# Consistently Good Plan Reviews

Rand Veerman – Electrical Inspector Normal, IL

Sorry Folks, you are stuck with me -

- BS in psychology ‘77 – accidental electrician
- JATC-IBEW apprentice graduate ‘83
- Contractor for 17 years
- BS in EE in 1996 – back to school at 40+
- Electrical Inspector for Normal since 2000 very lucky to have the job I do

What is Normal?

Population 55,000 + 20,000 students

No state licensing in Illinois for Electrical

License Manicure, hair stylists, Realtors, Plumbers, pawn shop owners, locksmiths, barbers, home inspectors, radon installers, but not electrical or heating.

Mike Forister thinks Wyoming is the wild west, but try it without any statewide support.

Normal - Home of Mitsubishi Motors

- Producing a car a minute (135,000 per year)
- 2.4 million sq ft of manufacturing (1000 robots)

## Normal – Bridgestone Tire Manufacturer

- Off road tire Production – 14' Tall tires
- Adding on – no GFP on the plans – just indicators


- Normal Is EV Town
  - 40 - Level II chargers (1 per 2500 population)
  - Only high speed charger outside of Chicago
  - 9 all electric in the city fleet – charge in 22 min

## Central IL – Wind capital of Midwest

- 3,360 Megawatts installed – Eq 3 nukes when the wind blows (65% of the time) May double 5 years
- Power all presold to states with mandated green power consumption. My hot air is natural.

## Todays Goal

Give you one or two ideas to make your plan review life easier. Keep you interested any way I can.

Many of you know the code better and do more plan reviews – please, just raise your hands ☺

A plan review can be as shallow or as deep as you want to make it. Review – don't design.

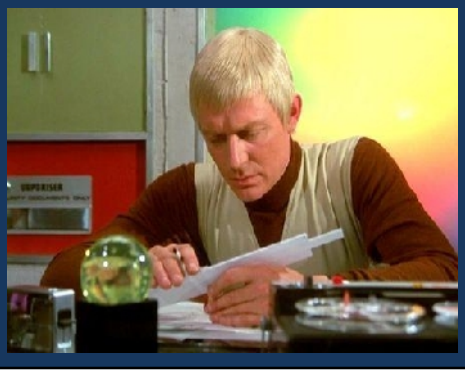
## Big Picture Outline – forecast

- Introduction – I am not Randi or Randy
- Who we do plan reviews for
- Work to do before you start the review
- Starting the Review – we will not finish
  - Goal is to establish methodology of how to do it
  - Only way to be consistent is with checklist or routine
  - Nothing more boring than reading a checklist
- Please mark up the templates in the handouts now while you are thinking about it -- make notes to yourself

## Who Benefits from Plan Reviews?

- The taxpayer – the pay us to protect them
  - Avoid unsafe installs
  - Make sure they get what they paid for
  - Most have no knowledge of our specialty

- For the designers – most do a good job, BUT
  - Architects cannot keep up with all trades
  - Contractors draw up plans that are sealed
  - Some designers count on us to require changes knowing the budget numbers

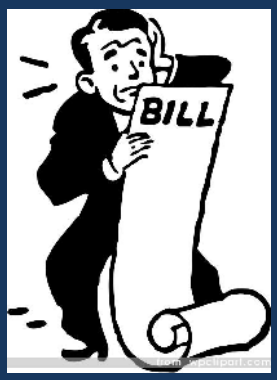



The Design World has changed with the economy

- Design Budgets have suffered just as entire economy has – cut to the bone
- Some designers are grateful for our plan reviews as they are charged with bringing a building in under an impossible cost and it cannot be done
- Some will thank you in their responses to your review – a few will argue – most will just comply.

- For the electrical contractors
  - We insure a good set of plans to keep field level
  - Contractor has to bare cost of changes / fight for $

No CEU's required in ILL so few own a current code book or take a class.

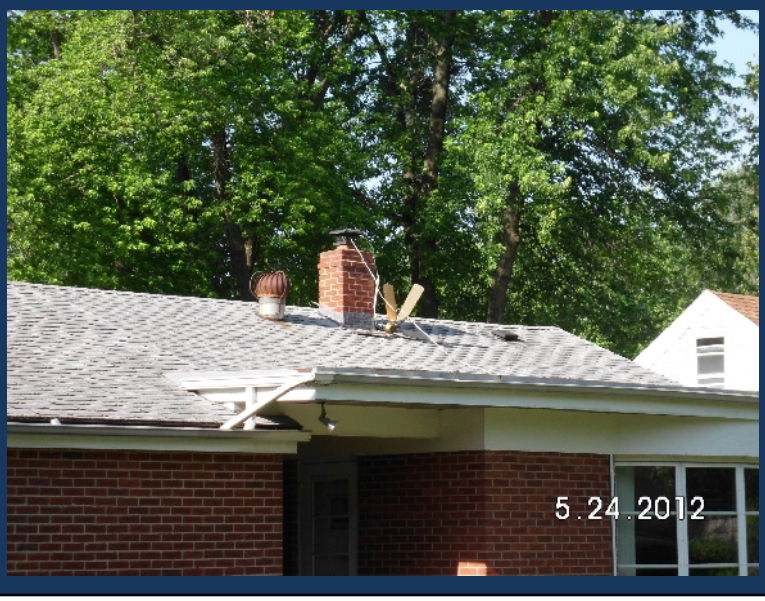



If the inspector asks for it, they have to pay for it!

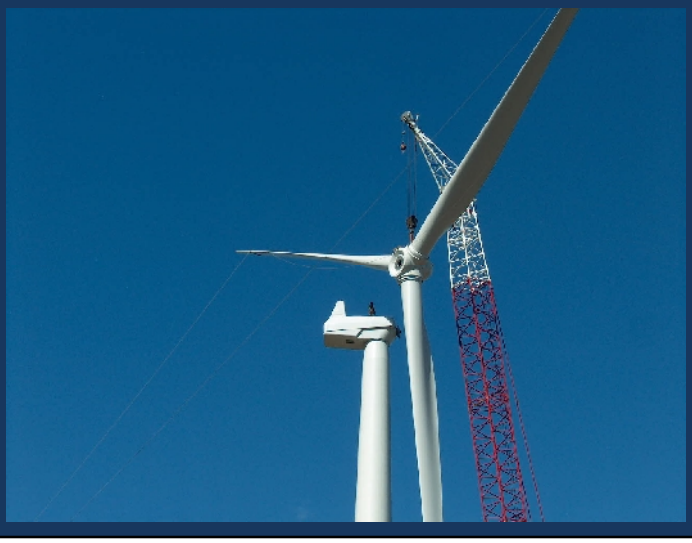
- For ourselves
  - Conflict is best resolved before initial install
  - Less time consumed if "headed off at the pass"
  - Most of our jobs are political and fewer calls to the boss (or emails to the city council) – the better
  - We are the AHJ and our jobs are to "make the call" and then follow it up – but we can be overruled
  - Bid docs have caveat "Install per local code" or "installation shall be approved by local authority"
  - We need to tell them our interpretations

## A Small Wind Project Done Without Plan Review

## 6 Days Later……those blogs on the internet – see notes



A Large Wind Project Done with Plan Review 1.8 MW



## Pre-Review Work – minimize your efforts

I) Provide a checklist to preparers

Briefly go thru my list – mark it up now

This is work you do once, but saves lots of time later

## Mark Up to suit your needs

**Electrical Plan Requirements for submission to the Town of Normal**

Any project may be required at the discretion of the electrical inspector to submit professionally designed plans sealed by professional engineer or architect.

Generally, all projects involving services larger than 400 amps shall require sealed drawings for review.

Submitted drawings shall include:
The design professionals stamp and expiration date. Designer's contact information.
The Code(s) the plan has been designed to (NEC 2011, NFPA 72, NFPA 20, etc) and edition date.

I have complete discretion -

Looking at 30 cities requirements I saw seals required on 200 amps and up OR "Complex Structures" OR $5000 in work OR all 480 volt and up – towns run the gambit

Design/Build – You design it, I review it, then you can build it

## Mark Up to suit your needs

Separate drawings for the following:

- One line power diagram from utility to branch circuit panelboards
  - Showing utility service point, feeders, service conductors, service disconnecting means, grounding and bonding conductors and terminations.
  - Drawing shall include raceway size and type as well as wire size and type.
  - AIC calculations at the service point and point to point at switchboards and panelboards

Add your own one line requirements now while you are thinking of them

## Mark Up to suit your needs

Panel Schedules with:

- Voltage, ampacity of main or lugs. Breaker type (single of multipole)
- Circuit number and description per NEC 110.22
- Load for each circuit in VA or KVA as calculated per NEC 220
- Demand Factors as listed in NEC 220

Panel schedule pages typically include the load numbers

## Mark Up to suit your needs

Scaled drawing(s) of the project showing location of all electrical devices.

- Drawings shall be 24" x 36"
- Drawings shall show routing for all feeders over 100 amps
- Electrical Rooms shall be drawn to scale and comply with NEC 110.26

Ask for what you are comfortable with – digital if you like

I want to see tray installations, and conduit routing for larger circuits

I hate 110.26 violations – so hard to fix after the structure is up

## Mark Up to suit your needs

A reflected ceiling plan showing the lighting layout with luminaires designated
An Emergency and Exit lighting plan with each brand and model of fixture shown
A comcheck filled out and sealed by the design professional certifying conformance with the IECC 2009.

Exit and Em lighting is often short of requirements
The Exit and EM requirements are in the IBC
Section 1006 Means of Egress Illumination
NEC specifies how it is installed

I ask for make and model so can verify illumination pattern if it looks short.

Show of hands on energy code enforcement – get 'em up

## Mark Up to suit your needs

For commercial kitchens, every piece of equipment shall be drawn on the kitchen plan and the following information:

- The method of electrical hook up (cord and plug vs hard wired, raceway)
- The rated voltage and full load amps of the device
- Conductor and breaker size
- GFI protection if required, including location of test and reset (Breaker type or receptacle type).

We do a lot of kitchens and I am fussy about GFI location
None allowed behind a hot fryer or behind a permanently installed ice maker

Some will try to cord and plug appliances meant to be hardwired. Ask for manufacturer's installation instructions if in doubt.

## Mark Up to suit your needs

Separately Derived Systems information shall include:
- Grounding and bonding conductor sizes and termination points
- Primary and secondary conductor sizes
- Overcurrent protection for primary and secondary
- A physical layout showing conformance with Tap length rules

Grounding/bonding plan to show:
- Location of each grounding electrode
- Size and type of each grounding electrode conductor (per NEC 250)

Find lots of errors on step down and step up systems.

I want it all spelled out plainly from "uffer" to ground rod
If its not on the plans plainly the wireman cannot install it
Ask for notes to be added to the plans to make things clear

II) Get your tools ready
Calculator –

II) Get your tools ready (cont.)
Scale


II) Get your tools ready (cont.)
Post-its

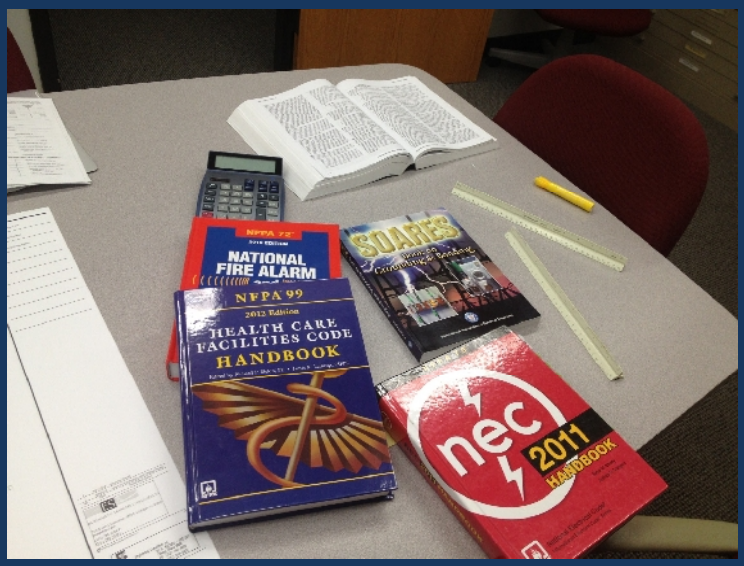

Tab pages or notes on plans or NEC

II) Get your tools ready (cont.)
Pack of multi-color Highlighters

Useful for EM and Exit Circuits
Grounding, Lighting Controls
Red for items need more research

II) Get your tools ready (Cont.)
References
- NEC Handbook and Soares
- NFPA 20 Fire Pump
- NFPA 72 Fire Alarm
- NFPA 99 Healthcare
- NFPA 101 Life Safety
- NFPA 110 Generators
- IECC 2009 and 2012
- IBC – telling us more about electrical
- Google on standby

Our NFPA Series is in a huge binder for 20, 110, 70e, etc
Makes me want to buy stock in Code Book publishers




References are the mother documents

- NFPA 99 has much on the essential electrical system for healthcare
- NFPA 20 has many more requirements than NEC for Firepumps
- Most are referenced in “information notes”, but not enforceable per se unless adopted
- Lucky in that our fire department has adopted NFPA across the board

II) Get your tools ready (Cont.)

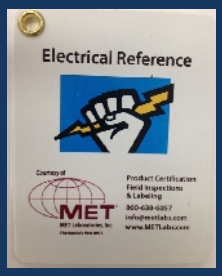
Make Quick references of code tables

Met Labs – thank you Mike Baldwin

Iphone ap NEC Quick (Love it)

Iphone ap Transformer Calc

Included are my transformer excel charts





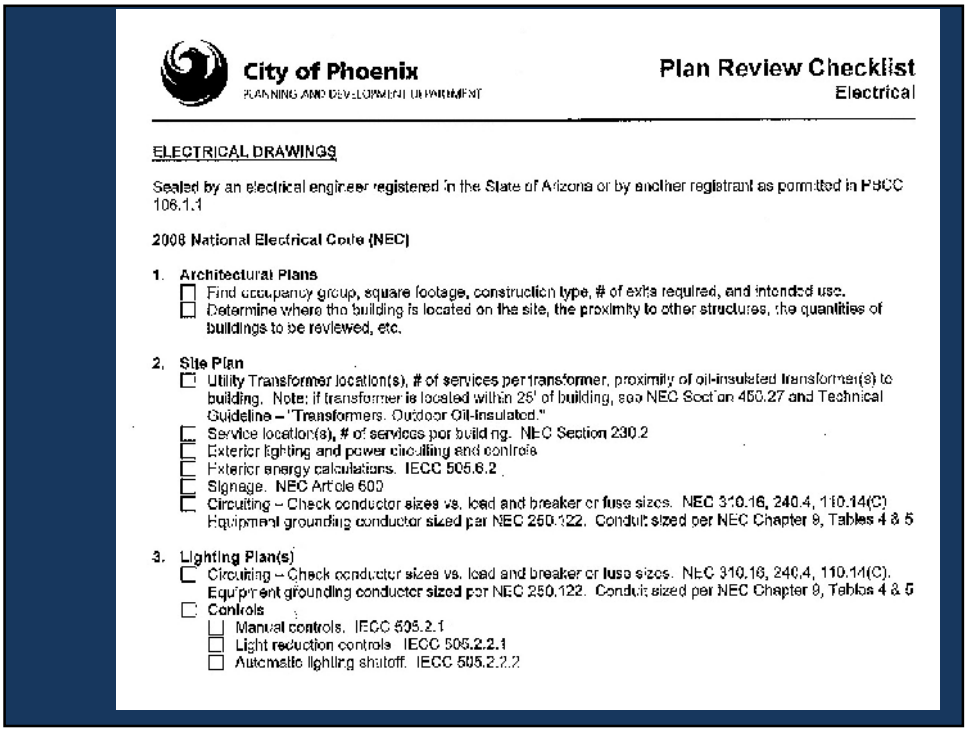

II) Get your tools ready (cont.)

Your Brain – Clear and ready

## II) Your Brain – Not after a Chinese Buffet


## Included are 2 more "Checklist" type items

- The City of Phoenix Plan Review Checklist
  - Reasonably Short and to the point, but thorough
  - It Cites the Code Sections for each item
  - It does cite the IECC code sections as well
  - Available in Braille, large print, disc, or audio
  - Thank you Phoenix
  - I am going to ad lib while viewing this – sing dance Whatever it takes to keep you awake



City of Phoenix
PLANNING AND DEVELOPMENT DEPARTMENT

Plan Review Checklist
Electrical

ELECTRICAL DRAWINGS

Sealed by an electrical engineer registered in the State of Arizona or by another registrant as permitted in PBCC 106.1.1

2006 National Electrical Code (NEC)

1. Architectural Plans
   - ☐ Find occupancy group, square footage, construction type, # of exits required, and intended use.
   - ☐ Determine where the building is located on the site, the proximity to other structures, the quantities of buildings to be reviewed, etc.

2. Site Plan
   - ☐ Utility Transformer location(s), # of services per transformer, proximity of oil-insulated transformer(s) to building. Note: if transformer is located within 25' of building, see NEC Section 450.27 and Technical Guideline – "Transformers. Outdoor Oil-Insulated."
   - ☐ Service location(s), # of services per building. NEC Section 230.2
   - ☐ Exterior lighting and power circuiting and controls
   - ☐ Exterior energy calculations. IECC 505.6.2
   - ☐ Signage. NEC Article 600
   - ☐ Circuiting – Check conductor sizes vs. load and breaker or fuse sizes. NEC 310.16, 240.4, 110.14(C) Equipment grounding conductor sized per NEC 250.122. Conduit sized per NEC Chapter 9, Tables 4 & 5

3. Lighting Plan(s)
   - ☐ Circuiting – Check conductor sizes vs. load and breaker or fuse sizes. NEC 310.16, 240.4, 110.14(C). Equipment grounding conductor sized per NEC 250.122. Conduit sized per NEC Chapter 9, Tables 4 & 5
   - ☐ Controls
     - ☐ Manual controls. IECC 505.2.1
     - ☐ Light reduction controls. IECC 505.2.2.1
     - ☐ Automatic lighting shutoff. IECC 505.2.2.2

## Included is a detailed plan review form for notes

- A detailed plan review form that is on the website in Word format.
- Filling it out may take some time, but most of the items are yes/no for compliance
- Only worry about the ab-normal items

## Please Mark up this handout to suit yourself

Plan Review Template for Western Section September 2012

Address of Project: _____

Engineer of Record: _____

Building Use(s): _____

Any Classified Locations? Y / N  Is Building a High Rise? Y / N

One Line Drawing:

Service(s): Number of Services: _____

Voltage/Ampacity: _____ _____ _____

Phase:

GFP or Fault Indicator _____ _____ _____

I max at terminals:

Service Conductors:

Are conductors from Utility to Service Disconnect(s) properly sized? Y / N

Is the Neutral (grounded conductor) reduced? Y / N  Calculations shown Y / N

Grounding Electrode System shown complete with conductor size(s)? Y / N

Raceway(s) properly sized Y / N  Ambient/Rooftop Correction Required: Y / N

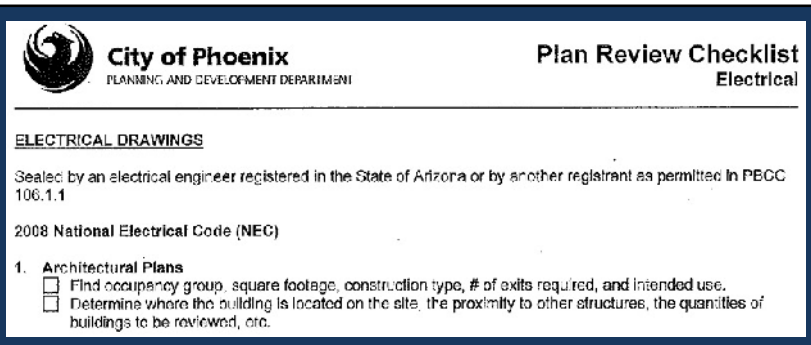
Is a duct bank shown Y / N  Is spacing shown per NEC 310 Y / N

Electrical Room(s) Adequate Size for NEC 110.26 Y / N

## III) The Review – (Time Check for me?)

- Briefly look at each section of the review
- You can amend this as needed for occupancy types
- The goal is to have a consistent methodology – not to spend more time than the designer did

Your comments should include the caveat that the plans are reviewed, but any code violations missed will still need to be fixed (not at the Town of Normal's expense).



**City of Phoenix**
PLANNING AND DEVELOPMENT DEPARTMENT

**Plan Review Checklist**
**Electrical**

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2008 National Electrical Code (NEC)

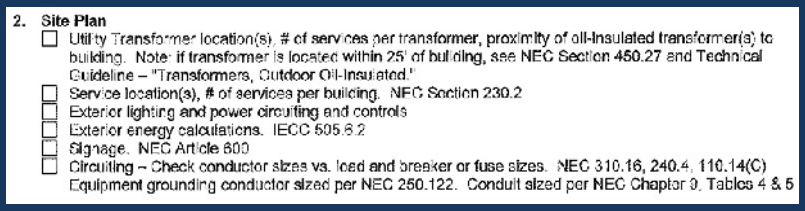
1. Architectural Plans
   - ☐ Find occupancy group, square footage, construction type, # of exits required, and intended use.
   - ☐ Determine where the building is located on the site, the proximity to other structures, the quantities of buildings to be reviewed, etc.

Get your Highlighters out and start marking.

Post-its for page markers to come back to

Romex ok? That is huge from cost/design point of view. Labor rates often cheaper (60%)

Is it remodel or new construction?



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Paging thru the drawings front to back.

Any large transformers inside the building?

How long are the pole lite runs? Upsize EGC

Are ground rods driven at each pole? No EGC?

Any trash compactors, EV chargers, water features, snow melt, PV systems, Parking lot illumination requirements?

3. **Lighting Plan(s)**
   - ☐ Circuiting – Check conductor sizes vs. load and breaker or fuse sizes. NEC 310.16, 240.4, 110.14(C). Equipment grounding conductor sized per NEC 250.122. Conduit sized per NEC Chapter 9, Tables 4 & 5
   - ☐ Controls
     - ☐ Manual controls. IECC 505.2.1
     - ☐ Light reduction controls. IECC 505.2.2.1
     - ☐ Automatic lighting shutoff. IECC 505.2.2.2
   - ☐ Interior energy calculations. IECC 505.5
   - ☐ Means of egress lighting (normal) and (emergency). IBC 1006.1, 2, 3, 4, NEC Article 700
   - ☐ Take note of length of any line-voltage track for feeder load calculations. NEC Section 220.43(B)

Note: most of this review item is not NEC

Most important for me is Exit and Egress

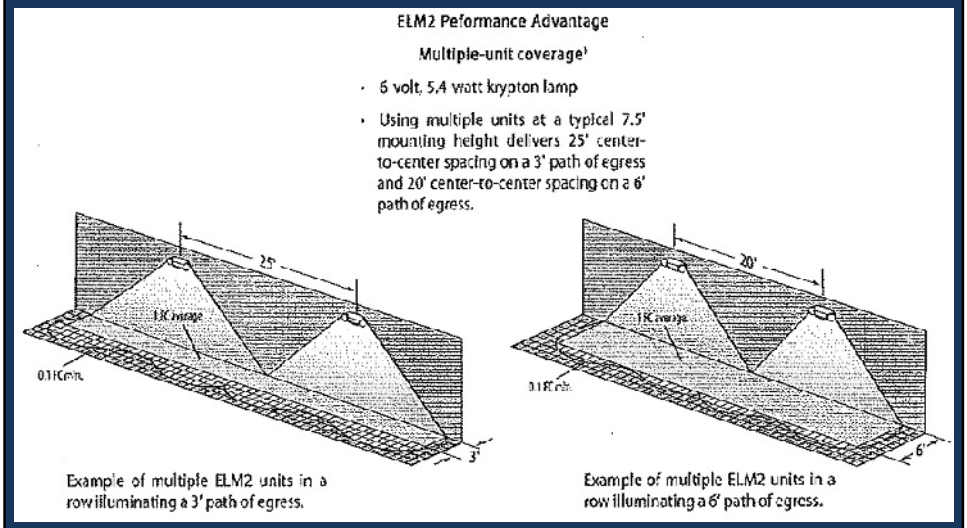
Battery units or genset or central UPS

Are there enough to provide 1 fc levels?

Outside common stairways require battery units that are good to -10 degrees—special battery paks

Suggest self testing units, the batteries last 3-5 times longer –not a code requirement

## Take a look at a commonly specified EM lite




20-25 feet on center at 7.5 feet mounting height – 3’ and 6’ width

## EM and Exit Deficiencies

- The chart is only good for 7.5 feet height
- At a big box store, could not get 1 fc anywhere when mounted at 15 feet
- Smoke rises and will obscure the light
- LED varieties are much better and brighter
- Have seen EM2's 40 feet on center at 18 feet because "they are economical"
- You may ask for a photometric drawing of the paths of egress to insure compliance - ouch

**4. Power Plan(s)**

- ☐ Circuiting - Check conductor sizes vs. load and breaker or fuse sizes. NEC 310.16, 240.4, 110.14(C) Equipment grounding conductor sized per NEC 250.122. Conduit sized per NEC Chapter 9, Tables 4 & 5
- ☐ GFCI per NEC Article 210.8
- ☐ Electrical distribution equipment layouts – Working space NEC 110.26
- ☐ Classified locations, NEC Articles 500 - 517, – identified on plan, electrical equipment and wiring methods within classified locations properly rated. (Note: also verify rating of lighting within or above classified locations)
- ☐ Review mechanical & plumbing equipment power, circuiting, OCPD sizes, loads, disconnecting means (Note: may be on separate power plans). Review mechanical and plumbing equipment schedules vs. load information shown in panel schedules and load calculations
- ☐ Review other equipment power, such as kitchen equipment, circuiting, OCPD sizes, loads, disconnecting means

I check all large equip for circuit correctness

I hate 110.26 violations. As I get fatter I can see myself wedged into those tight places trying to do service work.

Are Drinking Fountain GFI's inside the machine?

Sewage ejector pump classified?

- Create Separate review checklist for 517 and classified locations.
- Eyeball everything looking for odd or missing. Highlight everything that helps keep it clear
- Show of hands on who makes all 120 receptacles in a kitchen GFI? Isolated Ground receptacles too?
- Whew, lets break and see something cool

Done – 82 meters to hub – 144 foot blades 1.8 MW

**5. One-Line Diagram(s)**

- ☐ If more that one service is serving a building, verify that the design meets one of the conditions in NEC 230.2 permitting more than one service
- ☐ Verify building disconnecting means are provided for each building in scope. NEC 230.70 or 225.31
- ☐ Verify electrical distribution equipment ratings, (voltage, phase, wire, ampacity, AIC, enclosure). Check ampacity of distribution equipment vs. load shown in load calculations
- ☐ Verify if GFP is required and indicated. NEC 230.95, 215.10
- ☐ Check feeder sizes, (line, neutral, and grounding conductors, and conduit). Verify that loads do not exceed conductor ampacity
- ☐ Check OCPD (fuses, breakers) sizes and types. Verify that loads do not exceed OCPD ratings. Verify that OCPD's properly protect conductors and equipment
- ☐ Check grounding and bonding of service(s), transformer(s), generator(s), etc. per NEC Article 250
- ☐ Review any NEC Article 700, 701, and 702 systems indicated. Verify separation as required by code
- ☐ Review Essential Electrical Systems for health care facilities per NEC Article 517
- ☐ Verify if Special Electrical Inspection or Electrical Observation is required. Review Special Inspection or Observation form for completeness

Spend most of my time on the one line.

- Wire size violations
- System bonding jumper too small
- Transformer protection breaker too big

Ask for more information on any doubtful items

6. **Check load calculations**

7. **Check fault calculations**
   - ☐ Identify utility company. (APS or SRP)
   - ☐ Verify that AFC shown at the SES is no less than that shown in the utility company tables.
     Note: tables are based on one transformer serving one service. If more that one service is served by a single transformer, the transformer will likely be larger (KVA) and consequently have a larger AFC at each service served. If two or more transformers are networked, the AFC will be much higher than the table value.
   - ☐ Check fault calculations to all panels, contactors, relays, etc. vs. SCCR rating indicated for same. Other equipment should also be checked, such as chillers, A/C units, elevator controllers, etc.

I call the utility if needed. 450.27 on outside transformers—utility gives me Natl Elec Safety Code information.

Only at Mitsubishi do I have double fed bus (very high fault)

8. **Panel Schedules**
   - ☐ If multiwire branch circuits are present on plan drawings, verify compliance with 210.4(B)
   - ☐ Verify that any line-voltage track lighting is included in feeder calc for panel. NEC Section 220.43(B)
   - ☐ If show windows are identified in panel schedule, verify code required feeder load is included in load calculation for panel. NEC Section 220.43(A)
   - ☐ Sign circuit required by NEC Section 600.5(A) must have a minimum load per NEC Section 220.14(F)
   - ☐ Panel schedules should include: breaker ratings, circuit loads, description of loads, panel ratings, (voltage, phase, wire, ampacity, AIC, enclosure), and panel load calculations
   - ☐ Verify that load shown does not exceed panel ampacity rating
   - ☐ Verify panel available fault current (AFC) from fault calculations does not exceed panel AIC rating, or that a series rated system is designed

Most of the plan review is checking – but you find enough violations to keep it interesting

Got a job offer from one firm to just look their plans over before they send them out – all desk work

If the submitter listened to you requests, it should all be spelled out.

III) Good Catches

- SDS – system bonding jumper sized too small inside the transformer and down to the panel.
- Breakers not sized properly for 450 protection
- Service conductors inside the building
- Generator with one transfer switch (not em listed) serving emergency circuits and equipment
- Em circuits co-mingled with normal power in raceways – drawn on the print that way
- 500 kcmil used as 400 amps for 5 sets in parallel

III) More catches

- Violations of tap rule distance between xformer and secondary panel
- Generator SDS without grounding connection. Firepump feeders not sized per NEC 695, too many disconnects in firepump circuit, firepump conductors routed thru building not in rated method, firepump disconnects not monitored.
- Rooftop wiring increase in size from #10 to #6

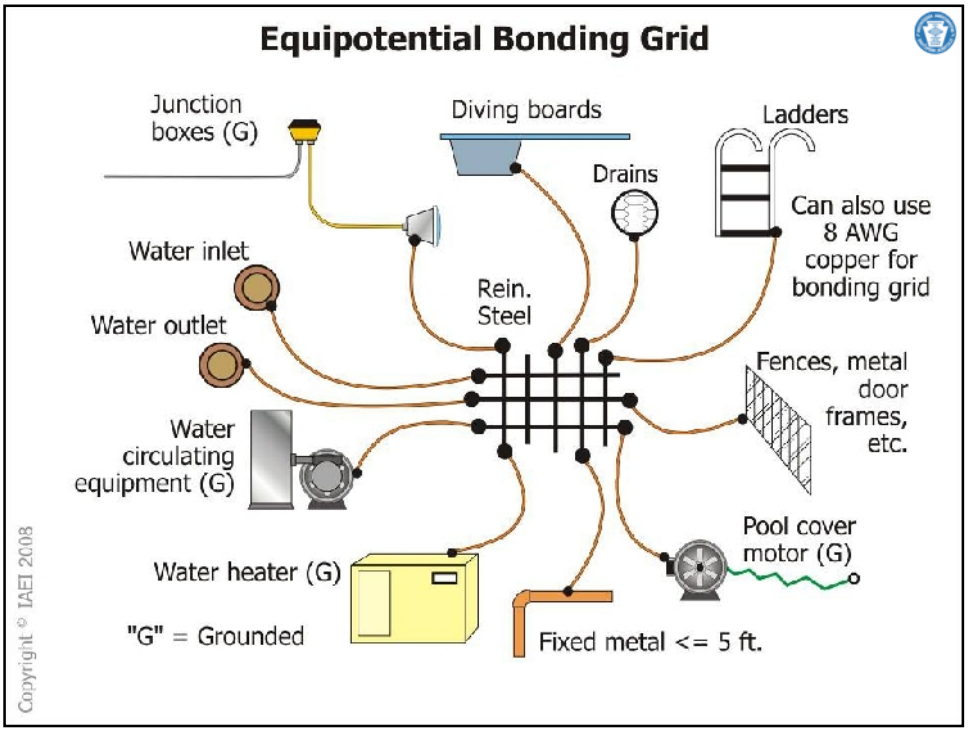
III) More catches

Equipment ground in parking lot lights #10 while phase conductors increased to #4

Fire Alarm wire in partial evacuation building run thru zones in other than CI cable

Satellite dishes with no bond at all

Big box - 277 to 120 step down x formers to provide power to door alarms. No protection primary or secondary. No ground connection.



III) Catches

Swimming pool lights are always a hodge podge. Show of hands on who likes the 680 language on 54" above ground pools? Can we get any manufacturer's on that panel?

Pool bonding missing.

No rapid restrike lamps in warehouse of HIDs or Time Delay on EM

Cat Scan Machine shown wired in PVC – the salesman said it was ok

III) Catches

Track lighting (less allowed with energy code)

Track Load Limiters are available to comply with energy code – custom breakers set as needed. But it is expensive

Check for interior NEON signage.

Check for specialty lighting and listings

A cattle tank heater used in Baptismal (was not shown on the plans, so I asked about heater)

III) Catches

Missing OX sensor locations, window fenestration controls.

Missing roof top receptacles

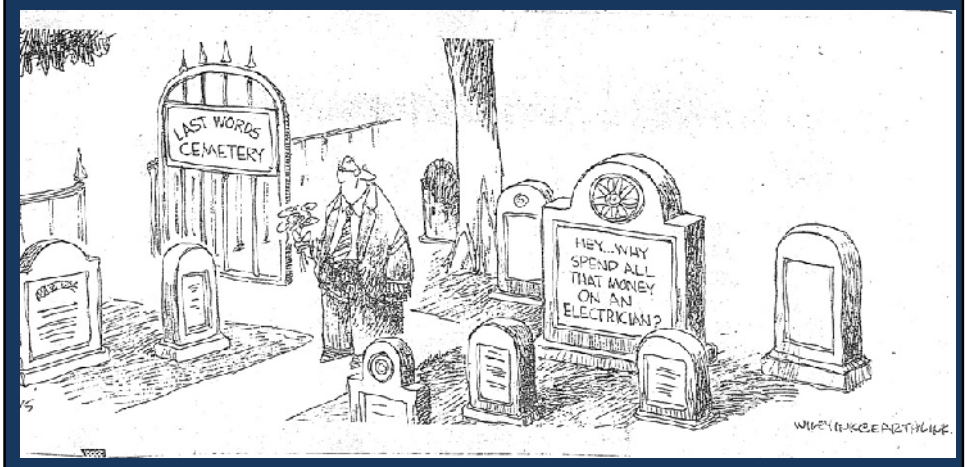
Missing GFCI protection on vending machines

Missing TR in daycare center

Missing show window receptacles

Aluminum wire used too close to earth

III) Famous Last Words Cemetery



- Calculations – you need to know how, but it is easier to review and spot check submitted calculations.
- Mike Holt has some Excel sheets that are easy to use and can speed up residential calcs
- How many look for Arc-Flash Labels per NEC 110.16 ??

III) The Review Wrap up

Make specific requests of what you want to see in advance

Scan thru the drawings highlight items to come back to

Follow a routine or checklist to be consistent

Don't be afraid to call fellow inspectors for something new – to see how they handle it

Avoid political comments in your review

The END

If time for your best catch.