BICSI
BALTIMORE
SPRING CONFERENCE & EXHIBITION, MAY 10-13
2009
ELECTRICAL POWER DISTRIBUTION FOR INFORMATION TRANSPORT SYSTEMS

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PARSONS
Your ITS equipment requires AC power...

- Do you know what is on the other side of that receptacle before you plug it in???

- What you should know (and do) before you plug it in!!!
How we got where we are...

• Then... (1843-1955)

- Telecommunications equipment and networks largely powered by local battery installations and large centralized DC power sources (e.g. Central Offices), typically at 24/48/130 VDC.
How we got where we are…

• Then… (1843-1955)

- Majority of telecommunications equipment was electromechanical (CO/PBX switching systems, telephone sets, teletypewriters, etc.).
How we got where we are...

• Then... (1843-1955)

  - Electronic equipment (audio/voice amplifiers, carrier equipment, RF transmitters and receivers, etc.) used in telecommunications networks and systems utilized electron tubes and hard-wired discrete components.
How we got where we are...

• Then… (1843-1955)

- Use of batteries and associated charging equipment effectively isolated equipment and networks from commercial AC power variations and disturbances and maintained service in the event of a commercial AC power failure.

- Equipment was largely immune to all but the most serious power disturbances.
How we got where we are...

• Then… (1843-1955)

  ▪ Service Providers (AT&T, Western Union, etc.) had almost total control of equipment installation and maintenance.

  ▪ Limited need to utilize commercial AC power, especially at the customer premises.
How we got where we are…

• Transition… (1955-1975)

  ▪ Installation of key systems (1A, 1A1, 1A2) and small PBX systems began.
How we got where we are...

• Transition… (1955-1975)
  
  - Invention of transistor (1956) begins introduction of solid-state equipment
  - Modem installations at customer premises for data communications usage begins.
How we got where we are...

• **Transition…** (1955-1975)

  - FCC Carterfone Decision (1968) allows connection of customer-owned equipment to the telecommunications network.

  - Use of commercial AC power at the customer premises for powering telecommunications equipment begins to increase.
How we got where we are...

- Now… (1975-Present)
  
  - ITS equipment and networks are almost exclusively electronic and computer-based.
  
  - Most, if not all, ITS equipment utilizes integrated circuit technology.
  
  - Reduced use of centralized DC power sources.
How we got where we are…

• Now… (1975-Present)

- ITS equipment is now a “consumer” item, similar to other generic electronic equipment and appliances.

- A large need to utilize commercial AC power at customer premises for ITS equipment !!
ITS Power Requirements and Trends

- Availability
- Reliability
- Stability

- ITS power needs have been and are growing exponentially!

- Equipment and systems are becoming more efficient in terms of power usage...

...but there is an ever-increasing number being installed!
Overview of Typical Electrical Power Distribution System

GENERATION (11-24 KV)

STEP-UP SUBSTATION

TRANSMISSION (138-765 KV)

STEP-DOWN SUBSTATION

SUB-TRANSMISSION (66-138 KV)

STEP-DOWN SUBSTATION

DISTRIBUTION
PRIMARY (2.4-34.5 KV)
SECONDARY (120-480 V)

UTILIZATION
• Normally, both primary and secondary distribution systems utilize either:

  ▪ Wye-connected 3-phase circuits with multi-grounded neutrals.
  
  ▪ Center tapped single-phase circuits with multi-grounded neutrals.
General Commercial AC Service Characteristics (cont.)

• These arrangements provide:
  
  ▪ The greatest degree of flexibility for connecting loads.

  ▪ Generally a high degree of voltage stability.

  ▪ A high degree of protection for equipment and personnel in case of faults and rapid detection and clearance of faults in conjunction with appropriate overcurrent and fault detection devices.
In certain cases, three-phase circuits may utilize delta instead of wye connection schemes for items such as motors, transformers and similar equipment.
Depending on the distribution and utilization voltages and the size of the connected load, the associated transformers, switchgear, and over-current/fault detection and protection equipment may be provided by both the customer and the serving electrical Utility.
Typical Primary Distribution Voltages (Single-Phase/Three-Phase)

- 2400/4160 Volts Wye
- 4800 Volts Delta
- 7200/12,470 Volts Wye
- 7620/13,200 Volts Wye
- 14,400/24,940 Volts Wye
- 19,920/34,500 Volts Wye
- 13,800 Volts Delta
Secondary Distribution and Utilization

- Single-Phase - 120/240 volts
Secondary Distribution and Utilization (cont.)

- Three-Phase - 120/208 volts (scheme A)
Secondary Distribution and Utilization (cont.)

• Three-Phase - 277/480 volts
Secondary Distribution and Utilization (cont.)

- Three-Phase - 120/208 volts (scheme B)
Secondary Distribution and Utilization (cont.)

- Typical Secondary Branch Circuit Arrangements - 120/240 volts
Secondary Distribution and Utilization (cont.)

• Typical Secondary Branch Circuit Arrangements - 120/208 volts

![Diagram of Distribution Panelboard with 120/208V Wye 3-Phase Feeder]

- 208V
- 120V
- WHITE
- BLACK
- RED
- BLUE
- GREEN

EQUIPMENT GROUNDING CONDUCTORS

PANELBOARD GROUND
Secondary Distribution and Utilization (cont.)

• Typical Secondary Branch Circuit Arrangements - 277/480 volts
• Special Cases - 120/208 volt and 277/480 volt metropolitan networks

- Transformer and protector in underground vaults
- Secondary lines along alleys/streets
- 120/208 volt wye or 277/480 volt wye three-phase network
- Primary feeders 12470/34500 volt three-phase
- Transformer and protector in underground vaults

TO LOADS
Secondary Distribution and Utilization (cont.)

- Special Cases - 120/208 volt and 277/480 volt spot networks

Diagram:
- Primary Feeders: 12470/34500 Volt Three-Phase
- Network Transformer and Protector
- 277/480 Volt Wye Three-Phase Bus
- Step-Down Transformers
- 120/208 Volt Wye Three-Phase Bus
- To Utilization Panelboards
Typical Unit Substation and Metal-Clad Switchgear Used in Spot Networks
What is your role in the process for obtaining AC power for ITS systems and equipment?
1. Understand That This is a **Team Effort**!

Some or all of the **KEY PLAYERS** (besides yourself) involved in furnishing and meeting your ITS AC power requirements:

- Electrical Engineers,
- Electricians/Electrical Contractors/Facilities Maintenance Personnel,
- Electrical Utility Personnel,
- Access/Service Provider Personnel,
- Facility/Building Owners,
- The Authority(ies) Having Jurisdiction (AHJ).
2. Determine ALL of Your ITS AC Power Requirements

• Include ALL of your ITS spaces and equipment - this could include, in some cases:
  - All CLA (Communications, Life Safety and Building Automation) elements,
  - Work Area/ end-user requirements and remote locations.

• Include loads related to test equipment used for maintenance and diagnostics, and equipment loads related to MAC (moves, adds and changes).
2. Determine ALL of Your ITS AC Power Requirements (cont.)

- Identify which equipment is to be directly connected (i.e. hard-wired) and which equipment is to be cord-and-plug connected through a receptacle; also identify the correct NEMA plug and receptacle configurations required.

- If applicable, include auxiliary loads (e.g. lighting, HVAC) within your ITS spaces.

- Include loads required for Access/Service Provider Equipment.

- Allow for at least a 25 percent growth factor.
2. Determine ALL of Your ITS AC Power Requirements (cont.)

- Identify ALL of your individual loads in terms of voltage, amperage, and wattage.

- Separate your loads by required operating voltage (e.g. 120, 120/240, 120/208, 277 or 277/480 volts).

- Are your loads single-phase, three-phase or a combination of both?

- Group loads by location.

- Develop a detailed summary of your requirements.
3. Special Areas to Consider

- Grounding/Bonding

- Overcurrent/fault protection equipment:
  - Selection and sizing
  - Coordination

- Load demand characteristics (continuous, cyclical or intermittent)

- Load balancing

- Load segregation
3. Special Areas to Consider (cont.)

- Need for power conditioning

- Reactive versus non-reactive power loads:
  - Reactive (large inductive and capacitive loads because of motors, transformers and similar equipment that result in a significant lagging or leading Power Factor).
  - Non-reactive (all or mostly resistive loads such as incandescent lighting, heating and similar equipment that result in a unity or a reasonably close to unity Power Factor).
3. Special Areas to Consider (cont.)

- Reactive loads are normally stated in kilovolt-amperes reactive (KVAR), non-reactive loads are normally stated in kilowatts (KW).

- The total of both reactive and non-reactive loads are normally stated in kilovolt-amperes (KVA).
3. Special Areas to Consider (cont.)

- Service continuity for critical loads
- Locations of AC Power Equipment used for ITS loads and related access and security issues:
  - Service equipment
  - Panelboards
  - Transformers
  - Power conditioning equipment (UPS, etc.)
- Codes, Standards and other published requirements
4. Discuss Your AC Power Needs With the Key Players

- Practice the “three C’s” when meeting with the Key Players:
  - Communicate…
  - Coordinate…
  - Cooperate !

- Support your needs and requirements with clear, complete, factual documentation (drawings, specifications, equipment data, calculations, etc.).
4. Discuss Your AC Power Needs With the Key Players (cont.)

- Meet with the Key Players as early as possible and as often as necessary.

- Understand their requirements and limitations in meeting your needs and be prepared to negotiate!

- If necessary, don’t forget to discuss and agree on testing, acceptance, labeling and documentation tasks related to the AC Power system for your ITS installation.

- All agreements between you and the Key Players relating to technical, contractual, financial or legal areas should be in writing.
5. Moving Forward and Making it Work

• Continue to meet with the Key Players as the work progresses.

• Make sure you are informed about any changes made to the AC power system that may or will affect your ITS equipment during the installation. Likewise, inform the Key Players if your AC power needs change before completion of the installation.

• Keep up your end of the bargain regarding any agreements made for things like testing support, field coordination and similar items.
6. After the Installation

• Make sure you are informed about any changes made to the AC power system that may or will affect your ITS equipment. Likewise, inform the Key Players if your AC power needs change.

• Keep your records up-to-date!

• If possible, coordinate any ITS inspection efforts with any premises electrical inspections. Pay special attention to:
  ▪ Bonding/Grounding integrity,
  ▪ General condition and cleanliness of AC power installations supporting ITS installations,
  ▪ Unauthorized additions or modifications.
Conclusion

• A proactive approach to AC power needs for ITS equipment and systems will result in:
  - Less downtime
  - More reliable operation
  - Satisfied customers
  - Lower maintenance costs
Some Useful References

- NFPA 70 – National Electrical Code
- BICSI Telecommunications Distribution Methods Manual; Chapter 16 – Power Distribution
- IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
- IEEE 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book)
- IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book)
- IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book)
- IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book)
- Electrical Power Distribution and Transmission by Faulkenberry and Coffer (Prentice-Hall)
- Standard Handbook for Electrical Engineers by Beaty and Fink (McGraw-Hill)
- American Electrician’s Handbook by Croft and Summers (McGraw-Hill)
- Ugly’s Electrical References by Hart and Hart (Burleson)