Section 490.24 of the 2011 NEC lists the requirements for the minimum air separation of field-fabricated installations. The minimum clearance distances are shown in Table 490.24. Note: The values from Table 490.24 do not apply to interior portions or external terminals of equipment designed, manufactured, and tested in accordance with accepted national standards.
When installing metal-clad power switchgear (greater than 600V), the external hinged doors or covers must be ___________.

A. provided with stops to hold them in the open position  
B. provided with a full-length hinge  
C. lockable.  
D. provided with a viewing window

Answer: A

To be compliant with Section 490.38 of the 2011 NEC, when installing metal-clad power switchgear (greater than 600V) the external hinged doors or covers must be provided with stops to hold them in the open position.
When installing PVC conduit or RTRC as an approved wiring method in an underground installation to supply a gasoline dispensing device at a gas station, which statement is true?

A. The conduit(s) must be installed with 24 in. of cover over the top of the concrete, which covers the conduit.

B. The conduit(s) must be installed with 24 in. of cover over the top of the conduit.

C. The conduit(s) must be covered by at least 2 in. of concrete

D. Where entering or emerging from the ground, the wiring method must remain the same. A change to another type, such as rigid metal conduit (RMC) or intermediate metal conduit (IMC) is not permitted.
Answer: B
There is no Code requirement to encase the conduit in concrete or place concrete directly over the conduit(s). The NEC simply calls for a minimum cover of 24 in. over the conduit(s). See Section 514.8 in the 2011 NEC.
When installing a transformer (such as a 75kVA unit), the disconnecting means for this piece of equipment shall be ________, and the location of the disconnecting means shall be ______ marked on the transformer.

A. approved / properly  
B. lockable / field  
C. suitable / suitability  
D. lockable / factory

Answer: B
As noted in 450.14 of the 2011 NEC, "Transformers, other than Class 2 or Class 3 transformers, shall have a disconnecting means located within sight of the transformer or in a remote location. Where located in a remote location, the disconnecting means shall be lockable, and the location shall be field marked on the transformers."
What is the NEC requirement regarding GFCI protection of outlets supplying pool pump motors?

GFCI protection is required for outlets supplying pool pump motors connected to single-phase 120V through 240V branch circuits rated 15A or 20A, whether by receptacle or by direct connection. See Section 680.21(C) of the 2011 NEC.
Where does the Code require a boundary seal when leaving a Class I, Division 2 location and entering an unclassified area?

A raceway seal fitting must be installed in each raceway that passes from a Class I, Division 2 location into an unclassified location within 10 ft of the Class I, Division 2 area on either side of the boundary [501.15(B)(2)] (see **Figure** below).
Can I install a reducing fitting at an explosionproof seal located just outside the boundary of a Class 1 Division I area?

Hint 501

Yes, if it's a listed explosionproof reducer fitting. However, if the reducer is located after the seal, then the reducing fitting isn't required to be explosionproof listed [501.5(A)(4)].
Is it permissible to wrap a stranded wire around the screw terminal of a receptacle?

According to the UL White Book under the RTRT category, stranded wire is permitted to terminate to a screw terminal of a receptacle [110.3(B)].
If I installed a listed breaker from one manufacturer in a listed panel from another manufacturer, does this void the panel listing?

Depends on whom you ask. I'm sure equipment manufacturers only warranty their panelboards when used with their circuit breakers. However, UL certifies circuit breakers by independent manufacturers to be suitable for installation in different manufacturers' panelboards. This is an issue equipment manufacturers constantly battle, and it will be resolved by the AHJ [90.4 and 110.3(B)] or by a judge in the courtroom.
Our township requires a sprinkler system in electrical equipment rooms. The sprinkler system in our building is located 2 feet in front of and just above the main switchboard. Several sprinklers are located along this run, and no protection is provided to the switchboard in case of a leak or a sprinkler goes off. Is this a violation of the NEC?

No. Section 110.26(E)(1)(c) permits sprinkler protection of electrical equipment as long as the piping isn't located above the switchboard.
I have a situation where our electrical engineer has designed something I believe may not be Code-compliant. He wants to supply three separate single-phase 480V transformers from a 3-phase breaker. The first transformer is connected to Line 1 and Line 2, the second to Line 2 and Line 3, and the third to Line 1 and Line 3. The overcurrent protection device for each of the transformers is sized in accordance with Table 450.3(B). Is it Code compliant to supply single-phase loads from a 3-phase breaker?

Sure. A 3-phase breaker may supply three single-phase line-to-line loads, but no more than one conductor can be placed on the circuit breaker terminal, unless the terminal is identified for two conductors.
Can I plug a power-strip into another power-strip (daisy-chain)?

No. According to the UL White Book (category XBYS), “Relocatable power taps are not intended to be series connected (daisy-chained) to other relocatable power taps or to extension cords.”
Can a 277V circuit supply a wall-mounted compact fluorescent night light in a homeless shelter?

Maybe, maybe not. According to 210.6(A) the maximum nominal voltage between conductors for luminaires in dwelling units and guest rooms of hotels, motels, and similar occupancies shall not exceed 120V. Because a room of a homeless shelter would be considered a “similar occupancy,” the maximum nominal circuit voltage for luminaires would be 120V. However, this only applies to the guest rooms of the homeless shelter, not the common area.
Where does the NEC require removal of abandoned line voltage wiring?

The only time the NEC requires removal of abandoned line voltage circuit conductors is for cellular concrete floors [372.13], cellular metal floors [374.7], underfloor raceways [390.7], information technology equipment if not installed in a metal raceway [645.5(F)], and temporary wiring [590.3].
Can we put multiple Type NM cables through a single knockout?

Yes, you can put multiple Type NM cables through a single knockout but only if the termination fitting is listed for the purpose. Most termination fittings are only listed for a single cable connection, but there are some that are listed for two cables [110.3(B) and 312.5(C)].
Are there any rules regarding electrical outlets that are close to sinks in a school?

All 15A and 20A, 125V receptacles installed within 6 ft of the outside edge of a sink must be GFCI protected [210.8(B)(5)].
Is there an exception to the 30-in. burial requirement for a ground ring?

No. A ground ring encircling the building or structure, consisting of at least 20 ft of bare copper conductor not smaller than 2 AWG, must be buried not less than 30 in. [250.53(F)].
We heard you can't enter conduit on the sides of a handy box. Can you show us where it states that in the NEC?

The NEC contains no such requirement.
When is ground fault protection of equipment required for feeder circuits?

Hint 230.95

Each feeder disconnecting means rated 1,000A or more supplied by a 4-wire, 3-phase, 277/480V wye-connected system must be provided with ground-fault protection of equipment in accordance with 230.95 and 240.13 [215.10]. See the definition of "Ground-Fault Protection of Equipment" in Art.100.

Exception 2. Equipment ground-fault protection isn't required if ground-fault protection of equipment is provided on the supply side of the feeder and on the load side of the transformer supplying the feeder. Ground-fault protection of equipment isn't permitted for fire pumps [695.6(H)], and it's not required for emergency systems [700.26] or legally required standby systems [701.26].
What is the minimum distance a receptacle must be located away from a sink?

The NEC doesn't specify a minimum distance that a receptacle must be located from a sink.
What is the minimum distance a dry-type transformer must be installed from an inside wall?

Transformers rated 112. kVA or less must be located at least 12 inches from combustible materials, unless separated by a heat and fire-resistant barrier [450.21(A)]. Transformers with ventilating openings must be installed so that ventilation is adequate to dispose of the transformer full-load losses without creating a temperature rise that is in excess of the transformer rating [450.9]. As always, be sure to comply with the Listing requirements [110.3(B)] for your particular installation. This typically calls for 6 inches of clearance.
A dwelling has an outside receptacle located on the back of it. The owner adds a sunroom on the back of the dwelling. Now the outside receptacle is located indoors. Is arc-fault protection required for this circuit now supplying this receptacle? Should another receptacle be installed on the backside of this dwelling?

Since the receptacle is now located inside the dwelling it must meet all the requirements for dwelling unit receptacles in Article 210 and Article 406. The sunroom receptacle must be tamper-resistant and AFCI protected. It must also meet the receptacle spacing requirements of 210.52(A)(1)&(2). An additional receptacle must be added to the outside of the dwelling to comply with 210.52(E)(1).
When a vapor barrier has been installed under a footer, can the steel rebar above the vapor barrier be used as a grounding electrode?

No. A concrete-encased electrode of the steel rebar type is only suitable to be used as a concrete-encased electrode if it's located within and near the bottom of a concrete foundation or footing in direct contact with the earth [250.52(A)(3)]. If a vapor barrier is installed between the footer and the earth, then the rebar can't be used as an electrode.
Is PVC conduit permitted to be used to supply circuits in a health care facility?

Yes and no. PVC conduit can be used to supply feeder circuits in health care facilities, but not for branch circuits. Branch circuits serving patient care areas must be provided with an effective ground-fault current path by installing the circuits in a metal raceway or cable having a metallic armor or sheath that qualifies as an equipment-grounding conductor in accordance with 250.118 [517.13(A)].
When 5 feet of conductor passes through a higher ambient temperature location, must the entire circuit still be subjected to ampacity correction?

It depends on the circuit length. When different ampacities apply to a length of conductor, the higher ampacity is permitted for the entire circuit if the reduced ampacity length doesn't exceed 10 feet — and its length doesn't exceed 10% of the length of the higher ampacity [310.15(A)(2) Exception].
Are light switches for exterior lighting required immediately adjacent to each entrance of a single-family dwelling?

No. The Code specifies the location of the lighting outlet in a dwelling unit [210.70(A)(2)(b)], but it doesn't specify the location of the switch.
Is GFCI protection required for a single-phase, 208V, 30A coffee maker receptacle in a commercial kitchen?

No, only 15A and 20A, 125V receptacles installed in commercial kitchens need to be GFCI protected [210.8(B)(2)].
Can copper wire be used to secure EMT in a metal stud wall?

This is really up to the authority having jurisdiction (AHJ). Electrical metallic tubing must be securely fastened within 3 feet of every box, cabinet, or termination fitting, and at intervals not exceeding 10 feet [358.30]. The NEC doesn't spell out specifically how the support is to be done, but all installations must be “approved” by the AHJ [90.4].
What are the NEC rules for splicing copper and aluminum conductors to each other?

Copper and aluminum conductors must not make contact with each other, except within a device that is listed and identified for this purpose [110.14].
I'm installing a 12A, 240V “wet saw,” and the manufacturer requires the motor to have GFCI protection. I don't believe this motor can be GFCI protected because it doesn't have a neutral. Do we need GFCI protection on this piece of equipment?

Yes. GFCI protection is required because equipment must be installed and used in accordance with any instructions included in the listing or labeling requirements. As an aside, remember that a neutral isn't necessary for the proper operation of a two-pole GFCI circuit breaker.
What do I do with the little bare aluminum wire in hospital-grade AC cable?

The internal aluminum bonding strip within the cable serves no electrical purpose once it is outside the cable; therefore, it can be cut off. However, many electricians use it to secure the anti-short bushing to the cable.
Is GFCI protection required for receptacles located in a walk-in freezer of a restaurant?

All 15A and 20A, 125V receptacles installed in an area with a sink and permanent facilities for food preparation and cooking [Art. 100], even those that don't supply the countertop surface, must be GFCI protected [210.8(B)(2)]. Many people would say that a walk-in freezer is not part of the kitchen “area,” but it is best to check with the AHJ.
Do we have to add GFCI receptacles in our facility each time the Code changes and requires more of them?

No, the NEC is an installation standard, not a maintenance standard. However, when existing receptacles are replaced in locations where GFCI protection is currently required, the replacement receptacles must be GFCI protected [406.4(D)(3)].
Where in the NEC does it indicate how far away from a bathtub or shower a switch needs to be located?

Switches can be located next to (but not within) a bathtub, hydromassage bathtub, or shower space [404.4, 680.70, and 680.72].
This question is in reference to separately derived systems under 600V installed within a building. Why does the NEC require a separately derived system to be grounded to a grounding electrode in accordance with 250.30(A)(2) and (A)(4), if the system ‘xo’ terminal is bonded to the system equipment grounding (bonding) conductor?

I don't think there is any technical reason to ground a separately derived system to an electrode if the system is under 600V — especially if it's located indoors. Since a separately derived system is bonded to the metal parts of the electrical installation [250.30(A)(1)], a zero system reference is established, the system voltage is stabilized, and the system-bonding conductor provides the low impedance path necessary to clear a ground fault. Don't forget that system bonding automatically grounds the system to the building grounding electrode system via the effective ground-fault path.
I'm planning to run three rigid nonmetallic conduits that each contains 500 kcmil conductors to supply a 1,200A panel from the service disconnect. According to Table 250.122, I need to supply a 3/0 AWG ground wire. Do I have to pull a ground wire in each conduit?

Well, let's first get the feeder conductor properly sized. A 1,200A feeder requires 600 kcmil conductors, not 500 kcmil. This is because the ampacity of 500 kcmil is only rated 1,140A (380A × 3) at 75°C [110.14(C) and 240.4(C)]. Now, back to your question. The equipment grounding (bonding) conductor must be a minimum of 3/0 AWG, and it must be installed in each of the raceways.
We use cords for motor connections in a Class I hazardous location in our industrial facility. I've been told that the cord must be explosionproof. Is there such a thing as an explosionproof cord?

There's no such thing as an explosionproof cord. The NEC only requires that the cord be of a type listed for extra-hard usage in accordance with Table 400.4 (501.1).
What is the minimum depth for placing Schedule 40 PVC conduit below a concrete slab?

If it's under a building, there is no depth requirement. If it's placed outside under a concrete slab, then the minimum cover is 4 inches [Table 300.5].
How high does a meter need to be mounted above grade? What about the service disconnect?

The NEC does not specify a minimum or maximum height for meters, but it does require switches and circuit breakers to be installed so the center of the grip of the operating handle of the switch or circuit breaker (when in its highest position) isn't more than 6 feet 7 inches above the floor or working platform. Note: Section 550.32(F) requires the service disconnecting means enclosure for mobile and manufactured homes to be mounted a minimum of 2 feet above the finished grade.
When can a transfer switch be installed ahead of the service disconnect?

Only when the transfer switch is rated as suitable for use as service equipment [230.66]. Suitable for use as service equipment means that the transfer switch contains a service disconnecting means. It's also supplied with a main bonding jumper so that a neutral-to-case connection can be made, as required in 240.24(B).
How do I size the ground wire for a circuit when the hot wires have been increased in size because of voltage drop?

When ungrounded circuit conductors (hot wires) are increased in size for any reason, the equipment grounding (bonding) conductor must be proportionately increased in size [250.122(B)].
For example:
If the ungrounded conductors for a 40A circuit are increased in size from 8 AWG to 6 AWG, the equipment grounding (bonding) conductor must be increased in size from 10 AWG to 8 AWG. This is because the circular mil area of 6 AWG is 59% greater than 8 AWG (26,240 cmil ÷ 16,510 cmil) [Chapter 9, Table 8]. According to Table 250.122, a 40A circuit protection device would require a 10 AWG equipment grounding (bonding) conductor, but it must also be increased in size by 59% (10,380 cmil × 1.59) = 16,504 cmil), which results in a 8 AWG.
The local inspector turned down my job for using THHN outside the weather head for service entrance conductors. He said I had to mark the conductors "sunlight resistant." I've been doing this for more than 15 years, and this is a first for me! Is he correct?

Yes. This is a new requirement in the 1999 NEC, added in Sec. 300.6 (C)1. The exact text reads, "Insulated conductors and cables used where exposed to direct rays of the sun shall be of a type listed or marked 'sunlight resistant.' " According to the UL White book, page 114, THHN, THHW, and THWN conductors that comply with an artificial weathering test are marked "sunlight resistant."
Does the NEC state the number of NM cables permitted under a single staple?

No. NM cable must be secured and supported in accordance with 334.30, which states that nonmetallic-sheathed cable must be secured by staples, cable ties, straps, hangers, or similar fittings designed and installed so as not to damage it. However, this section doesn't specify the maximum number of cables permitted under a single staple. As always, the installation must be approved by the AHJ (90.4), so basically it's up to the inspector.
Does the NEC require lighting fixtures in a factory to have a cover to protect against breaking bulbs?

No. However, lamps used for general illumination of temporary installations must be protected from accidental contact or breakage by a suitable fixture or lampholder with a guard [590.4(F)].
Is a splice permitted in a panel?

Yes. Splices and taps can be installed in cabinets, cutout boxes, or meter socket enclosures if the splices or taps do not fill the wiring space at any cross section to more than 75% (312.8).
Can an AFCI-protected circuit leave the bedroom of a dwelling unit and supply other receptacle or lighting outlets?

Sure. There is no Code requirement limiting the use of AFCI-protected circuits to bedroom outlets.
I'm wiring a showroom at a car dealership. We installed the receptacle outlets 16 inches (to center) above the floor, but the electrical inspector says it's a Code violation because there is a door along this wall, which opens into the service garage area (a classified location). He says this is the case even if the door has a closure on it and always remains closed. He also states this classification is the same for any room with a door that goes into the garage area, unless the air ventilation or air pressure exceptions apply to the space. Is my installation in violation of the NEC?

**Hint 511**

Yes. The area adjacent to a classified location, up to 18 inches above the floor, is classified as a Class I, Division 2 location, unless mechanically ventilated at a rate of four or more air changes per hour, or when walls or partitions effectively cut off the adjacent area [511.3].
How far away must I locate a receptacle outlet from a shower or bathtub?

Receptacles must not be installed within or directly over a bathtub or shower stall [406.9(C)], but they can be installed next to a bathtub or shower. Hydromassage bathtubs are treated like bathtubs [680].
Can the sum of the ampere ratings of circuit breakers in a panel exceed the rating of the panelboard?

Yes. However, each panelboard with supply conductors that include a neutral, and having more than 10% of its overcurrent devices protecting branch circuits rated 30A or less, must be protected by an overcurrent protective device having a rating not greater than that of the panelboard [408.36].
How many 12 AWG conductors can I install in 4-inch × 4-inch × 1¼-inch junction box if the enclosure has a plaster ring listed for 3.3 cubic inches, and there are no cable clamps or fixture support fittings in the enclosure?

According to Table 314.16(A), the box has a capacity of 21.0 cubic inches. Table 314.16(B) tells us that each 12 AWG conductor is considered as 2.25 cubic inches. So the calculation would be done as follows:

**Step 1** Determine the total volume of the box assembly [314.16(A)]
21 cubic inch box + 3.3 cubic inch plaster ring = 24.3 cubic inches

**Step 2** Determine the number of 12 AWG conductors permitted in the box.
24.3 cubic inches ÷ 2.25 cubic inches = 10.8
There is no permission to round up for box fill calculations, so the answer is ten 12 AWG conductors.
An electrical inspector recently failed one of our cell tower installations because nonconductive optical-fiber cable ran in the same raceway and enclosure with the 120V circuits. Can I run nonconductive optical-fiber cable in the same raceway and/or enclosure with power cable?

Yes. Section 770-110(B)2 states, “Nonconductive optical fiber cables shall be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, nonpower-limited fire alarm, or medium power network-powered broadband communications circuits operating at 600 volts or less.”
We recently bid a project that involved a stackable washer/dryer in each dwelling unit of an apartment building supplied by a single 30A, 240V receptacle circuit. The inspector says we must install a 20A, 120V laundry receptacle circuit in addition to the 30A, 240V receptacle circuit. This makes no sense to me.

The Code doesn't provide for an exemption to the rule in 210.11(C)(2) and 210.52(F) that requires a receptacle outlet served by a 20A branch circuit to be provided in the laundry area of a dwelling unit. This circuit would be in addition to the 30A branch circuit required for the combination washer/dryer.
If I'm using four 500 kcmil THHN conductors in each raceway (all current carrying), how many parallel runs would be required for a 2,000A feeder?

The installation of four current-carrying conductors in a raceway requires the use of an ampacity adjustment factor of 80% per Table 310.15(B)(3). The 90°C ampacity of 500-kcmil copper is 430A. The adjusted ampacity for 500 THHN is $430A \times 0.80 = 344A$. This installation will require the use of six sets of 500 kcmil for a 2,000A circuit ($2,000A/344A = 5.8$).
Can smart meters negatively impact health?

Smart meters use a wireless radio frequency (RF) interface, as well as power line communication (PLC) technology—although not all RF meters have smart capabilities. Exposure to large amounts of RF fields can raise body temperature and cause tissue damage.

However, the level of RF fields emitted by wireless smart meters is well below the amount that can cause heat-induced health effects. In fact, studies have shown that smart meter RF levels are far less than those of other everyday household devices.
Do the conduit fill requirements apply to a raceway containing telephone wires?

No. See requirements in 800.110(B).
Personal protective equipment (PPE) should protect which parts of the body?

Head, Eyes, Lungs, Arms, Legs, Torso, Hands, Feet
I have been told that I must use hospital grade switches in patient areas of a hospital.

There is no mention of these switches in the code.
When sizing the feeder for multiple motor loads I have been told that you use the total of all motor currents then multiply by 125%. Is this correct?

NO
From 430.24, you can see that conductors that supply several motors must have an ampacity not less than: 125% of the highest-rated motor FLC [430.17], plus the sum of the FLCs of the other motors (on the same phase), as determined by 430.6(A), plus the ampacity required to supply the other loads on that feeder.
Is it true that in a separately derived system the primary circuit conductors have no direct electrical connection to the secondary circuit conductors?

**Separately Derived System.** A premises wiring system whose power is derived from a source of electric energy or equipment other than a service. Such systems have **no direct connection from circuit conductors of one system to circuit conductors of another system**, other than connections through the earth, metal enclosures, metallic raceways, or equipment grounding conductors. [100]
Is it true that all smaller generators have to have GFCI installed on them?

Yes The 2011 Code requires all 15kW or smaller generators to have GFCI protection for the 125V or 125/250V, single-phase, 15A, 20A, and 30A receptacles installed on them. For generators manufactured or remanufactured prior to Jan. 1, 2011, cord sets or other devices that provide portable GFCI protection may be used [590.6(A)(3)]. Section 590.6 was also rewritten using a list format for easier reading and understandability.
I installed a receptacle type GFCI in a storage room off of the car port and daisy-chained it to the receptacles in the carport and outside the back door. The inspector turned it down, why?

210.8 Ground-Fault Circuit-Interrupter Protection for Personnel. Ground-fault circuit-interruption for personnel shall be provided as required in 210.8(A) through (C). The ground-fault circuit-interrupter shall be installed in a readily accessible location.
In the past an AFCI receptacle had to be installed within 6 feet of the overcurrent device and the conductor in metallic conduit. Is this still true?

No distant is any longer mentioned 210.12(A)
Exception No. 2: Where a listed metal or nonmetallic conduit or tubing is encased in not less than 50 mm (2 in.) of concrete for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install an outlet branch-circuit type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.
I replaced a regular 20 Amp receptacle outside a commercial building for use by the HVAC guys. When my boss came by to see how things were going he told me the receptacle was not of the correct type. What was he referring to?

406.4(D) (6) Weather-resistant receptacles shall be provided where replacements are made at receptacle outlets that are required to be so protected elsewhere in this Code.
We recently installed a service in a small industrial building the inspector turned us down for not supplying a field marking of the fault current. Is this a code requirement or a local requirement?

110.24 Available Fault Current.  
(A) Field Marking. Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault current calculation was performed and be of sufficient durability to withstand the environment involved.
Please tell me if there is an article in the 2011 NEC that states how many receptacles can be installed on a 15 Amp circuit.

The code doesn't say.

However it does state in several places that outlets should provide 180 VA. That is 1.5A per device.
Is AFCI protection required in nondwelling occupancies?

No

Here is the rule for AFCI protection, and it applies only to dwellings: 120V branch circuits in dwelling units supplying outlets in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas must be protected by a listed AFCI device of the combination type [210.12].
Must all conductors [ungrounded and neutral] of a circuit be run in the same raceway?

All conductors of a circuit must be installed in the same raceway, cable, trench, cord, or cable tray, except as permitted by (1) through (4) [300.3(B)]. Conductors installed in parallel in accordance with 310.10(H) must have all circuit conductors within the same raceway, cable tray, trench, or cable [300.3(B)(1)].

Exception: Parallel conductors run underground can be installed in different raceways (Phase A in raceway 1, Phase B in raceway 2, and so forth) if, in order to reduce or eliminate inductive heating, the raceway is nonmetallic or nonmagnetic and the installation complies with 300.20(B).

See 300.5(I)

Exception No. 2.

All conductors of a circuit must be installed in the same raceway, cable, trench, cord, or cable tray to minimize induction of the heating of ferrous metal raceways and enclosures, and to maintain a low-impedance ground-fault current path [250.4(A)(3)].
What is the minimum size conductor that can be used to run over head from structure to structure?

You can use conductors 10 AWG or larger for overhead spans up to 50 ft. For spans more than 50 ft, use 8 AWG or larger (unless supported by a messenger wire) [225.6(A)(1)]
I have been told that a TV dish can not be attached to a service mast. Is that true?

Only feeder or branch circuit conductors can be attached to the feeder and/or branch circuit mast [225.17]
What is the Code rule regarding wiring under roof decking?

Cables, raceways, and enclosures under metal-corrugated sheet roof decking must not be located within 1½ in. of the roof decking, measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. In addition, cables, raceways, and enclosures aren’t permitted in concealed locations of metal-corrugated sheet decking type roofing [300.4(E)].
I have been told that feeder circuits rated at 1,000 Amp or more supplied by a 4-wire, 3-phase, 277/480 V wye-system has to have some sort of GFCI protection. What is this?

Hint 240.13

According to 240.13, service equipment and feeder circuits rated 1,000A or more supplied from a 4-wire, 3-phase, 277/480V wye-connected system must be protected against ground faults per 230.95 [215.10 and 230.95], but this requirement doesn’t apply to:

1. Continuous industrial processes where a disorderly shutdown will introduce additional or increased hazards.
2. Installations where ground fault protection of equipment already exists.
3. Fire pumps [695.6(H)].
Are plug type fuses still allowed?

Plug fuses of 15A or lower rating are identified by a hexagonal configuration of the window, cap, or other prominent part. You can use plug fuses only when:
1. The circuit voltage doesn’t exceed 125V between conductors [240.50(A)(1)].
2. The circuits are supplied by a system with a line-to-neutral voltage not exceeding 150V [240.50(A)(2)].

Edison-base fuses are classified to operate at not more than 125V and have an ampere rating of not more than 30A [240.51(A)]. You can use them only for replacement in an existing installation where there’s no evidence of tampering or overfusing [240.51(B)]. You can install Edison-base fuseholders only if you install an adapter that lets them accept Type S fuses [240.52].

Type S fuses operate at not more than 125V and have ampere ratings of 15A, 20A, and 30A [240.53(A)].
Where can cartridge fuses be used?

The two basic designs of cartridge fuses are the ferrule type (maximum rating of 60A) and the knife-blade type (rated over 60A). The fuse length and diameter varies with the voltage and current rating. You can use cartridge fuses and fuseholders of the 300V type only for circuits not exceeding 300V [240.60(A)]:

- Between conductors.
- From any ungrounded conductor to the neutral point.
An inspector made me replace a 20 amp breaker that was used for switching fluorescent lights. She said it had to be marked SWD or HID. Where is this in the Code?

Circuit breakers used to switch 120V or 277V fluorescent lighting circuits must be listed and marked SWD or HID. Circuit breakers used to switch high-intensity discharge lighting circuits must be listed and marked HID [240.83(D)].
Is it true that all circuit breakers must be hand operated?

YES

Circuit breakers must be capable of being opened and closed by hand. Non-manual means of operating a circuit breaker, such as electrical shunt trip or pneumatic operation, are permitted if the circuit breaker can also be manually operated [240.80].
A circuit breaker must be rated for the overcurrent and an interrupter rating. What is the interrupter rating?

Circuit breakers have an interrupting rating of 5,000A unless marked otherwise. Be sure the circuit breaker has an interrupting rating sufficient for the short circuit current available at the line terminals of the equipment. If the interrupting current rating isn’t adequate, a line-to-line or ground fault can destroy equipment or result in serious injury or death [110.9].
Does the code specify the percent voltage drop on feeders?

Yes

215.2(A)(4)
Individual Dwelling Unit or Mobile Home Conductors
Informational Note No. 2: Conductors for feeders as defined in Article 100, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, will provide reasonable efficiency of operation.
When installing a new electrical service in an existing building, does the Code require the concrete be chipped up to access the rebar to establish a concrete-encased electrode?

NO

250.50 Grounding Electrode System. All grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. Where none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) through (A)(8) shall be installed and used.
Is there a minimum depth required for a junction box when conductors enter from the back of the box?

Yes and No
When insulated conductors 4 AWG or larger enter an enclosure in the wall opposite a removable cover, the distance from where the conductors enter to the removable cover must not be less than the bending distance as listed in Table 312.6(A) for one conductor per terminal [314.28(A)(2) Ex].
What is the minimum rating of the disconnecting means for a building or structure fed by a branch circuit or feeder?

A single disconnecting means for a building/structure must have an ampere rating not less than the calculated load as determined by Art. 220. If the disconnecting means consists of more than one switch or circuit breaker, the combined ratings of the circuit breakers must not be less than the calculated load as determined by Article 220. In addition, the disconnecting means must not be rated lower than [225.39]:

- 15A for installations consisting of a single branch circuit.
- 30A for installations consisting of two 2-wire branch circuits.
- 100A, 3-wire, for a one-family dwelling.
- 60A for all other installations.
Where are tamper-resistant receptacles required?

All nonlocking type 15A and 20A, 125V receptacles in the following areas of a dwelling unit [210.52] must be listed as tamper-resistant [406.12].

406.13 Tamper-Resistant Receptacles in Guest Rooms and Guest Suites.

406.14 Tamper-Resistant Receptacles in Child Care Facilities.

517.18(C) Pediatric Locations. Receptacles located within the rooms, bathrooms, playrooms, activity rooms, and patient care areas of designated pediatric locations shall be listed tamper resistant or shall employ a listed tamper-resistant cover.
Not in Code  But  --- Southwire says:

Wire and Cable exposed to floodwaters should be replaced to assure a safe and reliable electrical system. When wire and cable products are exposed to water or excessive moisture, the components may be damaged due to mildew or corrosion. This damage can result in insulation or termination failures. The problem can be more severe if the components have been subjected to salt water during hurricanes, etc., or inland flooding where there may be high concentrations of chemicals, oils, fertilizers, etc.

Wire and cable that is listed for dry locations only, such as NM-B, should be replaced if it has been exposed to floodwater. NM-B cable contains paper fillers that can pull contaminated water into the cable, which can cause premature cable failure. Flood damaged cable should be replaced to assure a safe and reliable installation.

Products listed for wet locations, such as THWN and XHHW, may be suitable for continued use if no contaminants are present in the cable. There may be problems that show up later because of corrosion of the conductor. This could result in overheating of the conductor. If the ends of a conductor have been exposed to water, the cable may be purged to remove the water. An insulation resistance test should be conducted before the cable is energized.

All wire or cable products that have been exposed to contaminated floodwater need to be examined by a qualified person, such as an electrical contractor, to determine if the cable can be re-energized. Flood damaged cable may not fail immediately when energized. It may take months for the cable to fail due to damage caused by floodwaters.

Should all wiring exposed to water from Sandy be replaced?
My boss asked me to size the single phase conductors for a phase converter which will supply a variable load. When I made the calculation I used 125% of the converts single-phase nameplate rating. He says it should be 100%. Who is correct?

You 455.6(A)(1)
Where the loads to be supplied are variable, the conductor ampacity shall not be less than 125 percent of the phase converter nameplate single-phase input full-load amperes.
The ampacity for the supply conductors for a resistance welder with a duty cycle of 15% and a primary current of 21 amps is:

a. 9.45 amps  
b. 8.19 amps  
c. 11.2 amps  
d. 21 amps

B 630.31(A)(1)  
The ampacity of the supply conductors for a welder wired for a specific operation for which the actual primary current and duty cycle are known and remain unchanged shall not be less than the product of the actual primary current and the multiplier specified in Table 630.31(A)(2) for the duty cycle at which the welder will be operated.
We just installed a stationary 1½ HP single-phase 230v motor and used a 15Amp general use switch as the disconnect. It was turned down by the inspector, why?

According to 430.109(C)(1) Stationary Motors of 2 Horsepower or Less. For stationary motors rated at 2 hp or less and 300 volts or less, the disconnecting means shall be permitted to be one of the devices specified in (1), (2), or (3):
(1) A general-use switch having an ampere rating not less than twice the full-load current rating of the motor.

A 1½ HP single-phase 230v motor requires 10Amp so you should use a 20Amp switch
When installing a surge-arrester we were told that the conductors must be AWG 6 or larger. Makes no sense!

280.23 Surge-Arrester Conductors. The conductor between the surge arrester and the line and the surge arrester and the grounding connection shall not be smaller than 6 AWG copper or aluminum.
Table 314.16(A) only goes up to 4 AWG. How do I size boxes for larger conductors?

314.24(B)(2) Conductors Larger Than 4 AWG. Boxes that Enclose devices or utilization equipment supplied by Conductors larger than 4 AWG shall be identified for their specific function.
What is a High Impedance or High Resistance Grounding system? I thought all grounds had to be 25 Ω or less.

High-resistance grounding (HRG) systems are commonly used in plants and mills where continued operation of processes is paramount in the event of a fault. High-resistance grounding is normally accomplished by connecting the high side of a single-phase distribution transformer between the system neutral and ground, and connecting a resistor across the low-voltage secondary to provide the desired lower value of high side ground current. With an HRG system, service is maintained even during a ground fault condition. If a fault does occur, alarm indications and lights help the user quickly locate and correct the problem or allow for an orderly shutdown of the process. An HRG system limits ground fault current to between 1A and 10A.
**Advantages**

- Limits the ground fault current to a low level.
- Reduces electric shock hazards.
- Controls transient overvoltages.
- Reduces the mechanical stresses in circuits and equipment.
- Maintains continuity of service.
- Reduces the line voltage drop caused by the occurrence and clearing of a ground fault.

**Disadvantages**

- High frequencies can appear as nuisance alarms.
- Ground fault may be left on system for an extended period of time.
I have been told by an inspector that all conductors larger than a 10 AWG installed in a raceway must be stranded. Is this true?

310.106(C) Stranded Conductors. Where installed in raceways, conductors 8 AWG and larger, not specifically permitted or required elsewhere in this Code to be solid, shall be stranded.
We can not find a code section requiring 3-way switches. Can you help?

210.70(A)(2)(c)
Where one or more lighting outlet(s) are installed for interior stairways, there shall be a wall switch at each floor level, and landing level that includes an entryway, to control the lighting outlet(s) where the stairway between floor levels has six risers or more.

Exception to (A)(2)(a), (A)(2)(b), and (A)(2)(c): In hallways, in stairways, and at outdoor entrances, remote, central, or automatic control of lighting shall be permitted.
Our company just completed a very expensive single-family home. There was a tremendous foyer in which we did not install any receptacles. The inspector made us go back and install two receptacles. Tell use why, the inspector just said they were required but could not tell us where this requirement is in the code.

210.52 (I) Foyers. Foyers that are not part of a hallway in accordance with 210.52(H) and that have an area that is greater than 5.6 m² (60 ft²) shall have a receptacle(s) located in each wall space 900 mm (3 ft) or more in width and unbroken by doorways, floor-to-ceiling windows, and similar openings.
We just finished a large commercial building with several mechanical rooms, in these we used motion sensors switches to control the lights as requested by the owner. The inspector says this is a No No. Please explain!

110.26(D) Illumination About Electrical Equipment

- Illumination required
- Additional luminaire not required where space is illuminated by adjacent light source
- Lighting sources for working spaces about electrical equipment cannot be controlled by automatic means only

Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, or motor control centers installed indoors.
A fellow contractor tells me that receptacles are required on all balconies regardless of size. I had assumed it was still only on balconies that were 20 ft² or more. Is this now true?

210.52(E)(3) Balconies, Decks, and Porches
Balconies, decks, and porches that are accessible from inside the dwelling unit required to have at least one receptacle outlet installed within the perimeter of the balcony, deck, or porch (regardless of size)
Must I put a tag on all panels which contain ungrounded systems?

250.21(C) Marking - Ungrounded Systems

Ungrounded systems shall be legibly marked "Ungrounded System" at the source or first disconnecting means.

The marking shall be of sufficient durability to withstand the environment involved.

Marking requirements required for ungrounded systems to indicate an ungrounded system.
It is my understanding that a grounded conductor is sized based on the unbalance in the systems. A friend says that on Delta motor systems the grounded conductor is not required. True

**250.24(C) Grounded Conductor Brought to Service**

Rules for routing the grounded conductor at service equipment have been revised for clarity.

Ampacity of grounded conductor of a 3-phase, 3-wire delta service shall be not less than that of the ungrounded conductors.
Temporary wiring for receptacles on construction sites are required to be GFCI protected. One would assume then that temporary receptacles in assembly halls for exhibition must be GFCI protected. True - False

518.3.(B) Temporary Wiring. In exhibition halls used for display booths, as in trade shows, the temporary wiring shall be permitted to be installed in accordance with Article 590. Flexible cables and cords approved for hard or extra-hard usage shall be permitted to be laid on floors where protected from contact by the general public. The ground-fault circuit-interrupter requirements of 590.6 shall not apply. All other ground-fault circuit-interrupter requirements of this Code shall apply.
In our area we wire a lot of agricultural buildings. What are the GFCI requirements if any?

547.5(G) GFCI - Agricultural Buildings

The omission of GFCI protection for an accessible receptacle supplying a dedicated load (located within 900 mm (3 ft) of a GFCI-protected receptacle) at agricultural buildings has been deleted.

All 125-volt, single-phase, 15- and 20-ampere general-purpose receptacles installed in agricultural building locations below shall have GFCI protection:

- Areas having an equipotential plane
- Dirt confinement areas for livestock
- Damp or wet locations
- Outdoors
Are the rules for GFCI’s in Mobile Homes different than for stick built home?

550.13(B) GFCIs (Mobile and Manufactured Homes)

All 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in the following locations shall be provided with GFCI protection:

(1) Outdoors; (2) In compartments accessible from outside the unit; (3) Bathrooms (including receptacles in luminaires); (4) Kitchen countertop receptacles; (5) Receptacle outlets located within 1.8 m (6 ft) of a wet bar sink

The exceptions in 210.8(A) shall be permitted
Are the rules for AFCI’s in mobile homes different than for stick built home?

550.25 AFCIs (Mobile and Manufactured Homes)

All 120-volt branch circuits that supply 15- and 20-ampere outlets installed in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas of mobile homes and manufactured homes shall comply with 210.12 (AFCI)

Overhead cut-away view of mobile home or manufactured home

Red = Outlets requiring AFCI-protected branch circuits
When sizing the service for a boat dock that has 25 receptacle for hook up by boats. How do we size this service? Is it the sum total of all receptacles?  

\[ 25 \times 20 = 500 \text{ Amp} \]

<table>
<thead>
<tr>
<th>Number of Shore Power Receptacles</th>
<th>Sum of the Rating of the Receptacles (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>100</td>
</tr>
<tr>
<td>5-8</td>
<td>90</td>
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<tr>
<td>9-14</td>
<td>80</td>
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<td>51-70</td>
<td>40</td>
</tr>
<tr>
<td>71-plus</td>
<td>30</td>
</tr>
</tbody>
</table>

Notes: (See NEC for text)

Table 555.12 has been revised to clearly indicate that the receptacles addressed by this table are shore power receptacles only
We just installed the electrical equipment for a in ground pool. The inspector turned us down for not bonding the metal window frames. Is this a code requirement or local requirement?

680.26(B)(7) Fixed Metal Parts

All fixed metal parts within 1.5 m (5 ft) horizontally and 3.7 m (12 ft) vertically of permanently installed pools must be bonded to the equipotential bonding grid.

This would include but not limited to metal sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames.
I just installed a branch circuit for a hydromassage and terminated the 8 AWG bonding jumper in the motor junction box, at the grounding conductor. The inspector says I have to add an additional length. What?

680.74 Hydromassage Bathtub - Bonding

All metal piping systems and all grounded metal parts in contact with the circulating water shall be bonded together using a solid copper bonding jumper, insulated, covered, or bare, not smaller than 8 AWG

An 8 AWG or larger solid copper bonding jumper long enough to terminate on a replacement non-double insulated pump motor is required when a double insulated pump motor is employed at a hydromassage bathtub

This bonding jumper is to terminate to the equipment grounding conductor of the branch circuit of the motor
Do emergency system receptacles in a hospital have to be identified in some manner?

517.30(E) Receptacle Identification. The cover plates for the Electrical receptacles or the electrical receptacles themselves supplied from the emergency system shall have a distinctive color or marking so as to be readily identifiable.
There are three branches for the alternate power source for hospitals. To which must the Nurse Call system be connected? My boss says the equipment I believe it is the critical branch. Who is correct?

You Are
517.33 Critical Branch.
(5) Nurse call systems
I'm running a 4-wire lighting circuit with a shared neutral. Can I use three single-pole breakers without handle ties?

Yes. Individual single-pole breakers can be installed on each ungrounded conductor of a multiwire branch circuit that supplies line-to-neutral loads for lighting or receptacle circuits [240.20(B)(1)]. However, multiwire branch circuits that supply switches, receptacles, or equipment on the same yoke must be provided with a means to disconnect simultaneously all ungrounded conductors that supply those devices or equipment at the point where the branch circuit originates [210.4(B) and 210.7(B)]. This can be accomplished by single-pole circuit breakers with handle ties identified for the purpose of a 2- or 3-pole breaker with common internal trip.
What is “redundant grounding,” and why would it be a requirement of the NEC?

The term “redundant grounding” is not used in the Code anywhere that I know of. However, Webster’s Dictionary defines redundancy as “the provision of a duplicate system or equipment as a backup.” Section 517.13(A) requires redundant grounding. Article 517 covers healthcare facilities, and because of the importance of a reliable ground-fault return path and the possibility of a failure in the metallic connections, requiring a copper-insulated grounding conductor to be run with the branch-circuit conductors ensures a reliable ground-fault return path.
Can a stranded neutral conductor be divided into two parts and be terminated in two adjacent holes in the neutral bus?

NEC 408.41 requires that each grounded conductor be terminated in an individual terminal.
I installed a two-head emergency battery lighting unit in a store. I installed the unit with one head in a hallway and mounted the second head remotely from the battery unit in a public washroom adjacent to the hallway. Is this installation in accordance with the NEC?

Emergency illumination must be installed so that a light bulb burning out will not leave the area in total darkness (see Section 700.16). That’s why units of the sort you describe are manufactured with two lighting heads. A two-lamp unit must be installed in each area you describe.
I’m running a circuit to a three-phase motor from a 120/240V, three-phase, delta service. Is it required to mark the high phase conductor with an orange color? Article 430 doesn’t state anything about this.

NEC 110.15 requires that the high phase conductor must be marked at each point on the system where a connection is made only if the grounded conductor is present.
What size grounding-electrode conductor should be used for service panels requiring 4/0 or larger copper wire where the grounding-electrode conductor is connected to a concrete-encased electrode and a metal water pipe?

NEC 250.50 requires that, where present, the metal underground water pipe and the concrete-encased electrode shown in 250.52(A)(1) and (3) be bonded together to form the grounding-electrode system. This can be accomplished by installing a 4 AWG grounding-electrode conductor to the concrete-encased electrode [250.66(B)] and a 2 AWG to the metal water pipe (250.66). You are permitted, however, to run a 2 AWG to the metal water pipe and bond the concrete-encased electrode to the water pipe using a 4 AWG bonding conductor. If you run to the concrete-encased electrode first and then bond the metal water pipe to it, you must run a 2 AWG the entire length to maintain the proper conductor size to the metal water pipe.
What is meant by the term “series rated”?

A circuit breaker can be used on a circuit having an available fault current higher than its marked interrupting rating if it is connected on the load side of an acceptable overcurrent device having the higher rating. For example, if a service panel had 14,000A of available fault current at its terminals, circuit breakers marked 10,000A could be used if the main breaker was marked 22,000A. If a fault occurs on the load side of a branch breaker, then the main breaker and the branch breaker act “in series,” and both trip “off.” Section 240.86 has additional information relating to series ratings.
Is ground up on receptacles a preference or a Code requirement? If the ground is up and the cord end starts to pull out and hang down, the ground is the first thing to be disconnected. I’m told it is to protect if an object was to fall against the cord end when it is pulled away from the receptacle.

There is no Code requirement for the orientation of the ground prong on a grounded receptacle. Every Code cycle, proposals are submitted to require the ground up or ground down with the submitters substantiation as to the importance of installing it that way. These proposals have always been rejected, leaving the orientation up to the installer. The ground prong on a plug is longer than the other prongs and is always the last to become disengaged.
Most architects and engineers prefer to install receptacle outlets for scheduling boards and projectors above a suspended ceiling for aesthetic reasons. Can factory-installed power cords actually be plugged into an above-the-ceiling receptacle?

No, 400.8(5) does not permit flexible cords to be used where located above suspended ceilings unless specifically permitted in 400.7. NEC 400.7 permits a variety of uses for flexible cords but does not permit any of the uses shown to be specifically located above a suspended ceiling.
References
Some questions from Georgia Electrical Contractors
Some questions and answers taken from EC&M Magazine and Electrical Contractor Magazine
Some graphics from a training presentation by IAEI
2011 Nation Electrical Code