PDHonline Course E191U (5 PDH)

2006 Introduction to Electrical Construction Specifications (Audio Version)

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2006 Introduction to Electrical Construction Specifications

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Course Content

Part I Course Introduction

The construction specifications presently in almost universal use are based upon the CSI 1995 format. (For discussions of who CSI is and how the specifications are organized, please jump ahead to Part II). The two large commercial sources for construction specifications are CSI (Construction Standards Institute) and BSD (Building Systems Design). The current list of electrical specifications offered by these two firms follows. You will note that the numbers don't always exactly line up. The 1995 format specs are still available from both firms and are not expected to be abandoned.

2005 (1995-Style) BSD SpecLink+	**2005 (MF95) AIA /Arcom MasterSpec**
01300 - Administrative Requirements for submittals procedures	
01400 - Quality Requirements	
01600 - Product Requirements (substitutions)	
16000 - Electrical (no content)	
16050 - Basic Electrical Materials and Methods (no content)	16050 - Basic Electrical Materials and Methods
16051 - Overcurrent Protective Device Coordination Study	
	16055 - Overcurrent Protective Device Coordination
16060 - Grounding and Bonding	16060 - Grounding and Bonding
16070 - Hangers and Supports	
	16071 - Seismic Controls for Electrical Work
16075 - Electrical Identification	16075 - Electrical Identification
	16080 - Electrical Testing
16095 - Minor Electrical Demolition	
16100 - Wiring Methods (no content)	
	16020 - Conductors and Cables
16121 - Medium-Voltage Cable	
	16122 - Undercarpet Cables
16123 - Building Wire and Cable	
	16124 - Medium-Voltage Cables
16125 - Undercarpet Cable	
16127 - Manufactured Wiring Assemblies	
	16130 - Raceways and Boxes
16131 - Conduit	
16132 - Surface Raceways	

16133 - Underfloor Ducts	
16134 - Cable Trays	
16135 - Utility Columns	
16138 - Boxes	16138 - Underfloor Raceways
16139 - Cabinets and Enclosures	16139 - Cable Trays
16140 - Wiring Devices	16140 - Wiring Devices
	16145 - Lighting Control Devices
16155 - Equipment Wiring	
16200 - Electrical Power (no content)	
16210 - Electrical Utility Services	
16215 - Electrical Sensing and Measurement	16215 - Electrical Power Monitoring and Control
16231 - Packaged Engine Generators	16231 - Packaged Engine Generators
16232 - Rotary Uninterruptible Power Supply	
16243 - Emergency Power Supply	
16261 - Converters	
16263 - Static Uninterruptible Power Supply	
	16264 - Static Uninterruptible Power Supply
	16265 - Central Battery Inverters
	16269 - Variable Frequency Controllers
16271 - Pad-Mounted Distribution Transformers	16271 - Medium-Voltage Transformers
16272 - Dry type transformers	
	16280 - Power Factor Correction Capacitors
16281 - Power Factor Capacitors	
	16289 - Transient Voltage Suppression
16300 - Transmission and Distribution (no content)	
16311 - Overhead Line Materials	
	16315 - Overhead Electrical Distribution
16341 - Switchgear	16341 - Medium-Voltage Switchgear
16342 - Air Interrupter Switches	
16343 - Medium-Voltage Oil Switches	
16344 - Medium-Voltage Motor Controllers	
16360 - Unit Substations	
	16361 - Secondary Unit Substations
16400 - Low-Voltage Distribution (no content)	
	16410 - Enclosed Switches and Circuit Breakers
16411 - Enclosed Circuit Breakers	
16412 - Enclosed Switches	
16413 - Enclosed Transfer Switches	
16414 - Remote Control Switching Devices	
	16415 - Transfer Switches
	16419 - Fused Power Circuit Devices
	16420 - Enclosed Controllers
16422 - Peak Load Controllers	
16423 - Enclosed Motor Controllers	

16424 - Motor Control Centers	
16425 - Variable Frequency Controllers	
16426 - Enclosed Contactors	
	16430 - Switchgear
	16441 - Switchboards
16442 - Switchboards	16442 - Panelboards
16443 - Panelboards	16443 - Motor-Control Centers
16450 - Enclosed Bus Assemblies	
16451 - Feeder and Plug-in Busway	
	16461 - Dry-Type Transformers (600V and Less)
16470 - Power Distribution Units	16470 - Power Distribution Units
16491 - Fuses	16491 - Fuses
16500 - Lighting (no content)	
16510 - Interior Luminaires	
	16511 - Interior Lighting
16520 - Exterior Luminaires	
	16521 - Exterior Lighting
16526 - Obstruction and Landing Lights	16526 - Sports Lighting
16555 - Theatrical Lighting	16555 - Stage Lighting
	16570 - Dimming Controls
16700 - Communications (no content)	
16710 - Structured Telecommunications Cabling and Enclosures	
16721 - Telephone Service, Pathways, and Wiring	
16722 - Nurse Call System	16722 - Nurse Call
16723 - Intercom System	
16781 - Television Distribution System	
16800 - Sound and Video (no content)	
16821 - Public Address and Music Equipment	
9999 - Section Template	

The current list of 2004 format electrical specifications offered by these two firms follows. You will note that the early Division numbers come much closer to exactly lining up. The point here is that electrical specifications are now Div 26 and section numbers within Div 26 do not closely match the old section numbers within Div 16..

2004 CSI Spec Numbers

MasterSpec	**SpecLink+**		
Full Section	**Division**	**Full Section**	**Description**
(none)	00		Procurement and Contracting Requirements (empty)

none		00 0	Introductory Information
none		00 1	Procurement Requirements
none		00 5	Contracting Requirements
01 0000	01		General Requirements (empty)
		01 0	General Requirements (empty)
01 1000		01 1	Summary
		01 2	Price and Payment Procedures
		01 3	Administrative Requirements
01 3300		01 3000	**Submittals, Submittal Procedures**
		01 4	Quality Requirements
		01 5	Temporary Facilities and Controls
		01 5100	**Temporary Utilities**
		01 6	Product Requirements
01 6000		01 6000	**Submittals and Substitutions**
		01 6600	**Product Storage and Handling** (empty)
		01 7	Execution and Closeout Requirements
		01 8	Performance Requirements
		01 9	Life Cycle Activities
		01 9113	**Commissioning**
	02-14		Facility Construction Subgroup - Div 02 - 14
02	02		Existing Conditions
03	03		Concrete
04	04		Masonry
05	05		Metals
06	06		Wood, Plastics, and Composites
07	07		Thermal and Moisture Protection
08	08		Openings
09	09		Finishes
10	10		Specialties
11	11		Equipment

12	12		Furnishings
13	13		Special Construction
14	14		Conveying Equipment
	21 -28		Facility Services Subgroup - Div 21 - 28
21	21		Fire Suppression
22	22		Plumbing
23	23		HVAC (look for supplied disconnects and single-point power)
(none)	24		(reserved for future use)
(none)	25		Integrated Automation (empty)
26	26		Electrical (empty)
		26 0000	Electrical (empty)
		26 0100	Operation and Maintenance of Electrical Systems (empty)
26 0500		26 0500	Common Work Results for Electrical (Materials and Methods)
(none)		26 0501	Minor Electrical Demolition
26 0513		26 0513	Medium-Voltage Cables
26 0519		26 0519	Low-Voltage Electrical Power Conductors and Cables
26 0519.13		26 0520	Under carpet Cables
(none)		26 0521	Manufactured Wiring Assemblies
26 0526		26 0526	Grounding and Bonding for Electrical Systems
26 0529		26 0529	Hangers and Supports for Electrical Systems
26 0533			Raceway and Boxes for Electrical Systems
(none)		26 0534	Conduit
(none)		26 0535	Surface Raceways
26 0536		26 0536	Cable Trays for Electrical Systems
		26 0537	Boxes
26 0539			Under floor Raceways for Electrical

			Systems
26 0543		26 0540	Under floor Ducts
26 0548			Vibration and Seismic Controls for electrical systems
26 0553		26 0553	Identification for Electrical Systems
26 0573		26 0573	Over current Protective Coordination Study
(none)		26 0600	Schedules for Electrical
(none)		26 0800	Commissioning of Electrical Systems
(none)		26 0900	Instrumentation and Control for Electrical Systems
26 0913		26 0914	Electrical Power Monitoring
(none)		26 0915	Peak Load Controllers
(none)		26 0916	Electric Controls and Relays
(none)		29 0917	Programmable Controllers
(none)		26 0918	Remote Control Switching Devices
(none)		26 0919	Enclosed Contactors
26 0923			Lighting Control Devices
26 0933			Central Dimming Controls
26 0936			Modular Dimming Controls
		26 1000	Medium-Voltage Electrical Distribution
		26 1100	Substations
26 1116		26 1116	Secondary Unit Substations
		26 1200	Medium-Voltage Transformers (empty)
26 1200		26 1200	Medium Voltage Transformers
		26 1300	Medium-Voltage Switchgear (empty)
26 1300		26 1300	Medium-Voltage Switchgear
(none)		26 1321	Air Interrupter Switches
(none)		26 1322	Medium Voltage Oil Switches
		26 1800	Medium-Voltage Circuit Protection Devices
(none)		26 1839	Medium-Voltage Motor Controllers
		26 2000	Low-Voltage Electrical Transmission
(none)		26 2100	Low-Voltage Overhead Electrical Power Systems
(none)		26 2101	Overhead Line Materials
		26 2200	Low-Voltage Transformers
26 2200		26 2200	Low-Voltage Transformers
26 2300		26 2300	Low-Voltage Switchgear

		26 2400	Switchboards and Panelboards
26 2313			Paralleling Low-Voltage Switchgear
26 2413		26 2413	Switchboards
26 2416		26 2416	Panelboards
26 2419		26 2419	Motor-Control Centers
26 2500		26 2500	Enclosed Bus Assemblies
		26 2501	Feeder and Plug-In Busway
		26 2600	Power Distribution Units
26 2600		26 2600	Power Distribution Units
		26 2700	Low-Voltage Distribution Equipment
		26 2701	Electrical Service Entrance
26 2713			Electricity Metering
(none)		26 2716	Electrical Cabinets and Enclosures
(none)		26 2717	Equipment Wiring
(none)		26 2723	Indoor Service Poles
26 2726		26 2726	Wiring Devices
		26 2800	Low-Voltage Circuit Protectives
26 2813		26 2813	Fuses
26 2816			Enclosed Switches and Circuit Breakers
		26 2817	Enclosed Circuit Breakers
		26 2818	Enclosed Switches
		26 2900	Low-Voltage Controllers
26 2913		26 2913	Enclosed Controllers
26 2923		26 2923	Variable-Frequency Motor Controllers
		26 3000	Facility Electrical Power Generating and Storing Equipment
(none)		26 3100	Photovoltaic Collectors
		26 3200	Packaged Generator Assemblies
26 3213		26 3213	Engine Generators
(none)		26 3229	Rotary Converters
26 3233		26 3233	Rotary Uninterruptible Power Units
		26 3300	Battery Equipment
(none)		26 3305	Battery Emergency Power Supply
26 3353		26 3353	Static Uninterruptible Power Supply
(none)		26 3500	Power Filters and Conditioners
		26 3513	Capacitors
26 3533			Power Factor Correction Equipment
		26 3600	Transfer Switches

26 3600		26 3600	Transfer Switches
		26 4000	Electrical and Cathodic Protection
		26 4100	Facility Lightning Protection
26 4113		26 4113	**Lightning Protection for Structures**
		26 4200	Cathodic Protection
26 4200		26 4200	Cathodic Protection
26 4313		26 4313	Transient Voltage Surge Suppression
		26 5000	Interior Lighting
26 5100		26 5100	Interior Lighting
(none)		26 5200	Emergency Lighting
(none)		26 5300	Exit Signs
(none)		26 5400	Classified Location Lighting
(none)		26 5500	Special Purpose Lighting
(none)		26 5537	Obstruction and Landing Lights
26 5561		26 5561	Theatrical Lighting
		26 5600	Exterior Lighting
26 5600		26 5600	Exterior Lighting
26 5668			Exterior Athletic Lighting
	27		Communications
		27 0100	Operation and Maintenance of Communications Systems
27 0500		27 0500	Common Work Results for Communications
27 0513			Conductors and Cables for Communications
		27 0600	Schedules for Communications
		27 0800	Commissioning of Communications
		27 1000	Structured Cabling
		27 1005	**Structured Cabling for Voice and Data - Inside-Plant**
27 1100		27 1100	Communications Equipment Room Fittings
27 1300		27 1300	Communications Backbone Cabling
27 1500		27 1500	Communications Horizontal Cabling
		27 1600	Communications Connecting Cords, Devices and Adapters
		27 2000	Data Communications
		27 2100	Data Communications Network Equipment

		27 2200	Data Communications Hardware
		27 2400	Data Communications Peripheral Data Equipment
		27 2500	Data Communications Software
		27 2600	Data Communications Programming and Integration Services
		27 3000	Voice Communications
		27 3100	Voice Communications Switching and Routing Equipment
		27 3200	Voice Communications Telephone Sets, Facsimiles and Modems
		27 3300	Voice Communications Messaging
		27 3400	Call Accounting
		27 3500	Call Management
		27 4000	Audio-Video Communications
		27 4100	Audio-Video Systems
27 4133			Master Antenna Television System
		27 4200	Electronic Digital Systems
		27 5000	Distributed Communications and Monitoring Systems
		27 5100	Distributed Audio-Video Communications Systems
27 5116			PUblic Address and Mass Notification Systems
		27 5117	Public Address Systems
27 5119			Sound Masking Systems
27 5123		27 5124	Intercom Systems
		27 5132	Television Systems
		27 5200	Healthcare Communications and Monitoring Systems
27 5223		27 5223	Nurse Call / Code Blue Systems
		27 5300	Other Distributed Systems
27 5313		27 5314	Clock Systems
	28		Electronic Safety and Security
		28 0000	Electronic Safety and Security
		28 0100	Operation and Maintenance of Electronic Safety and Security
28 0500		28 0500	Common Work Results for Electronic Safety and Security
28 0513			Conductors and Cables for Electronic

			Safety and Security
		28 0600	Schedules for Electronic Safety and Security
		28 0800	Commissioning of Electronic Safety and Security
		28 1000	Electronic Access Control and Intrusion Detection
		28 1300	Access Control
28 1300		28 1300	Access Control
		28 1600	Intrusion Detection
28 1600		28 1600	Intrusion Detection
28 1643			Perimeter Security Systems
		28 2000	Electronic Surveillance
		28 2300	Video Surveillance
28 2300		28 2300	Video Surveillance
		28 2600	Electronic Personal Protection Systems
		28 3000	Electronic Detection and Alarm
		28 3100	Fire Detection and Alarm
		28 3100	**Fire Detection and Alarm**
		28 3105	Fire Alarm System Equipment
28 3111			Digital, Addressable Fire-Alarm System
28 3112			Zoned (DC loop) Fire-Alarm System
		28 3200	Radiation Detection and Alarm
		28 3300	Fuel-Gas Detection and Alarm
		28 3400	Fuel-Oil Detection and Alarm
28 3500		28 3500	Refrigerant Detection and Alarm
		28 4000	Electronic Monitoring and Control
		28 4600	Electronic Detention Monitoring and Control Systems
28 4619			PLC Electronic Detention Monitoring and Control Systems
	31 - 35		Site and Infrastructure Subgroup, Div 31 - 35
		31	Earthwork
		32	Exterior Improvements
		33	Utilities
		34	Transportation (empty)
		35	Waterway and Marine Construction (empty)
	40 - 48		Process Equipment Subgroup, Div 40 -

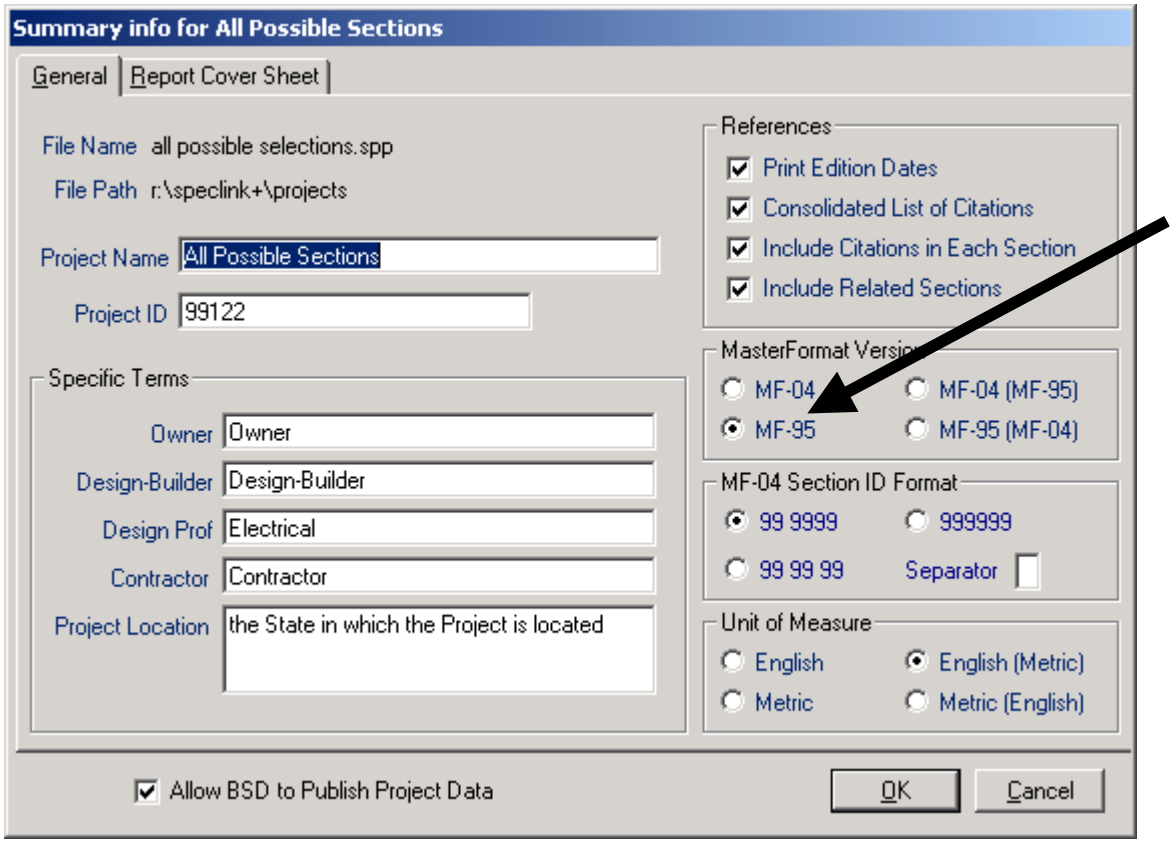
			48
		40	Process Integration
		41	Material Processing and Handling Equipment
		42	Process Heating, Cooling, Drying Equipment
		43	Process Gas and Liquid Handling, Purification and Storage
		44	Pollution Control Equipment
		45	Industry-Specific Manufacturing Equipment
		48	Electrical Power Generation
			Unassigned Sections
		90 1115	Green Building Requirements (user)
		90 2200	Site Preparation (user)
		90 2836	Mechanically Stabilized Earthen Retaining Walls (user)
		90 7724	Roof Hatches and Vents (user)
		91 3100	Lightning Protection (user)
		91 3100	Lightning Protection (user)
		91 3852	Fire Alarm System (user)
		91 5054	Water Soluble Flux (user)
		91 6721	Telephone Service, Pathways, Wiring (user)
		00 0000	3-Part Section Template

The bold specifications are referenced in the later discussions.

Explanatory Narrative	This explanatory narrative is your author's observations and opinions. This material is not included in the quiz. CSI sells different packages of their specifications. Every specification listed in the CSI column is available from CSI, individually for $110.00, including editor's notes for intelligently filling out the project specific areas. The definition of the new format can be purchased for $160. A number of very good .pdf articles are available at http://www.csinet.org/s_csi/sec.asp ?TRACKID=&CID=1377&DID=11339 BSD dreams a lot. Approximately one-half of the spec numbers listed in their column have no content. There is no promise that specifications to match will be forthcoming. On the other hand, the titles indicate items which should be specified and it may be possible to find a public domain spec on the internet by searching,

	using the dream number as a key. The lists above have expanded electrical sections; every electrical spec (and communications and security) is listed. In addition, all of the Divisions are listed and Div 01 is somewhat expanded. This ties in to Part II which discusses how submittal and substitution requirements should be defined for a project in Dv 01 and referenced from electrical. Very interesting information is contained in the Div 90 and Div 99 sections. These are user-provided specs which were stored in my employer's 1995 format SpecLink library and would not translate into 2004 format. This tells us that EVERYTHING BSD sells in the 2005 format is translated from their 1995 library - there are presently no additions.

BSD permits hands-off conversion between the CSI 1995 and CSI 2004 formats, using the radio button on the project summary information popup, located under the FILE menu. A sample follows:



Explanatory Narrative	Is there a new internal format to CSI specifications? Well, kinda. CSI promises that it will be released last year. It has not been approved internally, so it is unlikely that any translations have

	begun. PDHonline will offer a course on writing in the new CSI format as soon as it is released.

Part II Introduction

Part II of this course is separated into sections which speak generally about specifications. Separate PDHonline courses are offered for individual specifications, but examples are offered here from published construction specifications. If you are seeking immediate value and answers to the quiz questions so you can renew your license, please go lists of rules without delay. If your learning style requires that you understand what is going on "behind the curtain", then please read the explanatory narratives.

Explanatory Narrative	Construction specifications exist for a number of reasons - for the designer to communicate to the constructor - to permit the Owner and Construction Manager to verify what they are paying for and what they hope to get - to help determine which components are in the base bid and which are extras - to help the judge or arbitrator decide if the screwups were the designer's fault. Each of these situations has happened around me many times. You may not share the experience, so I will relate some anecdotes. Note, however, that we are talking $10,000, $100,000 or $1,000,000+ in consequences. Use this course as a guide for initiating discussions with your boss and project leader. Do not take any material here as bona fide engineering or legal advice. The designer is responsible for "design intent". The constructor is responsible for "means and methods". If the designer has a valve spec which states, "Locate supply and return isolation valves for each plumbing device in a readily accessible location", then the constructor knows they are required and he chooses the locations. Any awkward locations require rework - at the constructor's cost. If the designer has a valve spec which states, "locate supply and return isolation valves for each plumbing device as shown on the drawings", then any awkward locations result in extended discussion as to whether or not the constructor was following the drawings. Any isolation valves that were missed are clearly project extra costs - not in the bid documents or materials take-offs. The Owner wants a "first-class, but not gold-plated" job. Most of the visible, key details are discussed and documented. Electrical

details are not discussed. Wiring can use copper or aluminum conductors. Raceways can be heavy rigid steel, intermediate rigid steel, steel tubing, aluminum, flex, plastic, and in some cases, plastic jacketed conductors without raceway. Jobs have gone to bid without a clear statement on raceways. Many, many jobs require different raceway constructions in different areas. Very careful words are required for communication and agreement of all parties.

For several years, data jack devices were a problem. The electrical designer and electrical contractor put in empty conduits and empty boxes. The data or communications designer and contractor pulled the wires, terminated the wires to the jack devices and installed a cover plate. For unknown reasons, the jack devices "slipped through the cracks". They are available in a wide range of styles and nothing gets supplied unless it is called out on drawings or in the specs.

Today I know of several projects which call for wire tags and conduit tags but do not call out type, size, manufacturer or model number. I did QA review and noted the deficiency, but no one followed up. It may not be noticed until the drop ceilings are in place and all the equipment is buttoned up. I think we paid for the tags, but no one is going to install them for free at the end of the project.

I have not been deposed or appeared in court in 30-years of electrical design. That is good fortune for me and the projects I worked on. I make mistakes. I issue specifications with typos. (I think I do fewer than when I started out, but they still exist.) Let me tell you what I have heard over the cubicle walls.

The engineer specified a 120/208 V replacement elevator. During installation, the contractor noted that all building power was 120/240 V. This is a spec error and should be a liability to the design firm. By the grace of the Fates, the VFD supplied was dual-rated, 120/208V 3-ph / 120/240V 1-ph. This dual-rating did not show up in any of the invoicing, but was clear on the nameplate and instructions. A design manager mandated that all future construction drawings state that the constructor is responsible for verifying system voltage and rating of materials being provided.

This is a spec problem with a spec solution, but I would prefer

	more care during design and total avoidance of the discrepancy. The voltage problem showed up on another project involving HVAC electric reheat terminals. The manufacturer did not build the unit for the required voltage. No one noticed the discrepancy between the HVAC and electrical designs.. A lot of negotiation resulted in the addition of a number of transformers. I believe that the design firm contributed funds to the transformers purchase.

Explanatory Narrative	WARNING: No one reads specifications. Everyone in the design / construction trade wants to build another just like the last one. If the last one required steel tubing to protect electrical conductors, you can say heavy rigid steel many times and they still think tubing, will price tubing and install tubing if no one stops them. I have seen this situation result in $10,000x cost increases and I have seen the tubing installed, everyone smiled and everyone walked away. This is one of the big differences between “bid” documents and “as-built” documents. Today, however, there is no such thing as “as-built” documents, only endorsed checks for the service. Now, obviously, this discussion was of extreme cases. But, they are real cases, and repeated often. If no one reads specifications, why do we invest so much effort in writing, distributing and revising them? A big part is that there are conscientious Inspectors, Construction Managers and Constructors. A good estimator prices heavy rigid steel when you ask for it. A good engineer rejects submittals for thin wall tubing where rigid steel was specified. An honest contractor who lowballs the job by not reading the spec eats the cost when the spec is clear. A very big part of this is the role of the various inspectors. No one wants to go on record approving reduction of the quality of the project. Everyone involved may agree they would be just as happy with less, but no one will sign it. Sometimes, intense effort is invested to change the inspector’s report to also overlook the problem. I have a friend who left a good concrete testing job because of the stress.

Explanatory Narrative	What about Owner's specs, spec services, proprietary specs and roll-your-own specs? For 20 of my 30 years in this business, I thought everyone was smarter than me. I used my employer's specs. I used very old MasterSpecs (MasterSpec is the brand-name of construction specifications from CSI, sold by Arcom). I used vendor specs. It was before the internet and I had not encountered government public domain construction specs. Today, I use whatever source I am told to use, but I edit a lot. I include parts that relate to the current job and make it better. I delete parts that do not relate to the current job or damage the quality of the result. Today, I add a few sections routinely. These will be discussed in detail later. Owner's specs are usually bad and often very, very bad. One firm required a cast iron safety switch which had been replaced by a MicroSwitch 10 years previously. We mentioned it on each job, then followed the Owner's wishes. The manufacturer scheduled a special production run for them. The Owner went out of business. The problem is that construction technology changes. In the three years between each issue of the National Electric Code, many new sections describe approved methods. Each of these meets a need and provides economies to contractors and Owners. Owner's specs and old copies of MasterSpec will not include these innovations. I have very strong bad feelings about using vendor's specs. I work with some manufacturer's representatives who are the best of engineers (skilled, experienced PE's) and get repeat business by providing the right materials and services at competitive prices. I work with some manufacturer's representatives who are recent business graduates and cannot pronounce the words in the glossy literature. Who is going to answer to the Owner or to the Judge if it a bad spec results in an improper application and someone dies? If my name and seal are on the design, I want reason to think the requirements were correct - not trust in a salesman or parent firm.

Explanatory Narrative	What is critical in spec writing and editing? Really and truly, your best chance of communication is in the first

	paragraph. Say, “heavy rigid steel conduit” or “addressable analog photo electric smoke detectors”. It really belongs in Part 2 - Products, but they will read it here and no one can complain that the requirement was hidden in the fine print.

Origin of CSI Construction Specs

AIA, The American Institute of Architects, has been around since 1857. National membership costs $272 per year. State and local memberships are also required to participate. The AIA has created standard contracts, standard specifications and is involved in standard drafting practices and a range of additional standards activities. AIA is many things; specifications are a small but important part.

AIA works for architects. Every detail of every activity is to benefit architects. Very often the interests of project architects and consulting engineers (structural, civil, HVAC, plumbing, electrical, technology, etc) coincide. However, when the interests are not common, everything that AIA does is to favor the architect.

AIA set up CSI and contracted with Arcom to sell the standard specifications. Today, they talk about “partnerships”, but the relationships are very, very close.

CSI, The Construction Standards Institute, is now the author of record for CSI specifications. Membership costs $210 per year. CSI sells a guide for writing your own specifications to CSI 2004 format for $160. The page format guide costs $33 for the 1999 edition. A revision is overdue and presently unpriced. The CSI website contains links to Arcom and BSD. There are a preponderance of AIA members ($272/yr) in direction and managerial roles at CSI. CSI does nothing but specifications.

Arcom, Architectural Computer Services Inc, claims that MasterSpec is a product of the AIA. They claim a special, close link with AIA. They make little mention of CSI. The downside is that it is unclear who you go to for fixing a content problem in the specifications. The upside is that you get a set of well thought-out specifications with very strong credentials. Note that use of CSI wording is an absolute defense in legal action involving “standard of competence”.

In summary, AIA --> CSI --> Arcom --> MasterSpec

Arcom sells MasterSpec for $110 per spec, with many packages of groups available. MasterSpec is delivered in a form with hidden guidance text and optional paragraphs. Tiffany Neilson at Arcom told me that if you buy one year of service and do not renew you cannot continue to use those specifications. The biggest complaint against MasterSpec is the standard form which includes a choice of supplier paragraphs. The first says, “provide from one of the following manufacturers.” The second says, “provide from one of the following manufacturers OR EQUAL.” Almost every project spec book contains one spec where the engineer left both paragraphs in. Sometimes, a spec book has all specifications in a Division containing both paragraphs.

Arcom is a publishing house, selling CSI format specs and many other items.

BSD, Building Systems Design, has been around since 1983. Their 2003 product was made up of vendor specs with just the slightest effort to make them biddable. Their 2006 product is much better. The specifications do not carry the vendor names, genuine alternate sources are included and the wording is better in describing necessary product features. BSD is not closely linked to AIA and keeps a proper distance from CSI. Any changes to SpecLink come directly from BSD.

In summary, AIA --> CSI --> BSD --> SpecLink

BSD sells SpecLink for $1,795, single user. As with MasterSpec, there are many packages, but there are no single specs. Nikki Pierce at BSD told me that if you buy one year of service and do not renew, you can continue to use those specifications indefinitely and revise them yourself as you see fit. You will not get updates from BSD and you cannot use the database software. That is, you can export the complete specs in rich text format and they are yours.

SpecLink uses a different model than MasterSpec. With MasterSpec you get the spec. Next year you get a new spec. Any revisions you have made locally do not carry forward. With SpecLink, you get a sophisticated database manager a library of lines of specification and a repository for the linked lists you create for each project. You choose individual lines of each spec that you wish to use. Your development screen shows “grayed out” the lines you did not choose. You can add lines. Next year, you get some new lines for specifications. You decide if you want to accept the changes. You keep your lines. You can keep the old lines if you wish.

SpecLink Sections tend to be thin. They do not have as much technical detail as MasterSpec, do not include equipment ratings to choose from and often do not include vendors. It takes more work to get a good spec out of SpecLink, but it is much more reusable. The weight of SpecLink in court is not clear.

BSD is a publishing house, selling CSI format specs and many other items.

Content of CSI Specs

In this section we intended to show all the electrical spec titles that are recognized by the Construction Specifications Institute. Because of the addition of Part I, the list has already been displayed.

Here in Part II, we are focusing on the content, not the names or numbers. The project work defined by the electrical specifications (Div 16 or 26) are as follows:

- Scope of Work
- Equipment
- Materials
- Incidental Materials
- Demolition
- Cutting and Patching
- Roof, Floor and Foundation Penetrations
- Receiving and Storage
- Incidental Foundations, Shims and Grouting
- Cables, Conduits, Boxes and Supports
- Testing, Test Reports, Demonstration and Training
- Submittals and O&M Manual
- Temporary Power and Lighting
- Services from Subcontractors
- Coordination with Other Trades and Subcontractors
- Use of “or equal”
- Schedules or Lists
- Bypassing the Specifications

This is your author’s list of items which must be addressed in the specification package. We will discuss them individually.

Scope of Work
You have to tell the electrical contractor what he is being asked to do. Is he fully responsible for all aspects of the job, or is he working with other trades? Every project has geographic limits. Is he working exclusively within one building or does he have to upgrade the main feeder in another building? Does he have to buy a new feeder breaker or is there a spare available? Does he have to do a coordination study on the new feeder circuit?

Who gets salvage on removed materials? Or, who gets toxic waste handling on fluorescent light ballasts and a lamps?

Are asbestos or lead products present?

Amazingly, most projects to not have a clear scope of work statement. It is valuable to include one in your 16050 or 26 0500.

Related to Scope of Work is Design Basis. In HVAC a particular chiller or rooftop unit has supply, return and drain connections at specific locations and has a prescribed set of outside dimensions and weight. A substitution will almost certainly have different connection locations, outside dimensions and weight. Some designers identify the unit they have designed to as “Design Basis” and demand that the contractor pay for redesign to any substitution.

Clearly this destroys the opportunity to competitively bid the unit, both in cost and shifted liability.

Receiving and Storage

The National Electrical Code now requires that indoor-rated equipment be protected while waiting during construction. (2005 NEC 110.11). It is good to require proper handling and storage in several specifications, certainly 16060 or 26 0500. Coordinate with front end sections on receiving and storage, 01600 or 01 6000. (Coordinate means, make sure your wording doesn’t conflict with their wording. Some project leaders forbid restating same content in two sections. Make sure 01600 exists if you reference it.)

We will look at the internal organization of the CSI spec format next, but Part 3 - Execution, is the correct place to define acceptable handling and storage for particular items.

Equipment

Usually, equipment to be purchased by the electrical contractor is well-defined by specification. It is important to explicitly state that, “all pieces and parts required for normal operation are included, whether explicitly identified or not.” A certain steam turbine manufacturer (1,000 HP+) routinely forgets portions of the controls. If the spec clearly states that the goal is operation, not the checking off of a parts list, it helps. Another fine set of weasel-words is, “including but not limited to....”

Pay special attention to specified References in Part 1 - General. UL makes good standards, including testing/acceptance methods and labeling of accepted products. There are many manufacturer trade firms which certify anything from a member.

Materials
For us, materials means big-ticket, large quantity supplies which are used at the discretion of the electrical contractor. Conduit, conduit fittings, building wire, instrumentation cable and big boxes and little boxes are good examples. Almost always, the contractor chooses the routing for wire, conduit and supports. The Owner and Engineer don't much care if a particular run is 125-ft or 150-ft. We do care that he use 90-degree building wire, rigid steel conduit, steel electrical strut, two hole conduit straps with backs and explosive anchors or expansion shields. We usually want steel boxes, but sometimes reinforced plastic boxes. We want to tell him when to use steel boxes and when to use reinforced plastic boxes.

Except on the smallest job, the correct answer is to include full-blown Hangers and Supports for Electrical Systems 26 0529 / 16070, Raceway and Boxes for Electrical Systems, 26 0533 / 16131 and Low-Voltage Electrical Power Conductors and Cables 26 0519 / 16123. Better include Identification for Electrical Systems 26 0553 / 16075.

CRITICAL ADD-IN: Always include an Conduit Application Schedule in Part 3 – Execution of your Conduit Spec, 26 0533 / 16131. It should look something like the following:

Conduit Application	Above Grade	Below Grade	Outdoors	Buried or Duct
Exposed Admin	RGS min 3/4-in	RGS min 3/4-in	RGS min 3/4-in	n/a
Exposed Process	RGS min 3/4-in	RGS min 3/4-in	RGS min 3/4-in	n/a
Concealed Admin	EMT min 3/4-in	EMT min 3/4-in	EMT min 3/4-in	Sch 80 PVC, min 1-in
Concealed Process	RGS min 3/4-in	RGS min 3/4-in	RGS min 3/4-in	Sch 80 PVC, min 1-in
Chemical Handling, Open Water	Coated RGS min 3/4-in	Coated RGS min 3/4-in	Coated RGS min	n/a
Admin Motor Conn	MC, min 3/4-in	MC, min 3/4-in	Liquid tight flex min 3/4-in	n/a
Process Motor Conn	Liquid tight flex min 3/4-in	Liquid tight flex min 3/4-in	Liquid tight flex min 3/4-in	n/a
Data Receptacle	RGS min 1-1/2-in	RGS min 1-1/2-in	RGS min 1-1/2-in	
Data Backbone	RGS min 4-in	RGS min 4-in	RGS min 4-in	Sch 80 PVC, min 4-in

Key	RGS – Rigid Galvanized Steel EMT - Electrical Metallic Tubing (Thinwall) Sch 80 PVC - Heavy Duty Polyvinyl Chloride			

Explanatory Narrative	What about these “smallest jobs” that don’t get a spec book and individual electrical specifications for each category? I recommend an expanded Materials and Methods, 25 0500 / 16050, including the Conduit Application Schedule. List acceptable hangers and support, conduits and boxes, conductors and cables and identification. You should have a “canned” spec with this information from a recent job and just edit it. The downside of using 25 0500 / 16050 is that you have to anticipate every thing that will come up. The Application Schedule helps, because it is exhaustive.

Continuing with CSI spec content

Incidental Materials
Do you call out conduit fitting sizes and materials? No. In the conduit spec, simply say, “Provide necessary incidental materials to match conduit and sized (min) per NEC”. The exception is when you or the Owner want pullboxes every 200-ft, more frequently than the NEC minimum of 360-degrees and at the pulling tension limit of the cable.

There is no spec section for incidental materials, but you can detail as much as you like in the Conduit Spec, 26 0533 / 16131.

Conductor terminations are usually included in Building Wire and Cable 26 0519 / 16123 There are nasty gotcha’s if you do not specify application of terminations. The main grounding electrode can only be spliced or connected to with crimp, bolt-on or exothermic welding devices specially rated by UL for this use. Motor leads should never be terminated with spring connectors - just crimped ring-tongue terminals and nuts and screws. This information should appear in the wire spec or materials and methods spec.

Incidental Foundations, Shims and Grouting
The right way to handle the installation of large equipment (10-HP and larger) is to spend some project hours with the structural engineer and let him prepare installation details and specifications. Electrical engineers tend not to be good with concrete mixes and testing, reinforcing steel bars and motor alignment. There is usually a poured concrete spec in the Civil Division and an equipment

alignment section in the Process Division. Reference these from the electrical Division.

Demolition
Some projects have a large, identified electrical demolition component. The electrical contractor must remove lights, wiring and equipment. This is very common in a renovation job. Because there are so many details associated with demolition, it is best to use The Division 2 section on demolition. For minor electrical demolition, use Minor Demolition, 26 0501 / 16095.

The best approach is to assign a temporary storage location for toxic materials (fluorescent ballasts and lamps, anything with lead paint), but, regardless, make sure it is clear that responsibility for training of workers to handle the toxics and final disposal of the toxics and non-toxic waste. Occasionally the Owner wants salvage of particular pieces.

Cutting and Patching
All electrical projects involve cutting and patching, especially renovations. Electrical Materials and Methods, 25 0500 / 16050 or Conduit, 26 0533 / 16131 are good places for it. Key points are “paint to match existing” and “fire stop penetrations as required to maintain existing or proposed fire rating.” Note that fire stopping (non-shrink grout around conduits or UL-rated material) is required on new construction and is the responsibility of the electrical contractor.

Roof, Floor and Foundation Penetrations
Roof penetrations must be coordinated with the roofing contractor to maintain the roof warranty. Floor penetrations must be fire stopped and done to avoid an upstairs flood becoming a downstairs flood. (Note NEC 368.10.C.2.b, which requires a 4-in concrete curb around electric floor openings.)

Foundation penetrations must be sealed to avoid water and gas flow. Both outside the conduit and inside the conduit must be sealed.

The proper place for these instructions is Materials and Methods, 25 0500 / 16050 or Conduit Spec, 26 0533 / 16131. We will address overlap between specifications later.

Testing, Test Reports, Demonstration and Training
This is an evolving topic. For years, emergency generators have had instructions in the Part 3 - Execution for testing, witnessing, test reports and training. Part of this is NFPA-110 (National Fire Protection Association, Standard for Emergency

and Standby Power Systems, latest is 2005 Edition). Similar requirements have been applied to fire alarm systems, large motors (500HP+) and switchgear.

It is only recently, however, that the concept of commissioning has been applied to the power distribution system, lighting system and such. The front-end specs have broad-brush testing requirements, General Commissioning / 01 9113. Detroit Public Schools requires a Electrical Acceptance Tests, 16150, which is in the Appendix to this course. Interestingly, DPS 16150 references DPS 16010, Commissioning, which is also reproduced in the Appendix.

A very good method is to include acceptance testing criteria in each spec, Part 3 – Execution. For Instance, in Grounding and Bonding, 16060 / 26 0525, say, "Measured resistance to distant ground for the system ground field shall be less than 10 ohms. Apply conductive salts or additional ground rods at 10-ft intervals until criterion is reached."

CRITICAL ADD-IN: Always require a legibly signed and dated report be submitted within three days of the test. Contractors don't like to do the tests, don't like to be responsible for the results, don't want you to be able to ask questions of someone who was there and would rather forget to turn in any report.

Submittals and O&M Manual

First, you must confirm the project scope with your project leader. Does the Owner want an organized file of approved submittals? Does the Owner want organized, bound Operation and Maintenance Manuals? If yes, then you must advise the electrical contractor of his responsibilities and expect to invest considerable of your own hours hounding him and in clerical work. Many public works projects have requirements for submittals and O&M manuals which are supposed to be enforced by the Construction Manager.

Cleveland Department of Water has an excellent checklist for O&M contents. It is included in the Appendix. To the best of your author's knowledge, not first submission has ever fully satisfied the checklist, unless most of the items were inapplicable.

Submittal Procedures 01 3000 / 01399, is the right place for instructions to all contractors on the project. In theory, you can reference this requirement in each Section of the Division 26 / 16 package. As indicated above, you can expect the electrical contractor to try to avoid submittals and the O&M requirements. A documented personal contact by the Project Leader to establish a delivery schedule will help.

CRITICAL ADD-IN: Note items 3.e and 3.f, running line amps and running vibration, mils rms, at the bearing, in the X- and Y- directions. This information is

critical in later maintenance and readily available during start-up. Get it into the Maintenance and Operation book.

Temporary Power and Lighting
The electrical contractor usually provides temporary power and lighting for all trades. On a large project, this can be a massive undertaking and specification is in order. Temporary Utilities, 01 5100 is very detailed. If it is not being included in the front-end, then you should add a paragraph to Electrical Methods and Materials 25 0500 / 16050, "Provide construction power, min 120V/20A/GF/4-recept for each trade in each active working area. Provide construction lighting, min 30-fc for each trade in each active working area."

Allowances, Pass-thru and Roll-in for Services from Subcontractors
Almost every project requires electrical services closely allied to electrical but not normal electrical contractor tasks. The project leader has to decide how to pay for these, but the electrical specifier must define the work to be performed. Payment options include allowances, pass-thru and roll-in. An allowance is direction to the electrical contractor that he will get $10,000 to provide a personal computer workstation. Pass-thru directs the electrical contractor to buy the personal computer workstation as specified and to invoice the project for actual cost plus ten percent handling charge. Roll-in ignores the issue and directs the contractor to include the cost in his base bid.

The specifier must define the service, personal computer workstation, theatrical lighting and control system or electric service from the Utility. The specifier needs to know the payment intentions because they electrical contractor or Construction Manager will ask.

Coordination with Other Trades and Subcontractors
On most construction projects, the trades work with respect and consideration for each other. However, a project with late delivery penalties may strain goodwill. It is common for each Div 26 / 16 specification to include a paragraph directing the electrical contractor to coordinate his work with other trades. The front-end of the bid set should explain that back charges will not be accepted for tear-our and re-do resulting from lack of coordination.

Use of "Or Equal"
There is great inconsistency here, so please do not consider this discussion definitive for your project. Many governmental Purchasing Departments are required by law to accept materials from any firm who offers the product. Many engineers feel strongly that only tested and accepted materials should be used.

The result is that, just before bid, a governmental Purchasing Department may require that all supplier lists be edited to add “or equal”. Many engineers almost comply by adding “or approved equal”, sometimes, “or engineer-approved equal.”

The underlying problem is that no one has read the front-end spec 01300 which clearly defines submission of equal materials. In some process or limited space situations, there is a big problem with “equals”. In most commodity situations there is very little problem. But, since no one reads 01300, we argue over the wording in 16130, etc.

Private firms have the option of accepting low-bid or not. Similarly, they can require materials from a single supplier, “no equal”. Many private firm Purchasing Departments, however, have internal metrics to rate each purchasing agent on savings achieved. The purchasing agent can claim savings by opening the bid to more suppliers. Often this is done by a phone call between the supplier and the purchasing agent, without engineering participation.

EXAMPLE: Unnamed place needed a replacement electric water heater. The maintenance supervisor specified a manufacturer and part number. Purchasing bid it and accepted a different manufacturer. The delivered water heater would not fit in the space under the steps where the old one was located. Instead of repiping out into the hall, they returned the tall heater for the specified short one.

Schedules or Lists

I recently issued a job which involved buying 14 standby generators and 14 automatic transfer switches. I made a table and put it at the end of the generator spec and the identical table at the end of the automatic transfer switch spec. After I was off the job, the number of generators changed. The list in the generator spec was revised but the list in the transfer switch was not revised. This demonstrates the importance of presenting information only one place in the construction documents. On a drawing sheet is fine. In the generator spec and ref from the switch spec. In the switch spec and reference from the generator spec. Not two places.

Bypassing the Specifications

During bidding or during construction there is a very high likelihood that the Contractor will speak with the Owner about savings available by relaxing the specifications. In every case, the cost is substantially reduced. In some cases a portion is rebated back to the owner. The real problem, however, is liability. If the engineer specifies materials, problems go to the engineer. If the contractor gets the Owner to accept inferior materials, the problems will still go to the engineer.

CSI Specification Format (template)

A construction specification should look like a construction specification, not like a technical memo and not like an invoice.

The header and footer (CSI 1999 format) looks like this:

Owner Project Name / Location		Issue Date
	(spec text)	
Project Number	(spec number) – (page number)	Spec Name

The spec text (CSI 1999 format) looks like this:

[header]

SECTION 16131

CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A Conduit, fittings and conduit bodies

1.02 RELATED SECTIONS

A. Section 02582 - Underground Electrical Ducts and Manholes

1.03 REFERENCES

A. ANSI C80.1 - American National Standard Specification for Rigid Steel Conduit - Zinc Coated, 1994

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittals

procedures

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for Damage

[footer]

[header]

PART 2 PRODUCTS

2.01 SECTION INCLUDES

A Conduit Size: Comply with NFPA 70.
1. Minimum Size: 3/4-in unless otherwise specified.

2.02 MANUFACTURERS

A. Allied Tube & Conduit

[footer]

[header]

PART 3 EXECUTION

3.01 EXAMINATION

A Verify that field measurements are as shown on drawings

3.02 RELATED SECTIONS

A. Install conduit securely, in a neat and workmanlike manner, as specified in NECA 1.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07840.

[footer]

MAJOR WARNING: Make sure referenced specs are in bid set. It looks really bad to reference something that is not included.

The above sample pages are included to indicate the formatting and layout used internally for CSI specifications (1999 standard). The complete specifications in the appendix may help if the format use is not clear.

We are talking about CSI format. Be aware that prime engineering firms and Owners often have their own standard specifications and formats. (A prime engineering firm takes on the whole project but subs out portions, as electrical for various reasons, including meeting Minority Business Enterprise quotas.) The other specs may or may-not use CSI division numbers or internal format. It is non-trivial to convert from one format to another which is "very nearly the same". Very careful proofreading is required. Project leaders do not allocate enough time for conversion and proofreading.

Sometimes it is very difficult to edit a specification you are given. Each organization, however, usually has a "master secretary" who can do the job. The alternative is for a "journeyman secretary" to retype the spec on a clean sheet.

When you attempt to edit the specifications yourself, you discover an interesting "feature" of Microsoft WORD - auto indent. As soon as WORD figures out that you are making a numbered list, it tries to help. Unfortunately. It spaces between paragraphs different that specifications do and it tabs differently than specifications do. A highly skilled secretary can modify the WORD features to work on specifications. I cannot. Therefore, I turn off auto indent and the "feature" of converting readable fractions to unreadable characters, 1/8 --> ⅛

Duplicate and Overlapping Specifications

Do you want both a Materials and Methods, 25 0500 / 16050 and a Conduit Spec, 26 0533 / 16131 ? the 16050 conduit section is short and lists only key features which are important for this job. The 16131 tends to include a lot of boiler-plate, which is not appropriate to this job, but may be if the scope changes again.

There are three, conflicting rules, as follows:

- Use only 16050 on small jobs and only 16131 on large jobs
- Use both, with each referencing the other.

- Take the 16131 stuff out of 16050 and issue both. 16050 must reference 16131.

The “clean” approach is the first. One complete spec for each area. No duplications means no conflict. This is clearly the intent of both MasterSpec and SpecLink, which eliminated 16050.

My present employer and previous employer typically issued both. I think no one ever read our specs.

Your instructor recommends the third alternative. It eliminates the editing burden of changing both when a chance is made and largely eliminates conflicts. It keeps the 16050 spec, which is a good place for job scope and battery limits (physical extents). Having a 16050 provides a place for peculiar things that come up late in the project, without renumbering anything.`

Final Review of Specifications before Issue

1) Leaf through paper copies. Are the headers, footers, margins, numbering and layouts consistent?

2) Check the Reference paragraph of each electrical spec. Are the referenced specs in the set. Make sure that no additional references show up in Part 3 - Execution.

3) Make sure there is a Section Includes paragraph in every spec and that it matches the spec content. If you added Pushbuttons to Wiring Devices 26 2726 / 16140, make sure it shows up in Section Includes.

4) Read through the Part 2 – Products, Manufacturer list and make sure that “Or equal”, “Or Approved Equal” are used consistently and no spec contains the same list twice, once with “Or Equal” and the second without.

5) Check any schedules to make sure they contain the latest information.

Appendix - Detroit Public Schools Specification 16150

DPS Westside Multicultural Academy Gymnasium Addition DPSPMT Project No. 07900.05024.ADD	[header]	February 24, 2004
Eng Firm proj no 03098	16150- (page) [footer]	Electrical Acceptance Tests

SECTION 16150

ELECTRICAL ACCEPTANCE TESTS

PART ONE - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including general and supplementary conditions and division 1 specification sections, apply to this section.

B. All work performed under this Section of work is subject to all requirements contained under Section 16000 "Electrical General Requirements" and Section 16050 “Commissioning”.

1.2 DESCRIPTION

A. General: Provide basic materials for electrical work and install in accordance with the Contract Documents.

1.3 CONTENTS

A. Major items of work and equipment included under this Section of the Specifications are materials and finish application for a complete installation.

B. Described herein are the following:

1. Definition of Tests
2. Final Acceptance
3. Test Reports
4. Environmental Requirements
5. Protection of Personnel
6. Scheduling of Tests
7. General Testing Requirements
8. Test on Wire and Label in 120/208 Volt Lighting and Power
9. Test on Wire and Label in 277/480 Volt Lighting and Power
10. Tests on Grounding
11. Tests on Special Systems

1.4 DEFINITION OF TESTS

A. Preliminary inspections and tests: Visual inspections of electrical equipment, wire checks of factory wiring and

any other preliminary work required to prevent delays during performance of electrical acceptance tests.

B. Electrical acceptance tests: Those inspection and tests required to show that the workmanship, methods, inspections and materials used in erection and installation of the electrical equipment conforms to accepted engineering practices, IEEE Standards, the National Electrical Code and Manufacturers Instructions.

C. Operating tests: Those tests performed on all electrical equipment installed under other Sections of this Specification, to show that the electrical equipment will perform the functions for which it was designed.

1.5 FINAL ACCEPTANCE

A. Final Acceptance of electrical equipment will not only depends on equipment integrity as determined by the electrical acceptance test, but will also depend on complete operational tests.

1.6 TEST REPORTS

A. Submit test reports, including complete data on actual readings taken and each corrected values, to the Owner's Representative for approval after each test period.

B. Submit two (2) copies of final approved test reports to the Owner Within three days of the completion of the work under this Section of the Specifications. The report must be legibly signed and dated.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Humidity:

1. Do not perform megger or high potential test during times of high relative humidity.

1.8 PROTECTION OF PERSONNEL

A. During cable tests, station a man at each point where cable has exposed connections.

1.9 SCHEDULING OF TESTS

A. Schedule sequence of tests so that equipment can be energized immediately after completion of the applicable tests and approval of test reports. Notify the Owner's Representative of time of tests at least 48 hours prior to testing.

1.10 GENERAL TESTING REQUIREMENTS

A. Preliminary Work:

1. Perform preliminary inspections and test immediately prior to performing acceptance tests.

B. High Potential Tests:

1. Do not perform more than one high potential test on any conductor unless specifically authorized by the Owner's Representative.

C. Megger Tests:

1. Megger readings specified are the minimum readings desired at an ambient temperature of 60^{o}F and at a low relative humidity.
2. When megger readings fall below the specified minimum values at 60^{o}F, devise some means of applying heat for the purpose of drying out the equipment subject to the approval of the Owner's Representative.

D. Continuity Tests:

1. Perform continuity tests with a DC type device using a bell or buzzer. Do not use phones for continuity test: use phones only for communication.

1.11 TEST ON WIRE AND CABLE IN 208/120 VOLT DISTRIBUTION:

A. General:

1. Give each 208/120-volt power feeder and subfeeder cable a continuity test and a megger test. Verify

phase identification for each power feeder and subfeeder cable. Verify identification of 120 volt circuits on panel directories and make operational checks on 120 volt circuits to prove that the circuits perform all functions for which they are designed. Check all power feeder and subfeeder cable connections for workmanship and conformance with standard practice by visual inspection.

B. Megger Tests:

1. Minimum acceptable reading: For disconnect cables, 100 megaohms; for connected cables, no minimum required.

C. Records:

1. Include the following information in test report on each 120/208-volt power cable.

a. Complete cable identification and description of isolation means.

b. Megger readings, including converted values.

c. Approximation average cable temperature.

1.12 TEST ON WIRE AND CABLE IN 480/277 VOLT DISTRIBTION:

A. General:

1. Give each 480/277-volt power feeder and subfeeder cables a continuity test and a megger test. Verify phase identification for each power feeder and subfeeder cable. Verify identification of 277 and 480 volt circuits on panel directories and make operational checks on circuits to prove that the circuits perform all functions for which they are designed. Check all power feeder and subfeeder cable connections for workmanship and conformance with standard practice by visual inspection.

B. Megger Tests:

1. Minimum acceptable reading: For disconnect cables, 100 megaohms; for connected cables, no minimum required.

C. Records:

1. Include the following information in test report on each 277/480-volt power cable.

a. Complete cable identification and description of isolation means.

b. Megger readings, including converted values.

c. Approximation average cable temperature.

1.13 TESTS ON GROUNDING

A. General:

1. Inspect ground conductors and connections for conformance with design specifications and for the satisfactory workmanship. Test resistance to earth of each ground rod and each ground grid. Test ground paths for equipment and structural steel grounding.

B. Connections:

1. Maintain each ground rod isolated from the associated ground grid for tests on individual rods for resistance to earth.
2. Include associated ground rods and interconnecting wiring in tests on each grid system for resistance to earth.
3. Include ground bus on equipment, grid connection and associated intermediate copper ground conductors in tests on ground paths for electrical equipment.
4. Include structural steel connections, grid connection and intermediate conductor in tests on ground systems, the maximum acceptable resistance to earth is a five ohms.

C. Tests on each Ground Grid:

1. Test each isolated ground grid as specified for individual ground rods, except the maximum acceptable resistance to earth is five ohms. In tests on isolated ground systems, the maximum acceptable resistance to earth is two ohms.

D. Tests on Ground Paths:

1. Test ground paths of electrical equipment and structural

steel for continuity by applying a low voltage DC source of current, capable of furnishing up to 100 amperes. The ground path for electrical equipment or structural steel must conduct 100 amperes. resistance as calculated from the current and voltage must not exceed 0.010 ohms.

E. Acceptance:

1. Grounding materials and connection must pass all inspections and must meet all specified maximum and minimum values.

F. Records:

1. Make complete records of all tests. Include resistance values obtained, calculations of the same and methods of test and calculations. Reports must be legibly signed and dated. Indicate the test instrument used.

1.14 TESTS ON SPECIAL SYSTEMS

A. Perform operating tests on all special systems to prove that all design functions are satisfactorily performed.

END OF SECTION 16150

Appendix - Detroit Public Schools Specification 16010

DPS Westside Multicultural Academy /Gymnasium Additon DPSPMT Project No. 07900.05024.ADD	[header]	February 24, 2004
Eng Firm proj no 03098	16150- (page) [footer]	Electrical Commissioning

SECTION 16010

ELECTRICAL COMMISSIONING

PART 1 - GENERAL

1..0 COMMISSIONING

A. The Electrical systems and devices listed below shall be commissioned and the contractor shall follow and conduct all items necessary to complete the commissioning process as specified in this Section and Division 1 Section 01810. The contractor shall identify and provide services of an individual to participate in and be responsible for implementing and reporting the commissioning program. The proposed individual will be intimately familiar with the electrical installations and systems operation. The Commissioning Authority and PMT reserve the right to interview the candidate or request additional information prior to placement in the position. Final approval of the individual will be by PMT.

The following systems and devices shall be commissioned:

1. Sleeves & Firestopping
2. Grounding & Bonding
3. Identification
4. Conductors & Cables
5. Raceways & Boxes
6. Receptacles & Switches
7. Lighting & Lighting Controls
8. Electrical Control
9. Transient Voltage Suppression
10. Switchgear
11. Switches & Circuit Breakers
12. Enclosed Controllers
13. Panelboards
14. Transformers
15. Fuses
16. Fire Alarm System
17. Security TV
18. Security Motion Detectors and Door Switches
19. Educational TV
20. Data Distribution System
21. Sound System (Public Address)
22. Clock System

B. The contractor shall submit, conduct, participate in, support and document all relevant commissioning testing and tasks including but not limited to the following:

1. Manufacturer's Factory Testing Certificates
2. Pre-Installation Check Sheets
3. Pre-Start Checklists
4. Manufacturer's Check, Test, Start
5. Systems Start-up and Testing
6. Functional Testing, including numeric values of volts, amps, footcandles, sound pressure levels, noise levels in dB and bit error rates. Identify the instruments used for tests.
7. Training
8. Operations & Maintenance Manuals
9. Commissioning Meetings

10. Scheduling of Commissioning Events

11. Review the plans and specifications with respect to their completeness in all areas relating to the commissioning program. This includes ensuring that there are adequate items included in the design to ensure the ability to properly test and adjust the systems, and to document the performance of each piece of equipment and each system.

12. Assist in the development of the *Systems Testing Documentation Forms* for all equipment tests, system functional tests, and cross-system functional tests. Test procedures shall be in accordance with the equipment manufacturer's recommendations, where applicable. Test procedures shall fully describe the system configuration and steps required for each test; appropriately documented so that the independent CA can repeat the tests with virtually identical results. The test procedure for each system should include the following information: specific design criteria to be tested for, manufacturer checkout sheets, approved submittals, O&M manuals, approved sequence of operation, subcontractor measured results and controls point checkout and signoff for all associated parties.

13. Provide technical expertise to oversee, direct and implement the correction of deficiencies found during the commissioning process. Observe the start-up and initial testing of equipment by the contractor Manager all cross system testing such as HVAC, building automation, fire alarm, life safety, etc. The contractor's personnel shall be made available to execute the corrective actions of deficiencies found.

14. Note any deficiencies or inconsistency in system operations and enforce system compliance or recommend to the A/E modifications to system design, which will improve system performance.

15. Each report shall be legibly signed and dated and submitted to the Owner within three days of completion of the tests.

16. The contractor shall furnish the commissioning agent copies of the field quality control test reports (for example, tests specified under Section 16080). The contractor shall document all testing as part of the commissioning process.

END OF SECTION 16010

Appendix - Cleveland Department of Water Checklist for Operation and Maintenance Manuals

Cleveland Division of Water
Plant Enhancement Program

"M&O MANUAL SUBMITTAL REVIEW CHECKLIST"

Plant: _____

Project Title & Number: _____

M&O Submittal Number: _____

M&O Submittal Title Description: _____

M&O Submittal Date: _____

Reviewed By: _____

Date: _____

GENERAL INFORMATION: **COMPLETE (Yes / No / N/A)**

1. Cover Page, including Equipment Tag #s and Locations _____
2. M&O Submittal Quality/Appearance/3-Ring Binders _____
3. 16 Tab Dividers & Index Provided _____
   a. Supplier Data _____
   b. Manufacturer Data _____
   c. Operating Instructions _____
   d. Troubleshooting Data, _____
   e. start-up running line amps _____
   f. start-up running vibration, mils rms, X,Y, at bearing _____
   g. Electrical Diagrams _____
   h. Control Software/Programming Documentation _____
   i. Mechanical Diagrams _____
   j. Test Data _____
   k. Repair Parts _____
   l. Maintenance Instructions _____
   m. Parts List _____
   n. Warranty _____
   o. Maintenance Materials _____
   p. Approved Submittals _____

- Comments for each of the above listed divider sections are listed on the following detail checklist.
- If a divider section is not to be used, insert a page stating

"DOES NOT APPLY".

4. Any other specific requirements detailed in the individual equipment specification under Part 1.
5. Other Comments.

End Appendix

Related Links and References

AIA - American Institute of Architects - http://www.aia.org/

CSI - Construction Standards Institute - http://csinet.org/s_csi/index.asp

ARCOM - Architectural Computer Services - http://www.arcomnet.com/

BSD - Building Systems Design - http://www.bsdsoftlink.com/

Comprehensive corss index between CSI 1995 and CSI 2004 - http://www.pwgsc.gc.ca/nms/content/nms_ref_1995-2004-e.html

Public Domain Specs - (job spec = URL references all specs for entire job)

01300 - http://intranet.cps.k12.il.us/Technology/12/01300_Submittials.pdf
01400 - http://www.fm.virginia.edu/directives/Dir542B%20-%2001400_CAJ%207.doc
01600 - http://www.wbdg.org/ccb/NASA/NASAASC/NS01600.pdf

16000 - http://www.utexas.edu/campusplanning/dc/divisions/DivisionSixteen/16000.pdf
16010 - http://www.facilities.upenn.edu/uop/3_electrical/Section_16010_doc.pdf
16050 - http://www.va.gov/facmgt/standard/spec/16050.doc
16051 - http://www.ogs.state.ny.us/dnc/generalInfo/masterspec/html/16051H.htm
16060 - http://www.electro-specialties.com/technical/downloads/Spec%20Grounding.doc
16070 - job spec - https://ebs.nab.usace.army.mil/Solicitations/W912DR-04-B-0003%5CSPECS/SpecsPart1.pdf
16075 - job spec - http://www.epa.gov/oamcinc1/0510757/specs.pdf

16095 -
16100 -
http://facilities.dadeschools.net/planning/master%20specs%202004/pdfs/16100.pdf
16121 - http://www.wbdg.org/ccb/NASA/NASAASC/NS16121.pdf
16123 - http://wbdg.org/ccb/NASA/NKSCASC/NSK16123.pdf
16125 - http://www.cablefloor.com/pages/specs.html
16127 - http://wbdg.org/ccb/VA/VAASC/VA16127.pdf
16130 - http://www.wiremold.com/shared_content/msword/ed928.doc
16131 - job spec http://www.tw.gov.nl.ca/works/WSTSpec/div16.stm
16132 - http://www.dot.state.ak.us/anc/Engineering-Construction/TerminalConstructionStds/16132PullandJunctionBoxes.pdf
16133 - http://www.ogs.state.ny.us/dnc/generalInfo/masterspec/html/16133.htm
16134 - http://www.globetray.com/applications/specs.asp
16135 - http://www.udot.utah.gov/download.php/tid=731/16135-ElectricalJunctionBoxes.doc
16138 - job spec - http://www.blm.gov/nstc/eng/division16.html
16139 - http://www.wiremaidcabletray.com/pdf/cable-mgr-csi-specs.pdf
16140 - http://www.va.gov/facmgt/standard/spec/16140.doc
16155 - http://wbdg.org/ccb/VA/VAASC/VA16155.doc
16200 - http://www.fab.uab.edu/AandE%5CDOCUMENTS/16200%20-%20Emergency%20Standby%20Generators.pdf
16210 - job spec - http://facilities.stanford.edu/fdg/fdsactive.htm#16
16215 - http://www.geindustrial.com/products/specs/DEE-224a-0703.pdf
16231 -
16232 -
http://www.ogs.state.ny.us/dnc/generalInfo/masterspec/html/16232600.htm
16243 -
16261 -
http://www.liebert.com/products/english/products/netpwrpr/upsgxt2u/60Hz/guidesp/word/sl_23152.rtf
16271 -
http://www.utexas.edu/campusplanning/dc/divisions/DivisionSixteen/16271.pdf
16272 - job spec - http://igs.nigc.ir/STANDARD/FANAVARI.HTM
16281 -
http://www.utexas.edu/campusplanning/dc/divisions/DivisionSixteen/16281.pdf
16300 - http://www.ncsu.edu/facilities/univ-arch/4-const/16300_transmission-distribution.pdf
16311 - job spec -
http://www.doa.state.wi.us/dsf/masterspec_view.asp?catid=32
16341 -
http://www.leviton.com/sections/prodinfo/controls/aiaspecs/recept/Re,L%20SiWireDecora.doc
16342 -
http://www.utexas.edu/campusplanning/dc/divisions/DivisionSixteen/16342.pdf
16343 -

16344 - job spec - http://www.pp.wmich.edu/standards/
16360 - http://www.wbdg.org/ccb/DOD/UFGS/UF16360.pdf
16400 - http://www.liebert.com/products/english/products/surge/lm_srs/60Hz/guidesp/word/sl_22031.rtf
16411 - http://www.ogs.state.ny.us/dnc/generalInfo/masterspec/html/16411.htm
16412 -
16413 - http://www.nycenet.edu/Offices/SCA/DoingBusiness/AE/Specifications/StandardSpecifications.htm
16414 -
16422 - job spec - http://www.slcgov.com/publicservices/engineering/downloads/2002_standard_specifications.pdf
16423 -
16424 - job spec - http://www.sandia.gov/engstds/ConstSpecs/mesafab.html
16425 - http://facilities.dadeschools.net/planning/master%20specs%202004/pdfs/16425.pdf
16426 - http://facilities.dadeschools.net/planning/master%20specs%202004/pdfs/16425.pdf
16442 - http://www.bussmann.com/library/fusible/164XX%20-%20Elevator%20Shunt-Trip%20Fused%20Distribution%20Panel.doc
16443 - http://www.geindustrial.com/solutions/engineers/docs/16443%20or%2026%2024%2019%20MCC.doc
16450 - http://www.utsystem.edu/fpc/docs/electrical_mechanical/electrical/16450%20Grounding.doc
16451- job spec - http://www.eere.energy.gov/femp/financing/superespcs_ghpspecs.cfm#electric
16470 - http://facilities.dadeschools.net/planning/master%20specs%202004/pdfs/16470.pdf
16491 - and fuse equip - http://www.bussmann.com/apen/fusible/
16500 - http://www.archenergy.com/library/pier/div16c.pdf
16510 - http://www.utexas.edu/campusplanning/dc/divisions/DivisionSixteen/16510.pdf
16520 - http://wbdg.org/ccb/VA/VAASC/VA16520.doc
16526
16555 - http://www.techsavvy.com/industry/file/national/03tvy/mgt09.html?id=95971&comp_id=03TVY&base_region=*
16575 - http://windows.lbl.gov/comm_perf/pdf/NYT_Lighting-Spec12-31-04.pdf
16700 - whole Div 16 - http://its.ucsc.edu/services/network/include/16000.pdf

16710 - http://engstandards.lanl.gov/conspec/active_pdf/16710-R0.pdf
16721 - http://www.sandia.gov/engstds/ConstSpecs/Special/PETL_Bldg_701/DIV_16/16721_S_Fire_Alarm_System.doc
16722 - http://www.wbdg.org/ccb/HUD/HUDSPEC/h16722sa.pdf
16723 - http://intranet.cps.k12.il.us/Technology/12/16723_Intercom_and_Program_Equipment.pdf
16781 - http://wbdg.org/ccb/VA/VAASC/VA16781.pdf
16800 - http://wbdg.org/ccb/VA/VAASC/VA16800A.doc
16821 - http://www.ogs.state.ny.us/dnc/generalInfo/masterspec/html/16821.htm
16930 - http://facilities.ucsb.edu/_client/pdf/standards/16/16930_LIGHTING_CONTROL.pdf

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