



**PDHonline Course R125U (3 PDH)**

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# **Electrical Engineering Ethics Cases (Audio Version)**

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# Electrical Engineering Ethics Cases

*Thomas Mason, P.E.*

## Course Content

Most courses in engineering ethics discuss principles. That is a valuable approach. This course discusses specific instances of ethical problems faced by a real-world electrical design engineer. The real-world outcomes are presented, but not offered as the right answers. The purpose of the course is to help the student address the questions objectively and rationally, before he or she encounters them in an emotionally heated personal crisis.

- Case 1 - HVAC Rooftop Unit Delivered Voltage Doesn't Match Building Electrical Voltage
- Case 2 - Choice of Copper Conductors for Building Feeder Conductors
- Case 3 - Owner Demands Hazardous Area Be Wired Without Explosion-Proof Devices
- Case 4 - Office Trailer Installed and Hooked Up in Violation of Zoning Setback Requirements
- Case 5 - Employer Accepts Contract to Build Heavy Machinery without Brake
- Case 6 - Large Consulting Firm Designs Wastewater Plant without Hazardous Buffer Spaces
- Case 7 - Large Government Agency Talks Safety But Doesn't install NEC or OSHA required Labels
- Case 8 - Published Company Safety Policies Exclude Visitors and General Public
- Case 9 - National Construction Manager Requires all Contractors and Subs Sign Safety Policy
- Case 10 - Use of Diversity Factor in Sizing Distribution Equipment and Feeders
- Case 11 - Opening Energized Equipment for Observation or Testing
- Case 12 - Grounding 480V Feeders for New Equipment Tie-in
- Case 13 - Testing IT Panels for Overload and Documentation
- Case 14 - Surge Protection Devices at Building Entrances
- Case 15 - Applying Short-Circuit Withstand Ratings
- Case 16 - When You Learn to Fake Sincerity, You Can Achieve Anything

For each case, we will examine the situation, the question, the alternatives, the underlying ethical question, the activity selected and try to evaluate the success of the alternative selected. Finally, we will discuss lessons learned which might be used in future similar situations.

## Case 1 - HVAC Rooftop Unit Delivered Voltage Doesn't Match Building Electrical Voltage

### **The Situation**

The design team had issued Construction Documents for more than 50 schools and followed them loosely through construction. (The Architectural group typically handled bid and construction services and rarely called in the design group during construction.)

### **The Question**

About midway through construction of a middle school for a small metropolitan school district in the Midwest, the construction contractor called to complain that the first of three rooftop terminal unit delivered came with nameplate requiring 240V supply. The construction documents called for 480V circuit breakers and wiring to the rooftop units. There school had 480V distribution sized for the rooftop units and 120/208V distribution for receptacles.

Least-cost HVAC equipment rated 240V cannot operate on 208V.

### **The Alternatives**

- A. The contractor could check into returning the units and getting replacement 480V units.
- B. Each of the rooftop units could be fitted with a 480-240V transformer, with nothing else changed.
- C. Each of the rooftop units could be fitted with a 208-240V transformer, with new, larger feeders and new circuit breakers in 208V panels. (Available capacity must be confirmed and reasonably nearby 208V panels located.)

### **Discussion of Ethics**

Alternative A offers the least-cost solution, if workable. The downside is that it would be a very public "black mark" against the design group and work against future assignments from this architect and from others, as the story got around.

Alternative B offers a very reasonable-cost solution. It is not dependent upon the equipment distributor's goodwill and requires no redesign, beyond selecting the transformers. This, also, is a "black mark" against the designers.

Alternative C offers the highest cost. Existing wiring must be demolished and new wiring and circuit breakers installed from (probably) more distant panels. Engineering must be invested in the revised electrical design. There is no recovery available for the original capacity and wiring. The "black mark" is a big one.

### **Activity Selected**

Alternative A was chosen - because the burden is on the contractor and cost is subject to negotiation and apportioning between the contractor and designer.

### **Success of Selection**

Was this a good choice? Certainly, it was preferred by the architect, who came out whole and untarnished. (The architect made the decision.)

Was this a socially good choice? That is, were all stakeholders optimally satisfied by the decision? Probably. The designer wasn't going to win, from any of the choices. The school district made September opening; no students or families were inconvenienced and the cost was minimal.

### **What We Can Learn from This**

First, designers from the electrical and mechanical disciplines must coordinate. This is very much a moral/ethical conclusion. Disciplines don't coordinate because each person in each specialty has such a high opinion of himself or herself that they don't want to talk to the others and don't really care what the other has entered into the project design.

Some might conclude that the case described was a special instance of failure of supervision. That is a valid observation, but overlooks the underlying defect that participants refused to interact, even with the work product of the other.

Second, the design manager in this case issued an edict that all future contract documents must carry the note, "Contractor to verify HVAC equipment specifications match installed utility ratings." This is an attempt to transfer design responsibility to the installer and absolve the manager of his responsibilities.

This is what the participants learned. Is it what we learn? No, we learn that designers must execute their required actions. Design managers must execute their required actions. Also, if the architect is taking responsibility for overall supervision, he or she might invest some time in this coordination.

## Case 2 - Choice of Copper Conductors for Building Feeder Conductors

### **The Situation**

Technically, modern aluminum conductors are close equivalents to similarly rated copper conductors. Historically, early aluminum conductors were installed per the manufacturer's instructions and failed-in-service, sometimes causing fires. The problems were traced to the aluminum alloy used and the level of compression in installation.

The historic problems have been solved by use of a different alloy, and improvement in the manufacturer's instructions regarding level of compression in installation.

Rare modern installations have proven to be reliable, with considerable cost savings. The rule-of-thumb is that aluminum conductors are suitable for large capacity feeder cables, which are usually installed by more skilled tradesmen. Even proponents of aluminum have reservations on the compression level applied by most tradesmen on receptacle screws or wire nuts. (Aluminum conductors are not suitable for "just insert" connections, common for copper/receptacle connections.)

### **The Question**

When writing the wiring specification, does the electrical designer call for aluminum conductors on feeders and branch circuits of 30A and above ?

We focus on the design engineer because he or she, typically, creates the specifications. Obviously, the design manager, architect and owner can be involved in this decision.

### **The Alternatives**

- A. The designer can call for copper conductors for all circuits, including feeder and branch circuits of 30A and above.
- B. The designer can call for copper for circuits below 30A and aluminum for feeder and branch circuits of 30A and above.
- C. The designer can call for all copper with a Bid Alternate for aluminum for feeder and branch circuits of 30A and above.

### **Discussion of Ethics**

I view this as an ethics question because I do most of my design for municipal utilities and public agencies. We are spending public money to which I contribute. I feel very strongly that wise use of the funds provides public good, within the meaning of the engineering ethics guidelines.

It is, further, a personal moral/ethical decision. Owners, architects and mechanical engineers all have opinions about use of copper conductors. It is a personal moral/ethical imperative to act upon personally known truth, not merely accept orders from above (Nuremberg principle).

**Activity Selected**

Alternative A, copper-only has been chosen on every job I have ever worked on. Late in the last century, I tried to explain the advantages of aluminum, but was silenced at the design manager level, never got to the architect or owner.

**Success of Selection**

The projects were constructed with no problems on the wiring. The projects started up and ran successfully with no problems on the wiring. Maintenance persons have experienced no thermal problems on connection.

A small fraction of 1% of the capital cost was spent unwisely. Graft on many public projects exceeds 30% (ref recent Seattle third runway scandal).

**What We Can Learn from This**

I have agonized on this topic since reviewing published reports of successful aluminum feeder installations. My conclusion is to follow Alternative A without considering others. I still agonize over it, but it is only one of many heartburns.

### Case 3 - Owner Demands Hazardous Area Be Wired Without Explosion-Proof Devices

#### **The Situation**

A small regional consultant specializing in wastewater treatment plants hired me at the end of the design phase of a fairly large plant renovation. During my tenure, the owner requested that the septage loading area be enclosed. I was given the architectural background, with the walls and doors. There were no exhaust fans and I was told to use general purpose switches and lighting.

Septage is bad stuff from septic tanks. National Fire Protection publication 820 required, at the time of this event, that enclosed septage handling facilities be classified as Class I, Division 1, requiring explosion-proof electrical hardware and installation procedures. (The 2008 edition of NFPA 820 does not separately recognize septage, but considers it a sub-category of sludge, which also requires Class I, Div 1 hardware and wiring methods.)

#### **The Question**

Do I follow the national safety standard or my boss's instructions ?

#### **The Alternatives**

- A. Do as told.
- B. Talk to boss and request written directions.
- C. Design explosion-proof hardware and wiring notes without authority.

#### **Discussion of Ethics**

First, the situation is not as clear as it might appear from this summary. The National Electrical Code (NFPA 70) is, in fact, law. It is adopted by the State legislature and enforced by the local building permit issuing agency and electrical inspector. The NEC references NFPA 820, but does not incorporate it. NFPA 820 is not enforceable through the NEC, only by judgment of the local authority having jurisdiction.

Second, it was a clear directive from the municipality. The project was out of money and nearby residents were complaining over the odors from the outdoor septage receiving station. Wastewater consulting is very dependent upon maintaining good relations with the customer. The firm wanted very much to say, "Yes, sir."

Third, there is a range of opinion, among experts, about the flammability of gasses surrounding septage, or sludge gas, as it is now called.

The concern of the designer is that he expected to be asked to seal the construction documents. The seal is a unique reference number, issued by the State, so that the designer can easily be called into court at a later date.



### **Activity Selected**

Alternative B was selected. I went into my boss and explained the NFPA 780 definition of septage handling in a non-ventilated space as requiring explosion-proof equipment and wiring.

He answered that the owners of the firm had decided that septage was non-hazardous and the project could not afford explosion-proof equipment.

I asked for a written confirmation of the directive.

Three days later he delivered the memo. I noted that it was unsigned. He answered, "What do you think I am, crazy?"

### **Success of Selection**

I finished the design using general purpose equipment and wiring methods. I was not asked to seal the construction documents. It has not blown up yet. I was asked to leave employ of the firm a month after final issue of the construction documents.

### **What We Can Learn from This**

First, cost takes precedence over law or personal belief in many business decisions. This is not the exact wording of the NSPE Code of Ethics. It is actually quite contrary to this Code which we swear to in order to get our PE licenses.

Second, no one who doesn't remember Burt Lancaster honors the Nuremburg principle. [Burt Lancaster is an old-time actor who starred in a powerful motion picture ([http://en.wikipedia.org/wiki/Judgment\\_at\\_Nuremberg](http://en.wikipedia.org/wiki/Judgment_at_Nuremberg)) depicting the Nuremburg trials of Nazi officers after World War II. World War II was like Iraq, except, we were the good guys.]

Third, engineering ethics are considered part of the bureaucracy that must be honored to do business. It is not a personal commitment widely adopted within the industry. Quite the contrary, this example is one example, from many, of ethical questions being adequate reason for termination (<http://en.wikipedia.org/wiki/Whistleblower>).

## Case 4 - Office Trailer Installed and Hooked Up in Violation of Zoning Setback Requirements

### **The Situation**

The owner holds many industrial properties in the region. They employ an engineering staff of 80 to facilitate utilities for incoming tenants.

This tenant negotiated a five-year lease, with option for renewal for a prime storage location. The lease promised an office trailer, provided by the owner.

### **The Question**

The owner's Construction Manager asked at a construction meeting if City inspections were proceeding. The answer, from the Project Engineer (civil) was that applications had not been submitted.

In filling out the building permit forms, the Project Engineer noted that approval from the Greenspace Commission (required for the building permit) had not been sought.

The Greenspace form required a setback from a scenic object adjacent to the property. The office trailer had already been set and piped for electric, telephone/data, potable water and sewer. 35 tie-downs had been installed, at the request of the City inspector

### **The Alternatives**

- A. Demo the utilities and tie-downs; move the trailer, and, reinstall the utilities and tie-downs.
- B. Seek a variance from the Greenspace Commission.
- C. Seek a variance from the Zoning Commission.
- D. Do nothing and hope no one notices.

### **Discussion of Ethics**

Choice A is expensive, for a project already over budget and makes the contracted occupancy date nearly impossible.

Alternative B means applying for the permit and, at the same time applying for the variance. This is considered bad form in dealing with public agencies.

The problems with Alternative B bleed over into Alternative C.

Alternative C means intentionally violating the law and ignoring the public interest (as represented by the Greenspace Commission).

### **Activity Selected**

The Project Engineer either decided to pursue Choice D or the implemented it though inaction.

**Success of Selection**

First, the Zoning Department issued the Building permit late in construction, without the Greenspace form.

Second, the City Inspectors accepted everything (after a few fixes).

Third, the Zoning Department issued an Occupancy Permit.

**What We Can Learn from This**

First, ignorance, lethargy and inaction take precedence over law in many business decisions. This is not the exact wording of the NSPE Code of Ethics. It is actually quite contrary to this Code which we swear to in order to get our PE licenses.

Second, bureaucracy in government sometimes works in favor of the individual (corporate individual). This can't be counted on, but should be considered in projecting consequences.

Third, the entire owner organization conspired to violate the City regulations. There were at least five professional engineers, responsible for the project, who did NOT recommend the legal alternative.

I was the electrical engineer and considered the problem and resolution non-electrical in nature. This is a cop-out. The NSPE Code of Ethics does not limit responsibility to the public to the documents carrying our seal. Responsibility to the public is supposed to be overriding (<http://www.nspe.org/Ethics/CodeofEthics/index.html>)fs.

## Case 5 - Employer Accepts Contract to Build Heavy Machinery without Brake

### The Situation

The machine in question is a tube-former. It takes a coil of steel at one end. It then rolls it into a tube. It then bends the tube into a programmed shape like a badly distorted circle. The final step is to deposit the form on a pallet, to be wrapped and shipped when full.

The employer makes big and small tube-formers. The one in question was mid-sized, intended to act as a door opening guard on a GM auto.

For unknown reasons I was invited to the design kick-off meeting.

### The Question

As the design basis was being reviewed, I asked, "Are we providing a mechanical brake to stop the machine when the e-stop cable is pulled?" (I had done the hook-up diagrams for many such machines, and they all had mechanical brakes, except this one.)

The salesman asked the buyer, "Do you want a mechanical brake?"

The buyer thought for a moment and said, "Yeah, sure."

Afterwards, the salesman was unhappy with me. He felt compelled to follow through on the budgetary pricing he had provided and he hadn't included a brake.

### The Alternatives

- A. Do not mention safety considerations when the design basis is being formed.
- B. Insist on a meeting-before-the-meeting to become acquainted with the "official line".
- C. Start with the assumption that the salesman knows a lot more than the engineer about the product and the buyer's needs.
- D. Continue to use best personal judgment and speak at critical times.

### Discussion of Ethics

Choice A is well represented by the German public's acceptance of Nazi atrocities preceding and during World War II (<http://www.davidicke.com/forum/showthread.php?p=662474>). It speaks well of one's loyalty to his employer but poorly to his compliance with the NSPE Code of Ethics.

Choice B was not feasible. The salesman did not spend time with designers. If the salesman took responsibility for the problem, he might have modified this pattern.

Choice C is incompatible with the common arrogance of engineers (ref Dilbert). This approach, again, demonstrates loyalty to the employer. (Actually, loyalty to the employer is extolled by the NSPE Code of Ethics and even more so by some State amendments.)

Choice D presents a recognized shortcoming of your writer. I feel it is moral and ethical and I am willing to accept the consequences.

**DIGRESSION**

A friend who proofread parts of this paper offered the following personal definition of ethics:

“Do what you know is the right thing unless the rewards for violation are great and you are willing to accept the consequences, if caught” (JP Mullin, traveling minstrel and raconteur).

I think that even the worst violators would agree (ref Enron, Arthur Anderson, Merrill Lynch, and WorldCom; Sarbanes-Oxley Act of 2002). Except, maybe, they disagree on actual consequences.

**Activity Selected**

This case was reported in the past tense. I asked the question and the tube former was built with the brake.

**Success of Selection**

I didn't hear about anyone being hurt by this particular machine, but I didn't hear about any of the other machines built during my tenure at this employer. I did hear that it had been bankrupt and reformed three times do to operator injuries.

**What We Can Learn from This**

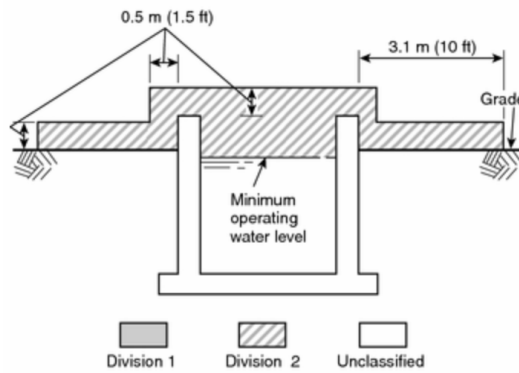
I learned that this was another place that I really didn't want to work for. One of the consequences, now, is that when I apply for a job, I have to explain the short duration of several of my jobs. The new employer doesn't want to hear about ethical differences. I have stories about driving distances.

Do we believe that employee and customer health and safety are primary concerns of American businesses? The news media constantly reports lapses, but, statistically, are survival rates more important than injury and death rates? Do we all love OSHA inspectors?

Case 6 - Large Consulting Firm Designs Wastewater Plant without Hazardous Buffer Spaces

**The Situation**

The NFPA 820 includes a graphic A.5.2 similar to the following on clearances required around open tanks of flammable substances: 18-in



There is no Division 1 (flammables normally present) but there is considerable Division 2 (flammables present under unusual conditions). Note the 10-ft extension of the Div 2 area, 18-in above grade.

A well respected major consulting engineering firm did a substantial upgrade design/construction on the plant in question. They built a 15kV electrical room adjacent to the incoming wastewater open channel. They placed a door to the substation within the 10-ft perimeter. The step and door swing was only 6-in above grade.

**The Question**

My employer was hired to do a hazardous area evaluation of the entire facility and report non-compliances.

We noted the electric room door in the Div 2 area of the incoming open channel.

The City wanted a report, not a construction project or a “smoking gun” should anything bad happen.

**The Alternatives**

- A. We could “miss” the non-conformance in our report.
- B. We could acknowledge the non-conformance and explain it away.
- C. We could note the non-conformance and offer corrective recommendations.

**Discussion of Ethics**

Choice A, to me, is intentional violation of the public trust. It was discussed by our consulting firm and with the City, but no one took it seriously (I hope).

Choice B was discussed and there was some sentiment on the City side to do this.

Choice C is the “white hat” response. It is compliant with regulations and the NSPE Code of Ethics.

**Activity Selected**

Choice C was selected and one of the recommendations was implemented about the time the final report was delivered.

**Success of Selection**

The situation had been non-compliant for about 6-years and there had been no consequences. There were no unfortunate results after digging out some gravel and earth at the steps.

**What We Can Learn from This**

I am proud that my employer chose this route. I am proud that we recommended walling up the door (solid walls are accepted to separate Div 2 from non-hazardous areas). I am proud that I came up with the idea of excavating at the step so that the grade was lowered to 18-in from the top of the step and the door swing.

What is the generalized conclusion?

First, large, national consulting firms make mistakes. It is not appropriate to trust them unquestioningly.

Second, The NEC requirement for documentation of the hazardous and non-hazardous areas (Section 500.4) is not generally recognized and provides genuine value when followed.

Third, innovation is possible and practical within the published Codes.

Case 7 - Large Government Agency Talks Safety But Doesn't install NEC or OSHA required Labels

**The Situation**

A large government agency is constantly talking, in-house and to the public, about their dedication to Safety, Health and Environmental Protection (SHEP).

A tour of their main facility reveals that switchgear, panels and motor starters do not have labeling required by the National Electrical Code and Occupational Safety and Health Act.

<b>DIGRESSION</b>
NEC Section 110.22 requires that each disconnecting means must be legibly marked to indicate its purpose. Section 110.16 requires warning of arc-flash hazard at all distribution equipment above 240V Section 210.5.C requires that facilities with multiple distribution voltages must utilize distinguishing wiring color codes and provide a label at each panel listing all of the voltages and colors used.
OSHA, through CFR 1910.132 and NFPA 70E require arc-flash labels that report available worst-case arc-flash energy in j/sq-cm and required personal protective equipment.

**The Question**

What is the new-hire electrical engineer to do?

**The Alternatives**

- A. Talk to the Manager of Electrical Engineering and propose interim labeling.
- B. Ignore it and demonstrate the value of silence learned in previous ethical situations.

**Discussion of Ethics**

Choice A has a lot to recommend it. It demonstrates loyalty, provides a test of the agency's true position and is private, so that consequences are not dictated by outside authorities.

Choice B has a lot to recommend it. The new EE is supposed to put marks on paper, not tour the facility and criticize previous projects and plant maintenance.

**Activity Selected**

I talked to my boss. He explained that efforts had been underway for at least three years to provide required labeling. In fact, the OSHA arc-flash labels had been calculated, but not printed.

The supervisor agreed that the new EE could purchase voltage labels and generic arc-flash labels from his own pocket and apply them at every opportunity.

**Success of Selection**

I bought the labels (\$20 total) and carry them around with the flashlight, screwdriver and lock-jaw pliers I am not supposed to have.



I have not applied any labels. I probably will not apply any labels. I have been thinking of the likely reaction when an electrician or electrical supervisor first discovers a “foreign” label. I see bad feelings being formed.

**What We Can Learn from This**

Intentional violation of the law has been disrespected earlier in this course. There should be a socially acceptable way to comply with the law. I urge the reader to apply his innovative skills.

## Case 8 - Published Company Safety Policies Exclude Visitors and General Public

### **The Situation**

A commercial business is constantly talking, in-house and to the public, about their dedication to Safety, Health and Environmental Protection (SHEP).

The published corporate SHEP policies all start with the same paragraph, "...applies to employees, contractors and subcontractors."

I was part of the summer picnic committee. The summer picnic was being justified as a group safety meeting. The selected topic was a game show version of Q & A on corporate policies. I offered question regarding the exclusion of visitors and general public from the policies.

All the rest of my questions were used. There was no comment on this set of excluded questions.

### **The Question**

Why are visitors and the general public excluded?

### **The Alternatives**

- A. The policies were created using word processing and the first draft of the first policy was reproduced extensively and never examined or edited.
- B. The policies were created in response to a government requirement or magazine article that listed employees, contractors and subcontractors. The reference didn't mention visitors or the general public.
- C. Someone in the legal department warned of liability if the firm claimed to take responsibility for visitors and the general public.

### **Discussion of Ethics**

Choice A indicates a lack of follow-through by the executives who issued the policies and the safety department that prepared them.

Choice B indicates a lack of follow-through by the executives who issued the policies and the safety department that prepared them.

Choice C indicates a high degree of respect directed toward the legal department but a failure of adherence to the NSPE Code of Ethics regarding public safety.

### **Activity Selected**

This is an after-the-fact review. I don't know how we got to where we are.

The policies are dated several years old and are not readily available. They were reproduced from unknown sources for our committee.

As indicated, there was no response from the executive heading the picnic committee. This may be a recurrence of the theme, "ignorance, lethargy and inaction are powerful forces in business decision making."

**Success of Selection**

A set of non-compliant corporate policies are in place.

**What We Can Learn from This**

Corporate policies should be reviewed at regular intervals and the NSPE Code of Ethics should be followed by technical persons involved in the task.

Case 9 - National Construction Manager Requires all Contractors and Subs Sign Safety Policy

**The Situation**

A national firm specializing in construction management was contracted for a large wastewater plant renovation in the Midwest. At the kick-off meeting of the CM, with engineers, contractors, subcontractors and invited safety representatives from each firm, a form was passed around for signing. It was requested that all persons working on the project get a copy of the form, sign it and return it to the CM.

The form is paraphrased as follows:

“I will read the Safety Manual and follow the rules at all times while on the job site. If I observe others violating the safety rules, I will immediately notify the CM office. Under no circumstances will I leave the job site without leaving notification with the CM (voice mail is acceptable).

I understand that non-compliance is reason for discipline and dismissal.”

**The Question**

Why don't more owners, contractors and construction managers do this?

**The Alternatives**

- A. Do it.
- B. Do something similar.
- C. Do something patently unworkable.
- D. Do nothing.

**Discussion of Ethics**

The NSPE Code of Ethics seems clear that each engineer has responsibility for public safety. The tone of the engineers' Code is toward construction documents and sealed reports.

It is an innovation to apply this concept to all time spent on a job site. This change is consistent with recent OSHA efforts, NFPA 70E and very public efforts of several large industrial firms

The required form appears to remove personal liability from reporting safety violations, though it does not explicitly provide whistle-blower protections.

Choices A, B and C are all dependent upon implementation. If seriously enforced, choices A and B would achieve the highest ethical goals, well beyond the NSPE Code.

Choice C implies wording to dissuade enforcement. With a strong safety department, though, a bad corporate policy might be used to achieve the highest imaginable results.

**Activity Selected**

Safety persons from the CM daily toured the site and talked to workmen and foremen. Each crew started the day with a brief safety meeting. Each construction meeting

started with a review of the week's safety incidents and asked each participant if they had seen anything that should be addressed.

**Success of Selection**

The job site that was the source of this case enjoyed a near-perfect safety record for the duration of the project.

**What We Can Learn from This**

A good, even extreme, policy and quality implementation can produce favorable results.

## Case 10 - Use of Diversity Factor in Sizing Distribution Equipment and Feeders

### The Situation

When I started electrical design, in the middle of the last century, my first boss told me, "It is extremely rare for industrial machinery to actually draw rated full-load current, even momentarily. Similar machines do not draw peak power at the same moment. At any given time, there are machines, even entire departments that are not in service.

We provide wiring to each machine sized for its rated full-load current. But, we usually provide a main panel or switchboard capable of providing less than 50% of the simple total of full-load currents. You will note that the plant utility meter never records more than 10% of the plant sum of full-load currents.

This is called *diversity*. It requires verification by periodically checking feeder and panel loading. That's why we have ammeters on main feeder circuits."

*Diversity* is not mentioned in the enforceable portions of the 2008 National Electric Code. It is mentioned in several non-enforceable footnotes and one table heading. It is used 8 times in the 2008 National Electric Code Handbook.

### The Question

Is diversity a valid concept if not defined and regulated by the NEC?

### The Alternatives

- A. Seek an interpretation from NFPA.
- B. Be very, very careful using *demand factor*, which is defined and regulated by the NEC.
- C. Continue using diversity as before.

### Discussion of Ethics

Choice A requires motivation on the part of the design engineer, with a firm expectation of no response or action (based upon the experience previous NFPA submissions).

Choice B is compliant with the NSPE Code of Ethics and well serves the public interest. The care in applying demand factors is that the tables are quite explicit and require effort for initial application and at least final coordination of equipment installed before release of the Bid Set.

Choice B is further complicated by few available demand tables in the NEC. There is nothing for tire building machines or CNC grinders or mist collectors.

Choice C includes choice B, with a little more judgment included.

### Activity Selected

I am pursuing Choice C.

**Success of Selection**

Up to and including the 2008 NEC this method has been satisfactory. Wording in the 2008 edition (Section 230.23), however, implies that future service sizing may be required to use the calculated w/sq-ft values, completely divorced from real-world loads.

**What We Can Learn from This**

There is a distance between the published electric Code and the practice of electrical design engineering. Good design results from ethical application of both experience and the Code. Simply following the Code is not adequate.

This would be a good place to beseech young, strong engineers to keep submitting NEC changes to try to bridge the gulf between the Code and the real world. This might apply to old, strong engineers, also.

FORM FOR PROPOSALS FOR 2011 NATIONAL ELECTRICAL CODE®

INSTRUCTIONS — PLEASE READ CAREFULLY
Type or print legibly in black ink. Use a separate copy for each proposal. Limit each proposal to a SINGLE section. All proposals must be received by NFPA by 5 p.m., EST, Friday, November 7, 2008, to be considered for the 2011 National Electrical Code. Proposals received after 5:00 p.m., EST, Friday, November 7, 2008, will be returned to the submitter. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

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Please indicate in which format you wish to receive your ROP/ROC [ ] electronic [ ] paper [ ] download
(Note: If choosing the download option, you must view the ROP/ROC from our website; no copy will be sent to you.)

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Company \_\_\_\_\_

Street Address \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Please indicate organization represented (if any) \_\_\_\_\_

1. Section/Paragraph \_\_\_\_\_

2. Proposal Recommends (check one): [ ] new text [ ] revised text [ ] deleted text

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted): [Note: Proposed text should be in legislative format, i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (deleted wording).]

Large empty rectangular box for proposal details.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that would be resolved by your recommendation; give the specific reason for your Proposal, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

Large empty rectangular box for statement of problem and substantiation.

5. Copyright Assignment
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Case 11 - Opening Energized Equipment for Observation or Testing

**The Situation**

An existing substation is needed for a current project. It hasn't been used since it was flooded ten years ago. It has been energized, providing security lighting, without recent inspection.

**The Question**

Are we going to follow corporate safety policy and de-energize for inspection or use arc-flash personal protective equipment and inspect it hot?

**The Alternatives**

- A. De-energize and inspect cold.
- B. Use PPE and inspect hot.
- C. No PPE and inspect hot.
- D. Hire a contract inspection firm.

**Discussion of Ethics**

Choice A is good corporate loyalty, NEC and OSHA. Certainly good NSPE Code.

Choice B involves considerable hazard, but protections are in place to limit consequences to "survivable burns" (<http://www.benchmarkfr.com/industries.html>).

Choice C is a bad idea. It is intentional violation of the law. Consequences are not limited to survivable burns.

Choice D is mostly-ethical. It limits liability, since it transfers it to the contractor. It is clearly ethical if the owner specifies OSHA-compliance and observes the work to verify compliance.

**Activity Selected**

We selected both C and D and didn't observe the contractor.

**Success of Selection**

The electrical foreman, electrician and I honestly thought there was a grounded plate behind the front cover, separating us from the energized busbars. There wasn't. The 480V copper was ~2-in from us swinging around the sheet metal cover (no hinges, big and heavy). We survived that and replacing the cover after taking pictures.

The contractor refused to tell the engineer the day he was going to open the cabinet until after it had passed. Interestingly, the engineer signed the requisition, and had included the requirement for witnessing. No contractor personnel were reported hurt or killed.

**What We Can Learn from This**

Now that I am aware of the normal safety level of our plant electricians, I will avoid being present when inspection work is performed. If I am there, and they continue such procedures, I am passively assisting in violating OSHA. I am actively violating the NSPE Code.

Next time, I will try harder to be present when the contractor does inspection work. I have an insatiable curiosity regarding theory and practice.

## Case 12 - Grounding 480V Feeders for New Equipment Tie-in

### The Situation

The contractor has requested to de-energize a main panelboard in order to terminate new incoming feeder conductors to a new circuit breaker. The published Safe Work Procedure states that they will ground the panel bus conductors.

### The Question

Will they really?

It is a Square D I-Line interior in a QED switchboard enclosure. It has excellent finger-safe power busses. I have been asking how they are going to ground the bus.

### The Alternatives

- A. De-energize, lock-out and tag-out, but do not ground the busses.
- B. Clamp on to the supply terminals on the source side of the panel.
- C. Rig up something that is grounded on one side and mates with the busses on the other side.

### Discussion of Ethics

Choice A is consistent with 480V work for the past 60 years, that I am aware of. It meets general standards of safety, but not the higher standard of the published Work Procedure.

Choice B is difficult. The source terminals are also finger-safe. There is no hazard associated with this effort, but possibly lost time, with the crew standing by.

Choice C is innovative and requires desk-time, if not crew field-time.

### Activity Selected

Choice A was selected.

Choice C was rejected due to time constraints and lack of interest. As motivated by preparation of this course, I have investigated Square D offerings for the I-Line Panels. They sell a 1200A molded case switch (non-automatic mccb) which is rated 100kA withstand (with a 100kA operating breaker upstream ([http://ecatalog.squared.com/pubs/Circuit%20Protection/Molded%20Case%20Circuit%20Breakers/Thermal%20Magnetic%20Molded%20Case%20Circuit%20Breakers/PA-PC-PH%20Circuit%20Breakers%20and%20Accessories/0601CT9101R12\\_03.pdf](http://ecatalog.squared.com/pubs/Circuit%20Protection/Molded%20Case%20Circuit%20Breakers/Thermal%20Magnetic%20Molded%20Case%20Circuit%20Breakers/PA-PC-PH%20Circuit%20Breakers%20and%20Accessories/0601CT9101R12_03.pdf), pdf page 145). This information will be presented to the current project construction manager and the plant electrical engineer for possible use in the future.

### Success of Selection

The shutdown went well.

### What We Can Learn from This

Safety advances are good, even if not mandated by OSHA or NSPE. It is possible to ground out low-voltage panels without extraordinary efforts.

### Case 13 - Testing IT Panels for Overload and Documentation

#### **The Situation**

Corporate management and IT management agree that the existing power distribution system in the data center should be documented and available capacity recorded.

Neither corporate nor IT want an unplanned shutdown.

#### **The Question**

How to trace the equipment power cords to see where they are plugged in without touching them? How to trace the power source circuits from plugstrips back to the panel without a flasher or tone injection tracer?

#### **The Alternatives**

- A. Schedule a weekend or late night testing session so that an unplanned shutdown can be accommodated.
- B. Try to be very careful during the day, perhaps after 5 PM.
- C. Give up and go work on something where you can make progress.

#### **Discussion of Ethics**

Please see Case 2, Selection of Copper or Aluminum Conductors. There seems to be a recurring theme on conveying engineering knowledge to decision makers.

Choice A was unacceptable to IT. The staying up late was the unacceptable. I offered to do the testing with no charge-back or request for comp-time off.

Choice B was unacceptable. IT was in the habit of coming in early to do software installs. They didn't want to work both early and late. I couldn't bear to get up at 4AM, but the opportunity was never offered.

Choice C sounds like dereliction of duty and abrogation of engineering responsibilities to the firm.

#### **Activity Selected**

The testing was never scheduled. Choice C prevailed.

#### **Success of Selection**

Documentation of power circuits and available capacity was never performed.

Two years later, the firm authorized ~\$50,000 to expand the computer room and install a new power panel and new circuits to the new racks. IT designed the connections of equipment to plug strips and circuits.

#### **What We Can Learn from This**

A previous case suggested that ignorance, lethargy and inaction are powerful forces in technical decision making. In this instance, ignorance, lethargy and inaction won again.

There is no governmental mandate to document data center power circuits. However, every voluntary guide published recommends such documentation. The recommendations do not address the possibility of unplanned shutdown resulting from the power cable connection verification.

## Case 14 - Surge Protection Devices at Building Entrances

### The Situation

The National Electric Code requires surge protection devices for every electrical service where they enter a building (Section 708.20.D, "Surge protection devices shall be provided at all facility distribution voltage levels). Section 285 discusses tiered application of SPD's at the power service, at the distribution panel and at the load panel (see also UL 1449, *Standard for Surge Protection Devices*).

### The Questions

- Why are SPD's so rarely observed at building power services?
- Why are tiered SPD's almost never seen?

### The Alternatives

- A. Include Type 2 SPD's at service, branch panels and significant loads on current and future designs.
- B. Apply Type 2 SPD's selectively on panels feeding critical equipment.
- C. Sit down with the design manager and negotiate SPD's into the design basis.
- D. Ignore SPD's

### Discussion of Ethics

Choice A appears to meet the standards and implications of the NSPE Code of Ethics. The devices are clearly required in some instances and provide value to the owner in every case. [SPD's perform cumulatively. Best protection is from one at the service entrance. Spikes that get past the first are further attenuated by the second and even more by the third. Another consideration is that most disturbances are internally generated at the facility ([http://www.engineeringtoolbox.com/electrical-transients-d\\_822.html](http://www.engineeringtoolbox.com/electrical-transients-d_822.html)) and best addressed close to the source. Note that production copiers are well-known as major internal transient sources (<http://www.wisconsinpublicservice.com/business/surge.aspx>)]

Choice B appears to address NEC requirements and the NSPE Code of Ethics, while observing the business mantra of cost containment.

Choice C has the advantage of offering an opportunity for development of favorable personal interactions, establishing a reputation of technical expertise and being a team player. If handled well, Choice A may result. If unsuccessful, you can blame him or her instead of yourself. Make sure you document the meeting for use in later recrimination meetings.

Choice D seems to satisfy the criterion indicated earlier, "ignorance, lethargy and inaction take precedence over law in many business decisions."

### Activity Selected

I have been pursuing Choice B on recent projects. I am not sure if I am proud of this decision or if I would recommend it if consulted by another engineer. I am weak. I avoid confrontations.

### Success of Selection

Actually, I get compliments from end-users. The IT folks don't get much input into most facility designs and they are pleased when their needs are met. I always put SPD's on panels in network closets. Remember, equal value would be achieved from SPD's on panels that serve large copiers and HVAC and factory equipment.

**What We Can Learn from This**

Engineers are compelled to use economic current technology for the benefit of the end-users (public, as NSPE says). The question remaining is, "How strong are you in pursuing public benefits that add cost to the project". This is a gradation scale.

**DIGRESSION**

I did electrical design for a series of speculative warehouses for a builder. The goal was absolute least-cost of construction, with the expectation that the buyer or tenant would spend his money to add frills he wanted.

The builder deleted the SPD's at the service panel and office panel.

My justification for agreeing was that the buyer or tenant was being required to do electrical design before move-in, so the SPD's were only being transferred, not eliminated. Was this a cop-out?

## Case 15 - Applying Short-Circuit Withstand Ratings

### The Situation

The National Electric Code requires that electrical equipment (distribution and end-use) be applied within its ratings (2008 NEC 110.9, Interrupting Rating). In order to comply, the specifier must know the available short-circuit current at the point of application.

The available short-circuit current value requires somewhat difficult and tedious calculations or a \$10,000 software program.

I have never had available short-circuit current values available for any design job I have worked on.

### The Question

How to comply with the NEC?

### The Alternatives

- A. Learn to do the computations or convince your boss to buy the \$10,000 software.
- B. Get a demo version of the software and run 840 typical cases with different transformers and feeder types and feeder lengths.
- C. Make SWAGs.

### Discussion of Ethics

Choice A is a textbook answer. In the real world, few persons have motivation to spend discretionary time learning new skills. In the real world, few supervisors really want 10x billable hours invested in something as arcane as short-circuit calculations. In the real world, few firms will spend \$10,000 on software that they can't back-charge to a client or project.

Choice B resulted in a new PDH course, Simplified Calculation of Available Short-Circuit Currents. The tables can be downloaded for free. (PDHonline.org) Data cannot be copyrighted.

Choice C means that you try hard to get the available short-circuit current from the utility and do the simple  $I_{sc} = KVA/VI-I/\sqrt{3}$  to see the  $I_{sc}$  at the transformer terminals. This is a real-world value and is a valid guide for downstream connections. Downstream connections must have lower  $I_{sc}$ ; you guess how much lower.

### Activity Selected

As indicated, up until the current month, I have pursued Choice C. Earlier this month, I submitted the tables of 840 software results for more accurate SWAG's.

### Success of Selection

All of the arc-flash hazard literature starts out with catastrophic cases of gear misapplied to the available short-circuit current. This is an unfavorable evaluation of the Choice C ([http://www.accessmylibrary.com/coms2/summary\\_0286-20898004\\_ITM](http://www.accessmylibrary.com/coms2/summary_0286-20898004_ITM)).

### What We Can Learn from This

I am proud of my constructive response to the problem. I hope that design engineers will have the opportunity to demonstrate motivation to use the simplified method. I



hope that design firms will invest in the modeling software and provide the best SWAG's to design projects.

Case 16 - When You Learn to Fake Sincerity, You Can Achieve Anything

**The Situation**

In 1997, my son started asking difficult questions about truth and ethics. I enrolled him in an ethics course at The University of Chicago.

We still talk about this weekly. He is now a graduate student at Harvard, so I listen more than I talk, but I still object to invalid observations and conclusions that don't track from the observations.

Son has identified the universal truth that, "When you learn to fake sincerity, you can achieve anything" (DJ Mason, Lawrence Berkeley National Laboratory).

**The Question**

Barrack Obama refuses to release his personal health report, his college grades or any of the written work he did while in college or as editor of the law review during his college days.

We elected him because we believe that he has good intentions and is sincere towards implementing government that furthers these good intentions.

Lacking facts, we chose apparent sincerity.

**The Alternatives**

- A. Extensively explore all sources of information available on the internet and choose a President who has performed in a way that matches your goals and beliefs.
- B. Watch the television debates and select the candidate whose stated intentions and demeanor you find most persuasive.
- C. Give up as impossible the gathering of valid information on the candidates and follow your "gut reaction" or the recommendation of someone you trust.
- D. Stay home and don't vote.

**Discussion of Ethics**

Choice A brings the immediate response that the media generally fell in love with Obama. There was very little factual information reported by the mainstream media and personal blogs are suspect as to accuracy and slant. (Mainstream media is suspect as to accuracy and slant, also.)

There were valid critical facts and opinions available over the internet, but they were few.

Choice B brings to fore how artificial the television debates were. It appeared that each candidate just waited his turn to read his prepared speech. They had good speech writers and presented the material persuasively.

Choice C gets a lot of support. If we agree that we are unable to get information to make a meaningful decision, at least we feel good with the decision we end up making.

Choice D is rational, but reason is not rewarded in our society.

**Activity Selected**

We chose Barrack Obama over John McCain.

Choice C is widely credited with being responsible for most of the votes cast, on both sides.

**Success of Selection**

This course is being written between President Obama’s selection and inauguration. The reader is better able to evaluate the success of the selection than is the writer.

**What We Can Learn from This**

The example of the US presidential election tends to support the initial hypothesis that, “When you learn to fake sincerity, you can achieve anything.”

I’m not sure I learned anything from this example. John Kennedy had serious medical problems that he hid from the public (<http://www.doctorzebra.com/Prez/g35.htm>). Franklin Roosevelt had serious medical problems that he hid from the public (<http://www.doctorzebra.com/Prez/g32.htm>). Would full disclosure have improved the quality of decisions we made in 1932, 1944 or 1960?

JFK and FDR were supremely successful in transmitting sincerity to the public. It is now known that FDR was working to change public opinion from anti-Brit to pro-Brit. He supported isolationism until public opinion swung sufficiently. Is that “faking sincerity”?

JFK officiated over both the Bay of Pigs fiasco and the Russian-missiles-in-Cuba crisis. Was he fully candid with the public or was he “faking sincerity”? Current history (sic) reports that the resolution of the Cuban missile crisis was our removing missiles from Turkey, not television posturing.

**DIGRESSION**

It continues to amaze me how history changes. In an audio course on Judaism, the professor stated that , “Not even God can change history. Only historians can change history.” (This is a well known reference to a story in the Torah about biblical scholars refusing God’s intervention in their discussion.)

In the context of the current discussion of Presidents and public perception and the changing course of history regarding specific events, I have been extremely interested in the rehabilitation of Richard Nixon (<http://openlibrary.org/b/OL1117614M>).

It will be very interesting to see how historic perspective of the Bush years develops.