See attachment photo of a Load ScheduleCalculation Procedure:Total connected load (TCL)First 10kVA of receptacle load = 10 kVAOver 10kVA of receptacle load = 110.4 kVAContinuous loads = 0 kVANon – continuous loads = 0 kVATotal connected load (TCL) = 120.4 kVATotal Demand Load (TDL)First 10kVA of receptacle load (100%) = 10 kVAOver 10kVA of receptacle load (50%) = 55.2 kVAContinuous loads (125%) = 0 kVANon – continuous loads (100%) = 0 kVAApplying Load Diversity factor 100% = 65.2 kVATotal Demand Load (TDL) = 65.2 kVASystem Voltage: 208V, 3ΦFull Load Current (FLA)FLA = (65.2*1000") / (1.732)(208)FLA = 180.9 ASize of Circuit ProtectionCircuit Breaker = 1.25 (FLA)Circuit Breaker = 1.25 (180.9A) = 226.13AUse: 300A, 3P, 208V, 60Hz, Bolt on type MCCBSize of Circuit conductorConductor size, as per table 3.10.2.6(B)(16) of PEC 2017Under THWN category, 75ºC thermal limitUse: 1 – 350 kcMIL conductor per phase including neutral and 1 - #4 AWG grounding conductor as per table 2.50.3.17 and 2.50.5.13(C)(1) of PEC 2017Applying derating factors:Ampacity of 350 kcMIL conductor = 305 AFinding derating factors for 4 conductors require = 80%Finding derating factors for 60ºC ambient temperature = 65%Allowable Ampacity for 350 kcMIL conductor:Allowable ampacity = [("305")("0.8")("0.65")] = 158.6 AThe allowable ampacity is limited to 158.6 amps for each 350 kcMIL conductor as per tables 3.10.2.6(B)(3)(a) and 3.10.2.6(B)(2)(b).Calculation for the short time current rating of #4 AWG copper grounding conductor installed and run in the racewayType of Insulation = TWCable Size = #4 AWGCable area = 41740 cir. milsRated Ampacity = 70A as per table 3.10.2.6(B)(16)T1 =60ºC;T2 = 150ºCt = 2 secsIsc = Short Circuit currentIsc = √({(A ^2 [0.0297log((T2+234) / (T1+234))]) / t })Isc = 1732.27 AmpsUse: 2000A short time current rating for #4 AWG cu grounding electrode conductor in 2 secs. Is it possible to derate connected load for a MCC feeder? ie if I have 410 amps connected load (motor full load amps) can I use a 400 amp breaker? Thanks for any help Probably not. You have to go by ?calculated load,? not ?connected load.? In many cases, the calculated value is lower than the connected value. But for motors, it doesn?t always work out that way. For starters, you have to add 25% of the largest motor, when calculating the load. Your best hope would be if two or more motors are interlocked in a manner that prevents one from running, if another is running. You don?t have to count both loads from a pair of loads that is non-coincident. Two more tidbits. Number one is that you do not ?derate? a load. You can sometimes apply a ?demand factor? for a group of loads. But the only thing that gets ?derated? is the ampacity of a conductor. Number two is that you should not be getting your motor load current from the nameplate. Look at tables 430.248 and 430.250. This might or might not make your situation better for you. You need to find out what the "demand" load is for the MCC. If it is an industrial facility then the client should have knowledge of the process and which motors will be on at one time. If it is another facility then someone (HVAC guy, building maint, etc.)should be able to give some input. If not, assume a 100% demand and size accordingly. The smallest MCC I have ever seen is 600 amps so why not assume that the MCC could grow and size the feeder for the max it could be? Thanks for all the answers...is there a formula or equation for figuring the demand? Iam going to install a larger than needed feeder, but I do need to know how to figure demand load..... Some of the motors (2 of the largest) only run about 2 % of the time Last edited: Dec 12, 2006 Demand varies with the application - there is no set rule. Good luck I?ve taken Article 220 (2002 NEC) and deleted all ?residential/dwelling? sections - as indicated by an ellipsis (?). For some of the remaining Subsections I retained only the title to indicate they don?t usually apply to industrial facilities. I retained the critical cross-references to external Sections that effect industrial / commercial design and the key ?basic? rules within the Article. I draw particular attention to Section 220.10. Since I have also left the references to ?? applicable demand factors permitted by Parts II, III, or IV?? (220.14 and 220.21) how would you size the Load? Cite your Code references. Remember: "noncoincident loads" are mutually exclusive such as electric space heating and air conditioning or "running" and "spares." They are not "probabilities,? "diversity? or ?demand? factors. ARTICLE 220 Branch-Circuit, Feeder, and Service Calculations. This article provides requirements for computing branch-circuit, feeder, and service loads. Exception: Branch-circuit and feeder calculations for electrolytic cells as covered in 668.3(C)(1) and (4). 220.2 Computations. (A) Voltages. Unless other voltages are specified, for purposes of computing branch-circuit and feeder loads, nominal system voltages of 120, 120/240, 208Y/120, 240, 347, 480Y/277, 480, 600Y/347, and 600 volts shall be used. (B) Fractions of an Ampere. Where computations result in a fraction of an ampere that is less than 0.5, such fractions shall be permitted to be dropped. 220.3 Computation of Branch Circuit Loads. Branch-circuit loads shall be computed as shown in 220.3(A) through (C). (A) Lighting Load for Specified Occupancies. ? (B) Other Loads - All Occupancies. In all occupancies, the minimum load for each outlet for general-use receptacles and outlets not used for general illumination shall not be less than that computed in 220.3(B)(1) through (11) ? (C) Loads for Additions to Existing Installations. ? (2) Other Than Dwelling Units. Loads for new circuits or extended circuits in other than dwelling units shall be computed in accordance with either 220.3(A) or (B), as applicable. 220.4 Maximum Loads. The total load shall not exceed the rating of the branch circuit, and it shall not exceed the maximum loads specified in 220.4(A) through (C) under the conditions specified therein. (A) Motor-Operated and Combination Loads. Where a circuit supplies only motor-operated loads, Article 430 shall apply. Where a circuit supplies only air-conditioning equipment, refrigerating equipment, or both, Article 440 shall apply. For circuits supplying loads consisting of motor-operated utilization equipment that is fastened in place and has a motor larger than hp in combination with other loads, the total computed load shall be based on 125 percent of the largest motor load plus the sum of the other loads. (B) Inductive Lighting Loads. For circuits supplying lighting units that have ballasts, transformers, or autotransformers, the computed load shall be based on the total ampere ratings of such units and not on the total watts of the lamps. ... II. Feeders and Services 220.10 General. The computed load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied, as determined by Part I of this article, after any applicable demand factors permitted by Parts II, III, or IV have been applied. FPN: See Examples D1(A) through D10 in Annex D. See 220.4(B) for the maximum load in amperes permitted for lighting units operating at less than 100 percent power factor. 220.11 General Lighting. The demand factors specified in Table 220.11 shall apply to that portion of the total branch-circuit load computed for general illumination. They shall not be applied in determining the number of branch circuits for general illumination. ? 220.12 Show-Window and Track Lighting. ? 220.14 Motors. Motor loads shall be computed in accordance with 430.24, 430.25, and 430.26 and with 440.6 for hermetic refrigerant motor compressors. 220.15 Fixed Electric Space Heating. ? 220.21 Noncoincident Loads. Where it is unlikely that two or more noncoincident loads will be in use simultaneously, it shall be permissible to use only the largest load(s) that will be used at one time, in computing the total load of a feeder or service. 220.22 Feeder or Service Neutral Load. ? III. Optional Calculations for Computing Feeder and Service Loads ... 220.34 Optional Method - Schools. ... 220.35 Optional Calculations for Determining Existing Loads. The calculation of a feeder or service load for existing installations shall be permitted to use actual maximum demand to determine the existing load under the following conditions: (1) The maximum demand data is available for a 1-year period. Exception: If the maximum demand data for a 1-year period is not available, the calculated load shall be permitted to be based on the maximum demand (measure of average power demand over a 15-minute period) continuously recorded over a minimum 30-day period using a recording ammeter or power meter connected to the highest loaded phase of the feeder or service, based on the initial loading at the start of the recording. The recording shall reflect the maximum demand of the feeder or service by being taken when the building or space is occupied and shall include by measurement or calculation the larger of the heating or cooling equipment load, and other loads that may be periodic in nature due to seasonal or similar conditions. (2) The maximum demand at 125 percent plus the new load does not exceed the ampacity of the feeder or rating of the service. (3) The feeder has overcurrent protection in accordance with 240.4, and the service has overload protection in accordance with 230.90. 220.36 Optional Calculation - New Restaurants. ? IV. Method for Computing Farm Loads ... Computing loads per Article 220 creates a modest ?safety factor? for electrical designs. We?re lucky; civil/structural and mechanical safety factors are often 5, 10, 20 and ocassionally 25. I'd add a brief comment to Charlie's first comment. The NEC does not actually require the loads to be interlocked. I'd add a brief comment to Charlie's first comment. The NEC does not actually require the loads to be interlocked. True. But if you do have an interlock, it might make it easier for you to convince the AHJ that the loads are non-coincident. Thank you very much for the detailed answer One of the most basic electrical calculations that an electrical engineer should know is to calculate the Total Connected Load (TCL) and Maximum Demand (MD). The one million dollar question: What is Total Connected Load and Maximum Demand? Total Connected Load (TCL) is the mechanical and electrical load (in kW) that will be connected (or to consumed) for that particular area. The Maximum Demand (MD) is the total kW that actually contributes the total power used in one time after applying the diversity factor based on the Total Connected Load calculated. Example 1 Let say, your own bedroom is having 1no. 2hp air-conditioning split unit, 4nos. of single phase socket outlet and 1no. 2X36W T8 Florescent Tube. I'm using the Excel program since I can easily manipulate all the values in case fine-tuning values need to be made in future. Then, your Total Connected Load and the Maximum Demand will be as per above; By looking into the figure above, the Total Connected Load and the Maximum Demand is 2.57kW and 1.36kW respectively. How The Calculation Works? 1. The unit for TCL and MD is in Watt. Therefore, all the loads need to convert into Watt. a) 2hp a/cond split unit = 2 X 746W = 1492W b) 2X36W Flou. Fitting = (2 X 36W) + Ballast Wattage = 80W c) 13A Socket Outlet = 250W (this is rather subjective since some engineer putting 300W/nos) 2. Determine the Diversity Factor (DF) for the respective load. The DF is the percentage of load that will contribute for the total of the Maximum Demand. For the above example, I'm expecting the split unit will contribute 6o% of the total MD, lighting will be 80% and socket outlet is 40%. 3. Multiply the Diversity Factor with the Connected Load to get the Maximum Demand. 4. Summing-up the individual MD to obtain the Total MD. Why I Need To Calculate The TCL and MD? By calculating the TCL, you'll know the total load connected for a particular area and also you can determine the sizing of cables. But, the most important thing is by having the TCL, you can determine your MD. This MD will be declared to the utility provider for the purpose of meter deposit and utility bill. The term "connected load" is the total nameplate rating of the appliance(s), whereas the term "demand load" refers to a reduction from connected load. What is the correlation between amps and volts? Amps = Watts / Volts Examples: 4160 Watts / 208 Volts = 20 Amps. 3600 Watts / 240 Volts = 15 Amps. How is connected load calculation? Calculation of Connected Load In every consumer's home, there is certain equipment installed. "Connected load" of a consumer is the sum of the continuous ratings of all the equipment of the consumer's premises. Then the connected load of one consumer is 5×100 + 2×60 + 500 = 1120 watts. Which is more connected load or maximum demand? Generally, the maximum demand on the power station is less than the connected load. How do you calculate electrical load demand? To calculate your load factor take the total electricity (KWh) used in the month and divide it by the peak demand (power)(KW), then divide by the number of days in the billing cycle, then divide by 24 hours in a day. The result is a ratio between zero and one. Power Load Factor = 2000/35/30*24 = 79.4% –> you are good! Are amps or volts stronger? You can't have a lot of amps without a lot of volts. So, back to which kills you, the amps or volts. Given your body is a constant resistance, it really is a combination of both. Higher voltage means higher amperage, and thus higher voltage has more potential to kill. What is the difference between amp and volt? Voltage and amperage are two measures of electrical current or flow of electrons. Voltage is a measure of the pressure that allows electrons to flow, while amperage is a measure of the volume of electrons. Which is more powerful amp or volt? Power and Run Times The higher the voltage, the more powerful your tool. Amp hours measures the run time of the battery. The amp hour rating can best be described as the 'fuel tank' of the battery. The higher the value, the larger the 'fuel tank'. Is connected load is more than maximum demand? It is because maximum demand is always less than the connected load. The knowledge of the demand factor is vital in determining the capacity of the plant equipment. How do you calculate maximum demand from connected load? Maximum demand Calculation: Maximum Demand= Connected Load x Load Factor / Power Factor. How can I reduce my MDI on my electric bill? Another option of avoiding MDI penalty is by shifting your peak load to a time of day when your load is less. For eg. A Thermal Storage system can help you shift your air conditioning load from the daytime to nighttime. A thermal storage device is like a battery that stores thermal energy. How do you calculate maximum demand for amps? Maximum Demand= Connected Load x Load Factor / Power Factor. What is the connected load? Definition of connected load : the total electric power-consuming rating of all devices (as lamps or motors) connected to a distribution system. What is the difference between a 30 amp and 50 amp RV hookup? Key Differences Between 30 and 50 Amps A 50 amp service RV provides a maximum 12,000 watts. Even with an adapter, your 30 amp service RV won't receive more power than the 3,600 watts it can handle. Conversely, if you use an adapter for a 50 amp RV, you'll be limited to 3,600 watts. Can I plug my 50 amp RV into a 30 amp outlet? Can I Plug My 50-Amp RV Cord into a 30-Amp Power Pedestal? Yes! With an adapter, you can plug a 50-amp RV cord into a 30-amp power pedestal at a campground. The female end of the adapter will plug into your RV cord, and the male end will plug into the power pedestal. What is the difference between amps and volts? Volts and amps or ampere are two measures of electricity. Specifically, voltage is the measure of electric potential difference between two points whereas ampere is the measure of electric current. They are closely related terms and can be a bit difficult to understand. What is the difference between maximum demand and connected load? The Maximum Demand (MD) is the total kW that contributes the total power used in one time after applying the diversity factor based on the Total Connected Load. Connected Load is the total load you have connected to a supply panel. The maximum demand load is the maximum load that is on during a predetermined period of time. eg Diversity. How do you convert volts to amps? Volts to amps calculator Amps to volts calculation. The voltage V in volts (V) is equal to the power P in watts (W), divided by the current I in amps (A): V (V) = P (W) / I (A) The voltage V in volts (V) is equal to the current I in amps (A), times the resistance R in ohms (Ω): V (V) = I (A) × R (Ω) Amps to volts calculation What is the difference between amps and Volts in a hose? Amps are the water pressure running through the hose, and volts are the diameter of the hose. Watts would be the volume of water coming out of the hose. Simply put, Amps x Volts = Watts. Hi friends, I encountered a Breaker size issue on a sequence service switchboard. Here is the information: The connected load on a 500A circuit breaker is 412.5A but the demand load on the breaker is only 340A. We have always been designing based on the fact that "Demand load" is always more accurate than "Connected load". But the inspector argues that the load should be less than 80% of the breaker size. I guess he was just giving us a hard time as they usually do...because that does not happen in reality... Could anyone please tell me where in the code does it say that breakers have to be sized according to the "Connected" load? Re: Demand Load ??? "Connected load" means nothing. All components (e.g., conductors, overcurrent protection, and panels) is sized to handle the load that is calculated in accordance with article 220. That article takes into account the connected load, but then gives demand factors for some types of loads in some types of facilities. In addition, some loads have to be ?upsized? by 25%, as part of calculating the total load. I do not know how you arrived at the ?demand load? value of 340 amps. But if you used article 220 methods, and that was your result, then a 500 amp breaker is acceptable. You would need to give more specific information, before I could give you more of a response. Re: Demand Load ??? By "Connected load", I mean that the demand factors for the appliances are not taken into account per Article 220. By "Demand load", I mean that demand factors are taken into account depending upon the quantities of the appliances. Re: Demand Load ??? 408.13 All panelboards shall have a rating not less than the minimum feeder capacity required for the load computed in accordance with Article 220. And 220.10 states that the computed load of a feeder is determined by part I after the demand factors of parts II, II, or IV have been applied. Thus, you do not have to size the panelboard for the "connected load", only the demand load. I'm not sure which code article extends this concept from the panelboard to the Main circuit breaker. Steve Re: Demand Load ??? Most breakers are 80% rated, not 100% rated. Here is an example: 100,000 sf bldg, 50 kva of receptacle load, 5 kva of misc load. For a 80% rated breaker: Lighting = 100,000 x 2.0 va/sf x 125% = 250 kva Recept = 10 kva + (40 kva x 50%) = 30 kva Misc = 5.0 kva TOTAL = 285 kva (792 amps at 208v, 3-ph), 800/3 can be used. For 100% rated breaker, use same calc above except do not multiply lighting by 125%, therefore Total load is 235 kva (653 amps) 700/3 100% rated breaker can be used. Continuous loads need to add additional 25% for 80% rated breakers, not needed for 100% rated bkrs. Therefore if you add up all your loads, and multiplied by 125% of the continuous load and came up with 499 amps, you can technically use a 500 amp breaker. Loads do not have to be less than 80% of the breaker rating, even on 80% rated breakers, if they are calc'd properly. This is a very simplified calc, but I just want to try and explain 80% rated, 100% rated, and continuous loads. Hope this didn't confuse you more. [March 11, 2005, 09:32 PM: Message edited by: eesac] by eees.in · Published June 3, 2021 · Updated June 3, 2021 It is the sum of continuous ratings in kW of all the equipment's connected to supply system. The Sum of Continuous rating of all the equipments (bulbs, tubes, CFLs, Fans, Electrical Motors, Socket Outlets, and Power Plugs etc) connected to Electrical Supply System is known as Connected Load. Ex:Five 100 Watt lamps & 500 watts of a power point, Total connected Load = (100 x 5) + 500 = 1000 watts Maximum Demand It is the greatest demand of load on the power station during a given period. The load on the station varies from time to time. The maximum load in kW which a consumer uses during a given period is called Maximum Demand. MD is helps to determining the installed capacity of the station. Maximum demand is always less than connected Load. Because all devices never runs at full load at the same time. Tags: Different types of tariff in power systemElectricity Tariff What is the difference between connected load kva and demand load kva on 277/480 3 phase panel 400 amp? What is the difference between connected load kva and demand load kva on 277/480 3 phase panel 400 amp? Demand load permits demand-factor reductions, and excludes the lesser of items when only one can be on at a time, such as heating and cooling. Connected load is exactly what it implies. What is the difference between connected load kva and demand load kva on 277/480 3 phase panel 400 amp? Connected Load is the total load you have connected to the 400 amp panel. As you probably know, all of that load is not on at the same time. The max demand load is the maximum load that is on during a predetermined period of time. If you live in a hot summer time region, the the peak load may be from 9am to 8pm when the A/C is running all of the time. The connected load is the sum of the continuous ratings of all the equipment connected to the supply system.In other words, the connected load is the sum of all the nameplate ratings of the equipment within the consumer installation.Connected load represents the maximum possible energy consumption when all connected systems, circuits, components, devices, or equipment are simultaneously operating and drawing power. Think of it as the "worst-case scenario" when every electrical item is switched on and demanding electricity simultaneously.For instance, in a household, the connected load would encompass the collective power requirements of all electrical appliances and devices, including lights, air conditioners, refrigerators, and more, assuming they are all running concurrently at their maximum capacity. In a manufacturing plant, it would include all machines and equipment running at full tilt.Connected Load is essential for sizing electrical infrastructure, such as wiring, circuit breakers, transformers, and generators. It helps ensure that the electrical system can handle the peak power demands without overloading or causing safety issues.Here is an example to illustrate what is the connected load on a power station and how it is calculated. Consider a power station supplying loads to 1000 consumers. In every consumer's home, there is certain equipment installed. "Connected load" of a consumer is the sum of the continuous ratings of all the equipment of the consumer's premises.For example, if each consumer of the power station has the following connectionsFive 100-watt lampsTwo 60 watt fansPower socket point of 500 wattsThen the CL of one consumer is 5×100 + 2×60 + 500 = 1120 watts.This is the Connected Load of one consumer. Similarly, every consumer has their own connected load depending on the electrical equipment used in their house.When you add up the CL of all the consumers, you get the connected load for the power station.Connected Load for the power station = 1120 × 1000 = 1120000 W = 1120 kW.Electrical load, in simple terms, refers to the total energy consumed by various components, devices, or equipment connected to a power source. It can be further divided into two: Connected Load and Operating Demand Load. These distinctions play a crucial role in efficient power management for both residential and industrial applications.Connected Load is the energy consumed when all connected systems, circuits, components,devices or equipment are operating and drawing power at the same time.While Connected Load provides a critical perspective on the electrical infrastructure's capacity requirements, it often paints an unrealistic picture of everyday energy consumption. In practice, not all electrical devices and equipment operate simultaneously at their maximum capacity. This is where Operating Demand Load comes into play.Operating Demand Load represents a more practical and accurate estimation of energy consumption. It takes into account the likely simultaneous operation of electrical items based on real-world usage patterns. For example, in a home, it acknowledges that the furnace and air conditioning unit are unlikely to run simultaneously, as they serve opposing purposes in different seasons. Therefore, when calculating the Operating Demand Load, these two items are not added together.In an industrial setting, Operating Demand Load considers the specific production processes, shifts, and operational schedules. It ensures that the electrical infrastructure is designed to meet the actual demands placed on it during regular operations, minimizing wasted energy and resources.The maximum demand often referred to as peak demand can be found in the load curve is defined as the greatest of all the demands which have occurred in the power station during a given period.The figure below shows the maximum demand in a daily load curve.Daily Load curve on Power PlantThe power plant supplies power to all the loads connected to it. This does not necessarily mean that they will all receive power together. For example, you might switch off the lighting loads during the daytime. During the night, certain factory loads might be disconnected. Occasionally, some motors will turn on and off. When the long travel motor of the crane is running, the hoist motor is switched off. Therefore, in practice, the total load on at any one time is less than the total connected load.Example:Imagine you were an electric company serving 1000 homes with only a 3000 watt electric oven in each house. Your connected load would be 3,000,000 watts.In reality, there may never be a time when all homes use heaters at the same time. Let's say that only 500 homes use heaters all at the same time. The reason for this is what we call load diversity, or load factor. This would result in a demand load (maximum demand) of 1,500,000 watts. In that case, you only need to design your system for half the value of the connected load.Many high-wattage appliances (such as toasters) have a very low load factor. Other appliances (electric heat) can have very large load factors at times (in very cold weather).Ultimately, there are a great variety of appliance types, each with its own load factor, and the utility has to worry about only the aggregate of ALL connected loads.Demand Factor is the ratio of maximum demand on the power station to its connected load.Demand factor = Maximum demand/Connected loadThe value of the demand factor is usually less than 1. It is expected because the maximum demand (peak load) on the power station is generally less than the CL.If the maximum demand on the power station is 80 MW and the connected load is 100 MW, then the demand factor = 80/100 = 0·8.The knowledge of the demand factor is vital in determining the capacity of the plant equipment. The connected load is defined as the sum of continuous ratings of all the equipment connected to the electrical power station. An electric power station supplies the power to thousands of consumers. Each consumer has certain equipment in his premises. The sum of the continuous ratings of all the equipment in the consumer's premises is the connected load of the consumer. The sum of the connected loads of all the consumers is called the connected load to the power station. The average load on a power station is defined as the average of loads occurring on the power station in a given period (either day or month or year). The daily average load on the power station is given by, $$\mathrm{Daily\: average\: load\:=\:\frac{Number\: of\: units \:generated \:in\: a\: day(in \:kWh)}{24\: Hours}}$$ The monthly average load on the power station is given by, $$\mathrm{Monthly\: average\ load\:=\:\frac{Number\: of\: units\: generated\: in\: a \:month(in\: kWh)}{Number\: of\: hours\: in \:a\: month}}$$ The yearly average load on the power station is given by, $$\mathrm{Yearly\: average\: load\:=\:\frac{Number\: of\: units \:generated \:in\: a \:year(in \:kWh)}{Number\: of\: hours \:in\: a \:year}}$$ Maximum Demand Load The maximum demand on a power station is defined as the greatest demand of load on the power station during a given period. The load on the power station varies from time to time. The maximum of all the demands that have occurred during a given period (let a day) is the maximum demand on the power station. Generally, the maximum demand on the power station is less than the connected load. It is expected because all the consumers do not switch on their connected load to the station at a time. The knowledge of maximum demand of a power station is very important because it is used to determine the installed capacity of the power station. Numerical Example (1) At the end of a power distribution system, a feeder supplies three distribution transformers, each one supplying a group of consumers, whose connected loads are given as − Transformer Load Demand Factor Diversity factor of group Transformer I 15 kW 0.7 1.3 Transformer II 10 kW 0.65 3 Transformer III 13 kW 0.5 1.4 If the diversity factor among the transformers is 1.5, then determine the maximum load on the feeder. Solution The sum of maximum demands of consumers is given by, $$\mathrm{\mathrm{Sum\: of\: max.demands\:=\:connected\:load\:\times \:demand\:factor}}$$ Therefore, $$\mathrm{\mathrm{Sum\: of\: max.demands\: of \:consumers\: on\: Transformer\: I}\:=\:15\:\times 0.7\:=\:10.5\:\mathrm{kW}}$$ Similarly $$\mathrm{\mathrm{Sum\: of\: max.demands\: of \:consumers\: on\: Transformer\:II }\:=\:10\:\times \:0.65\:=\:6.5\:\mathrm{kW}}$$ $$\mathrm{\mathrm{Sum\: of\: max.demands\: of \:consumers\: on\: Transformer\:III}\:=\:13\:\times \:0.5\:=\:6.5\:\mathrm{kW}}$$ Now, the maximum demand on the transform is given by, $$\mathrm{Maximum \:demand\:=\:\frac{Sum\: of\: Max.demands}{Diversity\: factor}}$$ Therefore $$\mathrm{Maximum\: demand \:on\: Transform\: I \:=\:\frac{10.5}{1.3}\:=\:8.08\:kW}$$ $$\mathrm{Maximum\: demand \:on\: Transform\: II \:=\:\frac{6.5}{3}\:=\:2.167\:kW}$$ $$\mathrm{Maximum\: demand \:on\: Transform\: III \:=\:\frac{6.5}{1.4}\:=\:4.64\:kW}$$ As the diversity factor amount the transformers is 1.5. Therefore, the maximum demand on the feeder is given by, $$\mathrm{Maximum\: demand\: on\: feeder\:=\:\frac{Sum\: of\: maximum \:demands}{Diversity\: factor}}$$ $$\mathrm{\therefore Maximum \:demand\: on \:feeder\:=\:\frac{8.08\:+\:2.167\:+4.64}{1.5}\:9.925\:kW}$$ Numerical Example (2) If the number of units (kWh) generated per year by a power station is 45 ? 105, then determine the annual average load on the power station. Solution The annual average load on a power station is given by, $$\mathrm{Annual \:average\: load\:=\:\frac{Number\: of\: units \:generated \:in \:a \:year\: (in kWh)}{Number\: of\: hours\: in\: a \:year}}$$ $$\mathrm{\therefore Annual\: average\: load\:=\:\frac{45\:\times 10^{5}}{8760}\:=\:513.7\:kW}$$ New member here. Searched and although there is several posts on the subject I can not find direction on my question, so dont burn me! All the posts Ive seen confirm what my logical thought that a "Connected Load" would represent everything in the system running wide open continuously. In comparison a "Demand Load" would be the "Peak" load of components in the system that you expect to run at one particular time. What I'm saying is a tenant space (lets say a salon) with hair dryers, electric water heating ect. may run heat in the winter and no AC. The "connected load accounts for both of these, yet the "Demand Load" I see stated on EE's drawings are always higher than the "Connected Load." Example would be a 1,100 SF Salon Space 200A | 3 Phase | 4W Electric Water Heating Split System HP and FCU Am I missing Something Here? Shouldn't the "Demand" be Lower than the "Connected":? It is an interesting question. The trouble you are having is with the meaning of ?demand load.? Although what you described is a reasonable interpretation of the phrase, you aren?t using the phrase in a technically correct manner. It is natural to expect that not all loads in a building will be operating at full capacity at the same time. We are allowed to make allowances for that fact, when we calculate the total amount of power needed to serve the building. So one would expect that the ?demand load? will be lower than the ?connected load.? But there are certain types of equipment that we have to account for at more than their rated capacity. Motors are one example. We have to take the largest motor in a building, and add 25% to its nameplate load. We have to do the same for storage-tank style water heaters. We have to do the same for any load that is likely to be operating for more than three hours at a time. There are other examples. When we take all these into account, it is not impossible that our ?calculated load,? also known as the ?calculated load after all demand factors have been applied,? or simply known as the ?demand load? might exceed the ?connected load.? I have not seen it happen often, but it can happen. Charlie, Thanks for the clear response. As I stated I'm certainly no EE or PE rather, my electrical know how is limited to 120V stuff in my own house and low voltage for A/V applications. I figured motors or those parts of the system that draw the most power would be the culprit, and I believe that electric motors probably use more on "start up" than once running. Maybe Im wrong. It just seems that nearly every panel schedule I see has the higher "demand" load as compared to "Connected" load as stated at the bottom of the panel schedules. I see a clear relationship between say number of light fixtures, their wattage, and the voltage they operate at + a power factor giving a KVA number, but motors I don't get. How does one determine a wattage or amperage number for a motor when only the HP and voltage are known? Is their a formula or are there more variables? Anyhow thanks again for your direction. The more I know the better my understanding of the "big picture" in building design and system. The help is greatly appreciated! How does one determine a wattage or amperage number for a motor when only the HP and voltage are known? Is their a formula or are there more variables? You also need to know if the motor is single phase or three phase. Then all you need to do is look up the amperage in a table. If you have access to a copy of the NEC, you will find the single phase motor amps in Table 430.248, and the three phase motor amps in Table 430.250. There is a formula that relates these quantities. Essentially, you get power by multiplying voltage times amperage. So if you know two of the variables (e.g., horsepower and voltage), you can get the third (i.e., amps). But there are some complications to the formula. Motor efficiency comes into play, so it is not a simple unit conversion from horsepower to watts. Also, if you are dealing with a three phase motor, then the factor of "the square root of three" will appear somewhere within the formula. It just seems that nearly every panel schedule I see has the higher "demand" load as compared to "Connected" load as stated at the bottom of the panel schedules. I just took a quick look at a set of panel schedules for a project we issued last Friday. Out of the first thirty schedules, 12 had a higher connected load, 12 had a higher demand load, and the rest had the same value for connected and demand load. It is not something I generally pay attention to. My only concern is that the demand load has to be less than, or equal to, the rating of the panel. I don't bother comparing the connected load to the panel rating, for that has no meaning to me. It is an interesting question. The trouble you are having is with the meaning of ?demand load.? Although what you described is a reasonable interpretation of the phrase, you aren?t using the phrase in a technically correct manner. It is natural to expect that not all loads in a building will be operating at full capacity at the same time. We are allowed to make allowances for that fact, when we calculate the total amount of power needed to serve the building. So one would expect that the ?demand load? will be lower than the ?connected load.? But there are certain types of equipment that we have to account for at more than their rated capacity. Motors are one example. We have to take the largest motor in a building, and add 25% to its nameplate load. We have to do the same for storage-tank style water heaters. We have to do the same for any load that is likely to be operating for more than three hours at a time. There are other examples. When we take all these into account, it is not impossible that our ?calculated load,? also known as the ?calculated load after all demand factors have been applied,? or simply known as the ?demand load? might exceed the ?connected load.? I have not seen it happen often, but it can happen. I guess that would make sense if the demand load uses the 25% adder for largest motor, or water heater and the connected load does not include it, otherwise they are both increased proportionally. What about a 100 HP motor that only is driving 85 Hp of load? I know NEC says we size motor circuit to tables in 430, but how do PE's add this load to the service or feeder? Is it added as 85 Hp or 100 Hp plus power factor, efficiency and demand considerations? I would still think the connected load would be bases on 100 Hp but the demand load may be based on 85HP still doesn't make sense how you can get higher demand than connected though. What about a 100 HP motor that only is driving 85 Hp of load? I know NEC says we size motor circuit to tables in 430, but how do PE's add this load to the service or feeder? Is it added as 85 Hp or 100 Hp plus power factor, efficiency and demand considerations? Presuming this is a 480 volt system, I would look up 100 HP in Table 430.250, see the value of 124 amps, multiply that by 831 (i.e., 480 volts times the square root of 3), get 103 kVA, and show (on the panel schedule) a load of 34.3 KVA on each phase. The panel schedule excel file I use would automatically take note of whether this was the largest motor on the panel, and if so it would add 25% (8.6 KVA) to each phase at the bottom of the page. I would ignore the fact that the mechanical load was only 85 HP, unless I really needed to reduce the calculated load (e.g., if the total was too close to my intended panel rating and I didn't want to get a bigger panel). How I calculate Demand How I calculate Demand If you see a panel schedule with a higher demand than connected load, it just means nobody bothered to update the panel schedule. In a large A/E firm, that task is often delegated to an inexperienced designer or CAD guy. (Not that the Engineer of Record isn't still ultimately responsible.) For residential panels, the demand is calculated according to article 220 and I put the calculation right on the drawing. For commercial, I'll use 10 kVA of receps @100%, remainder @ 50% and any other demand factors like kitchen equipment and non-coincident loads. Lighting is always @100%. In a pinch, I might put a diversity factor on a large group of HVAC loads, but there has to be a sound basis for it like units on opposite sides (i.e. sunny/shady) of a buiding or pump-and-a-spare type reserve. When one of my guys actually put a 3-pole breaker in a single-phase panel, I got fed up with error filled panel schedules and I wrote an AutoLisp program that calculated connected load and demand automatically. Each load gets characterized as lighting, power, receptacle or non-coincident and the program does the rest. It also prevents panel schedules with more than 42 poles and branches bigger than the mains. (All silly mistakes that I've seen over the years.) On the heat pump, you can't count the heat and cooling as non-coincident. They both work at the same time when it's in defrost mode. I guess that would make sense if the demand load uses the 25% adder for largest motor, or water heater and the connected load does not include it, otherwise they are both increased proportionally. What about a 100 HP motor that only is driving 85 Hp of load? I know NEC says we size motor circuit to tables in 430, but how do PE's add this load to the service or feeder? Is it added as 85 Hp or 100 Hp plus power factor, efficiency and demand considerations? I would still think the connected load would be bases on 100 Hp but the demand load may be based on 85HP still doesn't make sense how you can get higher demand than connected though. It has to be demonstrated that the assembly cannot exceed 85HP. You could do that in say, where current limiting would prevent the unit from applying >85HP or it would trip. Load monitors could also be used. But without demonstrating that the design is power limiting you can't derate the motor. If you see a panel schedule with a higher demand than connected load, it just means nobody bothered to update the panel schedule. Or it means that the calculated demand load really is higher than the actual connected load. Please see my post #5 above. In each case for which the demand was the higher value, that particular schedule had nothing but motors. So let me ask you to do the following math: Put five motors on a panel. Count four of them at 100% and one of them at 125%. Which value will be higher: demand :happyyes: or connected?:happyno: It has to be demonstrated that the assembly cannot exceed 85HP. You could do that in say, where current limiting would prevent the unit from applying >85HP or it would trip. Load monitors could also be used. But without demonstrating that the design is power limiting you can't derate the motor. Derating the motor is not the same as using only the equivelant KVA of 85hp for the feeder or service calculation IMO, that is what I am asking about. If you see a panel schedule with a higher demand than connected load, it just means nobody bothered to update the panel schedule... For commercial, I'll use 10 kVA of receps @100%, remainder @ 50% and any other demand factors like kitchen equipment and non-coincident loads. Lighting is always @100%. In a pinch, I might put a diversity factor on a large group of HVAC loads, but there has to be a sound basis for it like units on opposite sides (i.e. sunny/shady) of a buiding or pump-and-a-spare type reserve. Joe, I disagree with you that demand is never higher than connected. You are missing a few things. Lighting should be at 125%. Any electric heat needs to be at 125%. Any equipment that is on for more than three hours needs to be at 125% - if you are really dotting the i's this could be as mundane as a big flat screen TV in a lobby (but in that example I don't think anyone would begrudge you just calling it a receptacle). You are also missing largest motor. If you had a panel with few receptacles - say 90% lighting, elec heat, and/or motors - I would not at all be surprised to find the demand factor higher than the connected. And as we often put all our lighting on one panel, or all the motors on one panel, this is not that unusual. I also question the use of a diversity factor. This is allowed in the code for very specific instances (elevators, kitchen equipment). But where in the code are you allowed to apply this at your discretion? Say you have ten overhead doors. The chances of all of them opening at the same time are very small. But you can't prove they won't all go on at the same time. So you don't get to apply a diversity factor. Same with the sunny/shady example. If I were the signing engineer, or inspector, I would in no way allow that calculation, unless you can prove that there is something built into their controls that one is locked out when the other runs. Heating and cooling is allowed to cancel each other out (unless it is something such as cooling that would run in the winter, like for an IT closet or elevator machine room, or process heating needed in the summer). Even in the pump-and-spare scenario I am told by our plumbing engineers that although these are not intended to run at the same time, if there is a significant enough water event they both will run at the same time, and I should size my branch circuits & panel accordingly. The only time I ever used diversity factors like you suggest above is when trying to estimate the size of a generator - and even then, with the code revisions to 700/701/702 I don't think you can use diversity factors anymore (the revisions I am referring to went into effect in either '08 or '11). Don't take liberties with the code. Learn it and follow what it says, not what you think is a more reasonable practice. That's how I see it at least. Joe, I disagree with you that demand is never higher than connected. You are missing a few things. Lighting should be at 125%. Any electric heat needs to be at 125%. Any equipment that is on for more than three hours needs to be at 125% - if you are really dotting the i's this could be as mundane as a big flat screen TV in a lobby (but in that example I don't think anyone would begrudge you just calling it a receptacle). You are also missing largest motor. If you had a panel with few receptacles - say 90% lighting, elec heat, and/or motors - I would not at all be surprised to find the demand factor higher than the connected. And as we often put all our lighting on one panel, or all the motors on one panel, this is not that unusual. I also question the use of a diversity factor. This is allowed in the code for very specific instances (elevators, kitchen equipment). But where in the code are you allowed to apply this at your discretion? Say you have ten overhead doors. The chances of all of them opening at the same time are very small. But you can't prove they won't all go on at the same time. So you don't get to apply a diversity factor. Same with the sunny/shady example. If I were the signing engineer, or inspector, I would in no way allow that calculation, unless you can prove that there is something built into their controls that one is locked out when the other runs. Heating and cooling is allowed to cancel each other out (unless it is something such as cooling that would run in the winter, like for an IT closet or elevator machine room, or process heating needed in the summer). Even in the pump-and-spare scenario I am told by our plumbing engineers that although these are not intended to run at the same time, if there is a significant enough water event they both will run at the same time, and I should size my branch circuits & panel accordingly. The only time I ever used diversity factors like you suggest above is when trying to estimate the size of a generator - and even then, with the code revisions to 700/701/702 I don't think you can use diversity factors anymore (the revisions I am referring to went into effect in either '08 or '11). Don't take liberties with the code. Learn it and follow what it says, not what you think is a more reasonable practice. That's how I see it at least. The 125% factor for continuous loads, motors, etc does not mean the loads are going to draw more, a 10kW heater still demands 10kW not 12.5kW. This factor is for minimum conductor sizing and overcurrent protection selection, not for uprating the actual load. If you have 10 overhead door openers the chances are not that good they all run at same time. If they do they likely only run for 30 seconds or so and then shut off again. This will not result in any significant heating in the supply system and what extra heat was produced will dissipate rather quickly. Heating and cooling - only needs to not run simultaneously not that cooling can run in winter. If it is winter and heating and cooling are running at same time they are both counter productive of each other. The place you usually run into both running at same time is with heat pumps during defrost cycle, but this cycle is for a limited time and reality deserves some consideration although the code does not really address that. I don't know how it is possible to demand more than what is connected without something being overloaded. A motor operating in its 1+ service factor maybe but that service factor is not supposed to be continuous either it is supposed to be for temporary conditions. Motor inrush during starting need to be able to be supported by the source but is not taken into consideration when sizing conductors or overload protection, it is considered when selecting short circuit and ground fault protection but only to prevent unnecessary tripping during starting. Joe, I disagree with you that demand is never higher than connected. You are missing a few things. Lighting should be at 125%. Any electric heat needs to be at 125%. Any equipment that is on for more than three hours needs to be at 125% - if you are really dotting the i's this could be as mundane as a big flat screen TV in a lobby (but in that example I don't think anyone would begrudge you just calling it a receptacle). You are also missing largest motor. If you had a panel with few receptacles - say 90% lighting, elec heat, and/or motors - I would not at all be surprised to find the demand factor higher than the connected. And as we often put all our lighting on one panel, or all the motors on one panel, this is not that unusual. I think Joe is correct that demand load is never higher than connected load, though I disagree that the reason you see demand loads higher than connected is because "nobody bothered to update the panel schedules." The demand factor for lighting is 100% (not 125%) for all occupancies except Dwelling Units, Hospitals, Hotels/Motels and Warehouses. These other occupancies will have a lighting demand factor less than 100% (See T220.42). The demand factor for Electric Heat is 100% (not 125%) of connected load (See 220.51) except where the AHJ grants permission to use a demand factor of less than 100%. 220.40 says that the calculated (demand) load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied (connected load), as determined by Part II of this article, after any demands factors permitted by Parts III or IV, or required by Part V have been applied. None of the demands factors permitted by Parts III or IV, or required by Part V are greater than 100%. Therefore, the demand load can never be higher than the connected load. The reason we often see demand loads greater than connected loads, is that people are applying the 125% requirement for continuous vs. non-continuous loads for feeders (from Article 215) into what they call the "load calculation" even though they are two separate issues. The reason we often see demand loads greater than connected loads, is that people are applying the 125% requirement for continuous vs. non-continuous loads for feeders (from Article 215) into what they call the "load calculation" even though they are two separate issues. (Talking commercial here...) How do you separate those issues? If you are loading up your panel that you want to protect with a 100A breaker, and the only load on the panel is 35kVA (~95A) of connected lighting, don't you have to apply per 215.3 a 125% factor to this load in order to size the breaker correctly? So 95A x 125% = 119A. Now you can't use the 100A breaker. Maybe you can separate them if you are doing something that does not require a single main OCPD? Like if you are using the six disconnect rule you have to apply the 125% continuous factor to each of the six main breakers, but when adding up the total loads on the service panel you can disregard the continuous factor. I could buy that. Never thought of it that way before. But if you have a single main disconnect, would you not have to apply the 125% factor for continuous loads? I was under the impression lighting was considered a continuous load. I am not seeing anything that absolutely defines it as such, but if anything is going to be left on for three hours at a time it is a light or an electric heater. Even with the widespread use of occ sensors I would have a hard time considering a luminaire as a noncontinuous load. We are getting confused again over the use of the word, ?demand.? There are two common meanings for this word, and they are very different from each other. ?Demand? is used to describe the amount of load you actually see during day-to-day operations. That value is certainly less than the total connected load, for the simple and obvious reason that not everything will be running at full capacity at the same time. Mathematically, in this context of the word, ?demand,? it is physically impossible for the demand value to exceed the connected value. ?Demand? is also used to describe the results of a formal load calculation. That process sometimes requires us to add 25% to a load?s nameplate value. That can result in the calculated load being higher than the total connected load. The number that appears on a panel schedule under the phrase ?demand load? is this value, not the ?day-to-day actual load you really see? value. 220.40 says that the calculated (demand) load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied (connected load), as determined by Part II of this article, after any demands factors permitted by Parts III or IV, or required by Part V have been applied. None of the demands factors permitted by Parts III or IV, or required by Part V are greater than 100%. Therefore, the demand load can never be higher than the connected load. You are missing the fact that the calculation of the branch circuit loads is not just the connected load, but sometimes includes a 25% factor. Specifically, 220.14(C) tells us to calculate motors per 430.22 and 430.24, and that is where the 25% comes into play. As I mentioned earlier, I just issued a design that had some panels with nothing but motors, and their panel schedules correctly show demand as being higher than connected. (Talking commercial here...) How do you separate those issues? If you are loading up your panel that you want to protect with a 100A breaker, and the only load on the panel is 35kVA (~95A) of connected lighting, don't you have to apply per 215.3 a 125% factor to this load in order to size the breaker correctly? So 95A x 125% = 119A. Now you can't use the 100A breaker. Maybe you can separate them if you are doing something that does not require a single main OCPD? Like if you are using the six disconnect rule you have to apply the 125% continuous factor to each of the six main breakers, but when adding up the total loads on the service panel you can disregard the continuous factor. I could buy that. Never thought of it that way before. But if you have a single main disconnect, would you not have to apply the 125% factor for continuous loads? I was under the impression lighting was considered a continuous load. I am not seeing anything that absolutely defines it as such, but if anything is going to be left on for three hours at a time it is a light or an electric heater. Even with the widespread use of occ sensors I would have a hard time considering a luminaire as a noncontinuous load. You separate the two issues because they are in completely separate sections in the code. Article 220 tells you how to calculate the load for any specific feeder. Article 215 tells you how to size the feeder conductors based on the load on the feeder calculated by Article 220. These are two separate issues covered by two separate code sections. Lets say I had two feeders serving two separate panels. One panel was going to supply all my lighting loads, and the other panel was going to supply all my receptacle loads in a commercial setting, lets say a 25000 sf "Club". The minimum lighting load per T220.12 is 25,000 x 2 = 50,000VA. There area 500 duplex receptacles at 180VA each (per 220.14(I)) = 90,000VA. I then apply the demand factors from Part III of Article 220. For lighting, I have 50,000VA with a demand factor of 100% (T220.42) = 50,000VA. For the receptacles, I have 90,000VA with a demand factor of 100% for the 1st 10kVA, and 50% for the remainder (T220.44) = 10,000 + (0.5)*80,000 = 50,000VA. The calculated (demand) load for each panel is 50,000VA. Next, I need to size the feeders for each of the panels. The lighting I would consider continuous load, and the receptacles I would consider non-continuous load. I would go to Article 215 for this. The feeder for the receptacle panel must have an ampacity of at least 50,000VA/208V/1.732= 139Amps. The minimum OCPD size would be 150A. This panel could be fed with #1/0AWG and a 150A C/B. The feeder for the lighting panel must have an ampacity of at least 50,000VA*1.25/208V/1.732= 173Amps. The minimum OCPD size would be 175A. This panel could be fed with #2/0AWG and a 175A C/B. Both panels have the same calculated load after demand factors have applied (Article 220.) The lighting panel requires a larger feeder than the receptacle panel (Article 215.) You are missing the fact that the calculation of the branch circuit loads is not just the connected load, but sometimes includes a 25% factor. Specifically, 220.14(C) tells us to calculate motors per 430.22 and 430.24, and that is where the 25% comes into play. As I mentioned earlier, I just issued a design that had some panels with nothing but motors, and their panel schedules correctly show demand as being higher than connected. I am not missing that fact at all. 220.14(C) tells us to calculate the outlet load for motors in accordance with 430.22 and 430.24. That means that the 25% factor is already part of the "connected" load. The same number is carried through to the "demand" load in Part III. For instance, lets take a look at a panel with nothing but motors. Say a panel that had four branch circuits feeding four 5HP, 208V, 3ph motors. Per 220.14(C), each motor branch circuit has a load of 7,521VA (as calculated per 430.22.) The total connected load on the panel (the sum of all the branch circuit loads) is 4*7,521VA=30,084VA. Now lets apply the demand factors for the panel feeder, from Article 220 Part III. 220.50 directs us to 430.24, which tells us that the load would be (16.7A*1.25 + 3*16.7A) * 208V * 1.732 = 25,570VA. The load after the demand factors of Article 220 Part III are applied is smaller than the load calculated for the individual branch circuits per Part II of Article 220. David, In your example, let's say there existed options of getting a panel rated 100A, 125A, 150A, 175A and 200A. (I know they are generally 125A and 225A but I'd rather not reinvent the calcs to ask the question.) Your receptacle panel would be minimum 150A, correct? And your lighting panel would be minimum 175A, correct? So even though, using your terms, the step 1 "connected load" for the receptacle panel is greater, and the step 2 "demand load" of the two panels is equal, but the step 3 "I-don't-what-to-call-it-anymore load" (my term!) of the feeders dictates the lighting panel be larger. I think we may be in agreement as to the application of the code, but are differing in our vocabulary? I don't know that code speaks to what each of these steps should be called. I have always considered the second step (what you call "demand load") to just be a step on the way to a final load - step 3, which I always called demand load. Maybe that should be "calculated load", though that seems to be what many here are also applying to step 2. I remember one engineer working under me always getting irritated that in doing multifamily calcs I called the common area loads "house loads". One day we were walking through the codes for multifamily and he was like "oh, you're actually calling it what the code calls it!" And he relaxed after that. I wonder if what we have here is a bunch of people bristling about what they think it should be called, but there is no clearly defined name for it in the code. Or maybe there is! And I am calling it wrongly. Someone enlighten me! Page 2 I am not missing that fact at all. 220.14(C) tells us to calculate the outlet load for motors in accordance with 430.22 and 430.24. That means that the 25% factor is already part of the "connected" load. The same number is carried through to the "demand" load in Part III. For instance, lets take a look at a panel with nothing but motors. Say a panel that had four branch circuits feeding four 5HP, 208V, 3ph motors. Per 220.14(C), each motor branch circuit has a load of 7,521VA (as calculated per 430.22.) The total connected load on the panel (the sum of all the branch circuit loads) is 4*7,521VA=30,084VA. Now lets apply the demand factors for the panel feeder, from Article 220 Part III. 220.50 directs us to 430.24, which tells us that the load would be (16.7A*1.25 + 3*16.7A) * 208V * 1.732 = 25,570VA. The load after the demand factors of Article 220 Part III are applied is smaller than the load calculated for the individual branch circuits per Part II of Article 220. Good example, in that it points to where we disagree. You are correct that an individual branch circuit would have a load of 7521VA. But you are calling the loads this: CONNECTED: 4*(16.7A*1.25*208*1.732)=30,084VA. DEMAND: (16.7A*1.25 + 3*16.7A) * 208V * 1.732 = 25,570VA. Whereas I would call them this: CONNECTED: 4*(16.7A*208*1.732)=24,065VA. DEMAND: (16.7A*1.25 + 3*16.7A) * 208V * 1.732 = 25,570VA. Or again, maybe it is semantics, because we get the same "demand" load at the end of the day. I would never show a connected load of 30kVA in this scenario. In the above example, the way my panel spreadsheet is set up, for one of those motors you would enter a load of 6016VA (2005VA per each of three phases), the spreadsheet figures out the amperage and multiplies it by 1.25 to get a breaker size. (For simplicity's sake it does this regardless of whether it is a motor load, lighting load, receptacle load, non-continuous load, etc. I don't think this conservative approach affects anything in practice.) Then I would enter the load into three other breakers. The "connected load" in my spreadsheet would be 6,016*4=24,065VA (as shown above). Then my spreadsheet figures out what the largest motor load on the panel is (whether it is actually on the panel or subfed from a different panel), multiplies that number by 0.25, and adds it in. So I would end up with a "demand load" on that panel of 25,570VA. Or it means that the calculated demand load really is higher than the actual connected load. Please see my post #5 above. In each case for which the demand was the higher value, that particular schedule had nothing but motors. So let me ask you to do the following math: Put five motors on a panel. Count four of them at 100% and one of them at 125%. Which value will be higher: demand :happyyes: or connected?:happyno: Your question answers itself. 125% is always greater than 100% (At least, outside of Washington DC.) It seems you and I don't use the same definition of "demand load." It's interesting that the Code defines "Demand Factor" in terms of the "demand of a system", but doesn't define what the "demand of a system" is :?. You would be hard put to find a tighter tautology. It also does not give a name to the 125% factor found in 210, 215 and 430. I think of demand as the running load - same as you see on a commercial electric bill. It is the load you have left after you've applied a "demand factor" as in 220.42, 53, and 55; and all those factors are less than 1. What you're referring to is what I call "wire sizing amps." The code refers to continuous and non-continuous loads, but not "demand load", just "demand factors" for various types of loads. To me, demand load is always less than connected load. And connected load is always less than wire sizing amps. Last edited: Sep 13, 2012 Joe, I'll buy that. I think we have three terms here: Step 1, "connected load", I think we mostly are all in agreement on what that is. Step 2, "demand load", from here on out I will defer to your definition, as it makes logical and linguistic sense, and reflects the terminology used in code. (In the past I have not seen this as a separate step, and have integrated it directly into the next one - therefore called them one and the same.) Step 3, Instead of "wire sizing amps" as you suggest, I propose referring to that one as "calculated load". I believe some in this thread are using "demand" and "calculated" interchangeably as step 2. Note I'm not at all proposing a code change here. Just trying to reconcile what terms mean in my own head with what they mean in those of others so that I can communicate better. Joe, I'll buy that. I think we have three terms here: Step 1, "connected load", I think we mostly are all in agreement on what that is. Step 2, "demand load", from here on out I will defer to your definition, as it makes logical and linguistic sense, and reflects the terminology used in code. (In the past I have not seen this as a separate step, and have integrated it directly into the next one - therefore called them one and the same.) Step 3, Instead of "wire sizing amps" as you suggest, I propose referring to that one as "calculated load". I believe some in this thread are using "demand" and "calculated" interchangeably as step 2. Note I'm not at all proposing a code change here. Just trying to reconcile what terms mean in my own head with what they mean in those of others so that I can communicate better. I often see the term "Wire Sizing Amps" on HVAC equipment cuts. They always give me WSA and MOCP (maximum overcurrent protection), but look at me like I have two heads when I ask for RLA (compressors) and FLA (fans). It's frustrating to try to determine a multi-motor "calculated load" when all you have is WSA for a building full of condensing units. Not looking for a debate, but demand will always be less than or equal to the connected. Load is load, i.e. KVA is KVA. I believe there is some confusion going on here that the load value used for SIZING the equipment and conductors has nothing to do with connected load, i.e. sum total of all the loads physically connected, or the demand load, i.e. the maximum possible running load under any circumstance. They are three separate values. Good example, in that it points to where we disagree. You are correct that an individual branch circuit would have a load of 7521VA. But you are calling the loads this: CONNECTED: 4*(16.7A*1.25*208*1.732)=30,084VA. DEMAND: (16.7A*1.25 + 3*16.7A) * 208V * 1.732 = 25,570VA. Whereas I would call them this: CONNECTED: 4*(16.7A*208*1.732)=24,065VA. DEMAND: (16.7A*1.25 + 3*16.7A) * 208V * 1.732 = 25,570VA. Or again, maybe it is semantics, because we get the same "demand" load at the end of the day. I would never show a connected load of 30kVA in this scenario. Well, we seem to agree that when filling out a branch circuit panelboard load schedule, you would sum the branch circuit loads in the panel to get the "connected load." In other words, the connected load on a panel or feeder is the sum of the branch circuit loads on that panel or feeder. My question to you would be, when you are filling out the branch circuit loads why wouldn't you use the method proscribed in Part II of Article 220 of the code? The feeder load calculation procedure in 220.40 says that the calculated load on a feeder shall not be less than the sum of the branch circuit loads supplied, as determined by Part II of Article 220, after any applicable demand factors have been applied. In the example above, you do not calculate the branch circuit load for each motor in accordance with 220.14(C). In the above example, the way my panel spreadsheet is set up, for one of those motors you would enter a load of 6016VA (2005VA per each of three phases), the spreadsheet figures out the amperage and multiplies it by 1.25 to get a breaker size. (For simplicity's sake it does this regardless of whether it is a motor load, lighting load, receptacle load, non-continuous load, etc. I don't think this conservative approach affects anything in practice.) Then I would enter the load into three other breakers. The "connected load" in my spreadsheet would be 6,016*4=24,065VA (as shown above). Then my spreadsheet figures out what the largest motor load on the panel is (whether it is actually on the panel or subfed from a different panel), multiplies that number by 0.25, and adds it in. So I would end up with a "demand load" on that panel of 25,570VA. This illustrates my point in Post #14, your spread sheet is multiplying the sum of your loads by 125% to figure for continuous load, and you are calling this "demand load." In your spread sheet, you are entering motor branch circuit loads that are smaller than the Code tells you to include (so that the spread sheet can automatically calculate 125% of the largest motor for the feeder demand) but this is giving you a "connected load" for the panel which is smaller than the Code says it should be. If you look at the demand factors in Parts III, IV and V of Article 220, you will see that ALL of the demand factors are 100% or smaller. If you apply these demand factors to the sum of all the branch circuits loads on a feeder, as determined by Part II of Article 220, then the "demand" load will always be equal to or smaller then the "connected" load. Let's start over with the more simple example of lighting. Say you have a 208V/3P main service to a commercial building that for the sake of this example contains only lighting. Thirty 120V lighting circuits, spread equally over each phase, each breaker with 1000VA of load. Tell me where we disagree: 1. Start with 220.40. Move on. 2. 220.42. Lighting demand factor of 100% applied. 3. So each branch circuit has 1000VA of connected load on it. 4. 1000VA / 120V = 8.3A. To get the branch circuit feeder and OCPD we look to 215, which says a continuous load must be multiplied by 125%. So 8.3A x 1.25 = 10.4A. If there was an 11A breaker we could use it here, but as we live in a world where this is not readily available we'll put it on a 15A or 20A breaker. 5. Total "connected load" on the panel is 30 x 1000VA = 30,000VA. No demand factor applied here. 6. 30,000VA / 208V / 1.732 = 83A. Holy smokes. I think I found where I've been led astray. I thought the next step is you go to 215 (or some other article?) and size the panel feeder by multiplying all your non-continuous loads by 100% and your continuous by 125%. But 215.1 says this article is only for sizing BRANCH CIRCUIT loads, not FEEDERS to PANELS or MAIN SERVICES. How I would have done the next step is this: 7. Multiply all your non-continuous loads by 100% and your continuous loads by 125%. 30,000VA x 125% = 37500VA -> 104A, and voila you need a minimum 125A panel. Have I been doing this wrong? Can you size this panel off the 83A connected load without applying the 125% continuous factor? Could this panel be a 100A panel? If so I have been taught incorrectly, and my spreadsheets have some issues, and apologies will be forthcoming for my haughtiness. Let's start over with the more simple example of lighting. Say you have a 208V/3P main service to a commercial building that for the sake of this example contains only lighting. Thirty 120V lighting circuits, spread equally over each phase, each breaker with 1000VA of load. Tell me where we disagree: 1. Start with 220.40. Move on. 2. 220.42. Lighting demand factor of 100% applied. 3. So each branch circuit has 1000VA of connected load on it. I think you've already gone astray here. You seem to be applying the feeder demand factors to branch circuits. 4. 1000VA / 120V = 8.3A. To get the branch circuit feeder and OCPD we look to 215, which says a continuous load must be multiplied by 125%. So 8.3A x 1.25 = 10.4A. If there was an 11A breaker we could use it here, but as we live in a world where this is not readily available we'll put it on a 15A or 20A breaker. You would go to Article 210 to size the branch circuit conductors, not to Article 215. Article 215 is for Feeders, not Branch Circuits. 5. Total "connected load" on the panel is 30 x 1000VA = 30,000VA. No demand factor applied here. 6. 30,000VA / 208V / 1.732 = 83A. This is where you would apply the demand factors. The FEEDER to the panel has a load of 30kVA. The FEEDER gets the demand factors. The demand factor for lighting is 100%, so the load stays at 30kVA. Holy smokes. I think I found where I've been led astray. I thought the next step is you go to 215 (or some other article?) and size the panel feeder by multiplying all your non-continuous loads by 100% and your continuous by 125%. But 215.1 says this article is only for sizing BRANCH CIRCUIT loads, not FEEDERS to PANELS or MAIN SERVICES. How I would have done the next step is this: You had it right in the first place. Article 215 is for the sizing of FEEDERS, not BRANCH CIRCUITS. 7. Multiply all your non-continuous loads by 100% and your continuous loads by 125%. 30,000VA x 125% = 37500VA -> 104A, and voila you need a minimum 125A panel. Have I been doing this wrong? Can you size this panel off the 83A connected load without applying the 125% continuous factor? Could this panel be a 100A panel? If so I have been taught incorrectly, and my spreadsheets have some issues, and apologies will be forthcoming for my haughtiness. You haven't been doing this wrong (except that you would need a feeder OCPD that is minimum 110A, not 125A.) Your feeder load after applying your demand factors is 30kVA. It is all continuous load. Therefore the minimum feeder ampacity would 104A and the minimum feeder OCPD would be 110A. Lets say that after applying demand factors, the load is 30kVA, but 15kVA is continuous and 15kVA is non-continuous. Then the minimum feeder ampacity would be 93.7A, and the minimum feeder OCPD size would be 100A. Or if after applying demand factors, the load is 30kVA, but it is all non-continuous. Then the minimum feeder ampacity would be 83A, and the minimum feeder OCPD size would be 90A. But in all 3 cases, the load is 30kVA. I still don't see how demand can be more than connected. I also have not seen a demand factor of more than 100%, someone please point out where some of these are if they exist. 220.14(C) points us to 430.22 and 430.24, yet both of those sections are about minimum conductor size and not about demand issues.:? How does one call that a demand factor? 220.14(C) tells us to calculate the outlet load for motors in accordance with 430.22 and 430.24. That means that the 25% factor is already part of the "connected" load. The same number is carried through to the "demand" load in Part III. This is where we disagree. But it is a matter of terminology. We are in the middle of the classical debate that I like to characterize as follows: The first person says, ?The sky is blue.? The second person says, ?No you are wrong, the grass is green.? Using your 5HP motor example, I believe you and I would both come up with the same design choices for branch circuit wiring and for panel sizing. But I would use the phrase ?connected load? to refer to the 16.7 amp (6,012 VA) load on each branch circuit, not the 16.7 amps times 125% (7,515 VA) that is used to determine the branch circuit wiring. I have ?connected? a 5 HP motor to the circuit. I have not ?connected? a 5 x 125% HP motor. That is why my panel schedule would show a ?connected load? of 4 times 6012, or 24.0 KVA, while at the same time showing a ?demand load? of 7515 plus 3 times 6012, or 25.5 KVA. So if the OP comes across a panel schedule from a design of mine and sees a demand load that is higher then connected load, this will be the reason. If anyone sees the situation differently, it is not because one of us is right and the other is wrong, it is because we are using the words differently. Please note that the NEC does not define either ?connected load? or ?demand load.? So neither one of can say that ?only I am right in my use of the phrases.? It is all in the manner in which you are using those two phrases. Please see my post immediately above this one. I see what you are getting at. That said your demand load and connected load on your panel schedules are meaningless if they are not defined, JMO. To calculate the maximum demand of electrical circuits by applying diversity, first you need to know the total connected load. The total connected electrical load is all of the loads added together. Diversity might also be applied to individual items of electrical equipment such as a cooker. The Total connected load (or full load) is the sum of all electrical loads added together, for example: Total Connected Load = Load 1 + Load 2 + Load 3 and so on… Electrical Diversity is a factor applied as an allowance of load not likely to be used at the same time, for example: If load 1 is only used 50% of the time and load 2 is only used the remaining 50% of the time,10 Amps (Load 1) + 10 Amps (Load 2) = 20 Amps (Total Connected Load), then 20 Amps (Total Connected Load) x 0.5 (Diversity Factor @ 50%) = 10 Amps (Maximum Demand). This method might be referred to as a usage factor (UF). For another example a 32 Amp ring final circuit for standard 13 amp socket-outlets, every socket-outlet on the circuit are very unlikely to all be used at the same time, therefore the On-Site Guide offers a diversity factor calculation which maybe applied to this circuit. The IET On-Site Guide of BS 7671 Appendix A "Maximum demand and diversity" section offers some guidance on applying diversity to different types of loads and varying types of premises. Maximum demand is the load after applying diversity, for example, Total Connected Load x Diversity = Maximum Demand. After diversity maximum demand (ADMD) is used in the design of electricity distribution networks. ADMD is the load after applying diversity, for example: Load x Diversity = After diversity maximum demand (ADMD). ADMD (After diversity maximum demand) is the calculated "Maximum Demand", after applying "Diversity". There are many ways to apply different electrical diversity factors to different types of electrical loads, fixed equipment or electrical circuits. Calculating diversity is not an exact science since there are multiple varying factors which must be considered when calculating diversity and maximum demand, these factors will vary from premises to premises. It is also worth considering the life span of the electrical installation as should the way the installation is used change then the diversity factors applied previously may no longer be relevant. As a very basic example to calculate diversity for a cooker in a dwelling, based on Appendix A of the OSG: Cooker = 8kW 8kW ÷ 230v = 34.78 Amps The first 10 Amps + 30% of the remaining load so, 10 Amps + 7.43 Amps = 17.43 Amps. Diversity can be applied to a cooker as it is very unlikely that the oven, grill and all 4 hob rings are going to be heating all at the same time, once the oven or hob ring has reached its target temperature then it will switch itself off until the temperature drops. Some types are load are not permitted to have diversity to be applied such as electric heaters and showers because it is either on or off. For easy of use, try out our Maximum Demand Calculator. The designer of an electrical installation might also take into account that certain circuits or loads within the installation are not likely to be used at the exact same time so they might apply a usage factor (UF) to those loads. An example of this might be in a premises with a master water heater and a backup water heater, the backup water heater can only be used if the master water heater fails. What diversity factor should i use? Although there is some guidance in the OSG unfortunately there is no single answer to this one, which is why applying diversity to connected loads can be time consuming and complicated, detailed knowledge of the electrical installation in question and experience is required to decide on which diversity factors to use and apply to the connected electrical loads. A diversity factor defined by the following formula, Diversity Factor = Total Connected Load / Actual Maximum Load We have recognized this issue so have developed an electrical Diversity Calculator to assist with the calculation of diversity which consists of 3 different methods for calculating and applying diversity to electrical loads which include the OSG guide values, rule of thumb method, and a custom diversity factor with an additional usage factor which could be applied to the OSG method. Preparing for the Texas electrician exam requires a comprehensive understanding of electrical concepts, including load calculations. One critical distinction that can significantly impact your exam success is knowing the difference between the connected load and the demand load. In this guide, we'll delve into this essential topic to ensure you're well-prepared for the state exam with this type of NEC code questions and answers. Connected Load: The Starting Point The connected load, often referred to as the connected load VA (Volt-Amperes), represents the sum of the ratings or nameplate values of all electrical devices, fixtures, and appliances connected to a circuit or electrical system. It's essentially the total capacity or potential load that could be drawn if all connected devices operated simultaneously at their maximum ratings. Understanding the connected load is foundational for load calculations, as it provides the starting point for assessing the electrical requirements of a system. During the Texas electrician exam, you may encounter questions that require you to determine the connected load accurately. Demand Load: The Realistic Load On the other hand, the demand load represents the actual load or power consumption that a system or circuit is expected to draw based on typical usage patterns. It takes into account the probability that not all connected devices will operate simultaneously at their maximum ratings. The demand load considers diversity and load factors, reflecting real-world scenarios where not all appliances or equipment run simultaneously at their peak. This load calculation method provides a more realistic assessment of a system's electrical requirements. Other Calculation NEC Code Questions in the Master Exam 33 Items (including 3 Non-Scored Items) 170 Minutes - 70% Correct to Pass CONTENT OUTLINE - CALCULATIONS PORTION Subject Area # of Items Calculations and Theory 2 Electrical Services, Service Equipment, and Separately Derived Systems 8 Electrical Feeders 3 Branch Circuit Calculations and Conductors 4 Electrical Wiring Methods and Electrical Materials 2 Electrical Equipment and Devices 2 Motors and Generators 6 Electrical Control Devices and Disconnecting Means 1 Special Occupancies, Equipment, and Conditions 1 Renewable Energy Technologies 1 Exam Significance Understanding the difference between the connected load and the demand load is crucial for success on the Texas electrician exam. Questions related to load calculations may involve scenarios where you need to calculate the demand load based on the connected load and specific diversity or load factors. Mastering this distinction enables you to apply load calculation principles accurately, ensuring that your electrical designs and installations meet code requirements and safety standards. Conclusion As you embark on your journey to become a licensed electrician in Texas, remember that load calculations are a fundamental aspect of the profession. Knowing the difference between the connected load and the demand load is not only crucial for exam success but also for your future career as a skilled electrician. By grasping this essential distinction, you'll be better equipped to tackle load calculation questions on the Texas electrician exam and, more importantly, to provide safe and compliant electrical installations in the real world. There are a couple cases in article 220 where they specify the load you are required to use for a given purpose such as for a signage circuit (1200 VA) and for show window receptacles (75 va/ft) etc. These loads by their nature obviously run continuously (greater then 3 hours). In my load calcs, I have always taken these loads at face value and never bothered taking them at 125% because I assumed that when they wrote the NEC it was understood that these loads would run continuously. I received 2 rejections within 6 months requesting that I take these loads at 125%. I didn't bother arguing with the plan reviewer because it represented such a small load. My question is, if the NEC gives you a fixed VA, should you still apply the demand factor of 125%? There are a couple cases in article 220 where they specify the load you are required to use for a given purpose such as for a signage circuit (1200 VA) and for show window receptacles (75 va/ft) etc. These loads by their nature obviously run continuously (greater then 3 hours). In my load calcs, I have always taken these loads at face value and never bothered taking them at 125% because I assumed that when they wrote the NEC it was understood that these loads would run continuously. I received 2 rejections within 6 months requesting that I take these loads at 125%. I didn't bother arguing with the plan reviewer because it represented such a small load. My question is, if the NEC gives you a fixed VA, should you still apply the demand factor of 125%? First off, 125% factoring for continuous loads is not part of Article 220 load calculations. It is part of conductor and ocpd selection under under 210.19(A)(1) or 215.2(A)(1). Note these sections state that "conductors shall have an ampacity not less than required to supply the load as calculated in Parts III, IV, and V of Article 220. The minimum ... conductor size, before the application of any adjustment or correction factors, shall have an allowable ampacity not less than the noncontinuous load plus 125 percent of the continuous load." So if the loads are continuous, then yes they are required to be factored at 125% for conductor and ocpd selection. Last edited: May 14, 2013 So why wouldn't the NEC require you to use 1500 VA for a sign rather then 1200 VA? A building's signage circuit will always be continuous and wont vary between building to building. I understand what you're saying just not sure why the code is written as it is. So why wouldn't the NEC require you to use 1500 VA for a sign rather then 1200 VA? A building's signage circuit will always be continuous and wont vary between building to building. I understand what you're saying just not sure why the code is written as it is. It is written as it is because the calculated load and the required ampacity are two different things and are discussed in two different sections of the code. The wire has to be able to carry 125%, but the service does not have to be sized to supply 125% of the calculated load. So lets say you have just a single 200A panel feeding all the lights, receptacles, signage etc. and you provide a load calculation for the panel which is pretty typical on a project. Are you saying that you shouldn't apply a demand factor of 125% for the lighting etc? Only apply the 125% demand for the branch circuit? Ie. Panel "X" Panel Schedule Lighting: ____va @ 125% Signage circuit: 1200 VA @ 125 %= 1500 VA Misc.: _____VA @ 100% -- Panel "X" load calculation Lighting: 3 VA/ft^2 @ 100% Signage: 1200 VA @ 100% Misc.: _____VA @ 100% So why wouldn't the NEC require you to use 1500 VA for a sign rather then 1200 VA? A building's signage circuit will always be continuous and wont vary between building to building. I understand what you're saying just not sure why the code is written as it is. Not sure what you mean here. The 1200VA value is a minimum, just like the 75VA/ft for show windows. This value has to be included in the calculation whether there is an actual connected load or not. If the actual connected load is greater, you have to use the connected load value. If the connected load is less or non-existent, it is an allowance for future load addition without requiring upsizing of the service. As to why Code uses these particular values is a moot discussion. So lets say you have just a single 200A panel feeding all the lights, receptacles, signage etc. and you provide a load calculation for the panel which is pretty typical on a project. Are you saying that you shouldn't apply a demand factor of 125% for the lighting etc? Only apply the 125% demand for the branch circuit? Ie. Panel "X" Panel Schedule Lighting: ____va @ 125% Signage circuit: 1200 VA @ 125 %= 1500 VA Misc.: _____VA @ 100% -- Panel "X" load calculation Lighting: 3 VA/ft^2 @ 100% Signage: 1200 VA @ 100% Misc.: _____VA @ 100% Application of 125% for continuous loads is not generalized. In some situations the same load can be noncontinuous. In a commercial environment, some lighting will likely be continuous, some not... but signage and show window loads are rarely noncontinuous.