How to Estimate the Cost of an Emergency Back-Up System for a Hospital

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Section 1 – Introduction

This technical paper is intended to illustrate and explain the methodology of preparing a complete and professional cost estimate for the complex systems that make up an Emergency Power Back-Up System of a Hospital. Before getting started with the quantity take-off of the generator and its accessories, the Estimator should be familiar with the different codes that govern the requirements and installation of Emergency Back-Up Power Systems for Hospitals. These include different Articles and Codes found in the NEC and NFPA publications. It is also extremely important and highly recommended that the estimator become familiar with all of the contract documents, including all drawings, details, addenda, specifications and electrical codes. An electrical estimator should understand Ohm's Law, and be able to perform the basic calculations that will be required in order to confirm the wiring and circuit sizes for this system. This estimate will start with the power provided by the emergency generator system and continue on to the different points where the emergency power connects to the emergency loads through ATS's (Automatic Transfer Switches). These include Emergency Equipment Loads, Critical Power Loads and Life Safety Loads. (See Figure 2 on Page 20)

Main CSI (Construction Specifications Institute 2004 MasterFormat) Division

- Division 26-00-00 Electrical

Main CSI (Construction Specifications Institute 2004 MasterFormat) Subdivisions

- Subdivision 26-32-00 Packaged Generator Assemblies
- Subdivision 26-32-13 Engine Generators

  - Sub-Subdivision 26-32-13.13 Diesel-Engine-Driven Generator Sets
- Subdivision 26-36-23 Automatic Transfer Switches

Brief Description

An Emergency Power Back-Up System for a Hospital is much more complex than an emergency generator system for a typical commercial building because it provides power for such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety communications systems and other processes where interruption of power would produce serious life safety or health hazards. It consists of the generator, diesel engine, lubrication system, engine fuel system (including a fuel tank that will allow the generator to run at full electrical load for 96 hours), engine cooling system, engine exhaust system, starting system, control and monitoring systems and multiple Automatic Transfer Switches that provide emergency power back up to the different electrical systems that are required by the NEC and NFPA. In order to comply with the applicable codes and laws, and meet the intent of the Electrical Engineer who has designed this Emergency Power Back-Up System, we will review the specific installation requirements that must be followed.

The estimate will be prepared from an electrical subcontractor's point of view and we will treat the estimate as if the electrical requirements were delivered to us through a set of Construction Documents, including all drawings, addenda, details and specifications. We will also take into consideration historical data from other Emergency Back-Up Systems for Hospitals that we have either estimated before, or for those which we have actually seen installed by our company and know what the actual costs are through accurate historical data. A company's historical data can be a benefit to the estimator in vetting the bid and making sure that all requirements have been met and have been assigned a value in the estimate.

The system for this estimate will include a 500KW/625KVA 480/277 Volt, 3-Phase Generator, a 1000 ampere Emergency Distribution Switchboard that will connect to the required emergency loads through three Automatic Transfer Switches. There will be sample quantity take-offs and extension of all costs with labor and material pricing included. We will also include the necessary indirect costs, overhead and profit to develop a complete total cost estimate.

Section 2 - Types and Methods of Measurement

Electrical estimates are usually done with quantity take-offs that are relatively simple and elementary. The take-offs are usually done by counting individual items and/or by measuring lengths using an architectural scale, digitizer or a rotometer. On-Screen take-off software is becoming more and more popular for many reasons, such as auto-count features, symbol recognition, printing costs, physical storage space and instant exportation into the estimating software. The decision should be made by each company on which method they will use, mostly depending on what they feel most comfortable with to achieve accurate counts and measurements. Typically, an electrical estimator will use the count feature to perform all of the device counts, which usually show up in the extension as "each" (E). The estimator will measure lengths of conduit, which usually show up in the extension as either "linear feet" (E) or "hundred linear feet” (C). The estimator will also measure lengths of different types of wire, which will usually show up in the extension as “thousand linear feet” (M). It is very important to make sure that the appropriate unit of measure is being applied to each item in the extension and that the calculations are correct. While an estimator is performing quantity take-offs, there may be some opportunities to use common assemblies, which normally include all of the necessary parts and pieces for a particular take-off item. For example, when taking off conduit and wire, there may be a common assembly that includes the conduit, couplings, connectors, conduit supports and the appropriate number of conductors needed. Everything is calculated off of length and count. Another example of a common assembly is a 120 volt duplex receptacle. The assembly for the duplex receptacle would include the receptacle, a 4-square box, box support, plaster ring, grounding pigtail and the appropriate cover. These common assemblies are usually assemblies that companies have developed over time to assist the estimator in being more efficient. The estimator should understand how these common assemblies have been built, and know what is contained for each one.

If the electrical estimator knows that their company will be self performing the excavation required for the installation of the underground conduits, they will also need to have knowledge of cubic yard measurements for excavation, backfill and concrete ductbanks. The estimator should be familiar with the requirements of Division 33, or earthwork specifications, which will contain the requirements for trenching and backfilling. If concrete encased ductbanks are required, the estimator will typically find different details contained in the drawings that give specific dimensions and conduit layout for the different sections of ductbanks. It is critical that the estimator has the ability to perform the necessary calculations to figure cubic yards of excavation, backfill and concrete for the ductbanks. If the estimator is not familiar with excavation take-offs, or the company does not normally self perform the excavation, this could be an item in the estimate that might require a subcontractor to provide a cost that will cover that specific scope of work.

Section 3 - Specific Factors That May Affect Take-Off and Pricing

Small Quantities vs. Large Quantities

Typically, larger construction projects will include items such as mobilization, non productive leadership costs, and other indirect costs that smaller projects simply will not have. Usually, the overhead costs will be applied at a lower percentage of the project costs than on a smaller project. With a larger project that has large amounts of materials, the estimator should have the ability to negotiate better commodity pricing from their vendors. A vendor may even be able to get better pricing from their different manufacturers based on the larger quantities required for certain projects. A company that has a large annual gross volume of work is more likely to negotiate better pricing agreements for commodity materials than a smaller contractor that doesn't have the same volume of work. Depending on whether a cost estimate is a standalone estimate for an addition or replacement to an existing building, or if it is part of an estimate for a complete new building, an estimator should consider the different ways to obtain the best pricing available from vendors. Different vendors might be willing to give the best pricing based on either the quantities for a single estimate, or for the overall quantities that a company has purchased in the past and what they plan on purchasing in the future. It is important that the estimator is familiar with material price fluctuations and be aware of the time frame of each project. If the project isn't going to be built right away, the estimator may want to include some contingencies for high risk materials, such as copper and steel.

Other items in the estimate that are usually affected by having larger or smaller quantities of materials are the labor rates used for installation. If the estimator knows that there will be opportunities to increase productivity when building the project, he may assign lower labor rates to specific items in the estimate. For example, if there are several underground conduit runs that will be installed in the same trench, the estimator can assign a lower, more aggressive labor rate, knowing that this installation will only take slightly longer than if there was a only a single conduit run. The same methodology can be applied to the wire installation. The labor rates will be significantly lower for the installation of wire when the electricians are able to set up and pull several runs at a time from a single location, rather than having to stage materials and set up multiple times at multiple locations for individual wire pulls. On the other hand, if an estimator knows that a particular conduit run will have to be installed over 20' above finished floor, they may decide to assign a higher labor rate for installation, knowing that it will take an electrician more time for this type of installation.

Geographic Location

There are several elements of an estimate that might be affected by the geographical location of a project. Construction costs can vary depending on where the job is located. If a company is based out of a different region than where the project is located, the estimator will need to factor items such as local labor costs, per diem, travel expenses, material delivery costs and expediting costs into the estimate. Material prices can also vary depending on the location of the project. The estimator will need to either contact a vendor that is in close proximity to the project for material pricing, or make sure that the shipping costs are covered for all materials. The estimator will need to make sure that the project doesn't have any special wage requirements, such as Davis Bacon and/or Prevailing Wages. If the project is considered an "out of town" project, the estimator should get real costs for the price of hotel rooms, as well as availability of hotel rooms. If the project is located in a remote part of the geographical location, and there are several other construction projects taking place at the same time, these resources may have inflated costs or be completely unavailable.

Seasonal Effect on the Work

The construction industry as a whole is affected by the different seasonal changes experienced in different regions of the country. Different trades are impacted more severely during the cold winter months, which can contribute to a domino effect on the trades that follow on the schedule. For example, if a project starts in the winter in an area that sees freezing temperatures and moisture, production rates for the excavation subcontractor and the concrete subcontractor will most likely be impacted negatively. This in turn, can affect the production rates for the electrical subcontractor. If the earthwork is not able to move forward because of frozen ground, the underground electrical rough in cannot be completed either. If the concrete slabs cannot be poured because of inclement weather or frozen ground, the under slab electrical rough in cannot be completed or will progress at a much slower pace than anticipated in the original estimate. If the estimator is not familiar with the construction schedule provided in the contract documents, and the sequencing of activities listed, he may not take the adverse conditions into consideration and most likely will not provide any additional costs for these conditions into the estimate. The estimator should become familiar with the terms and conditions in the specifications in regards to weather conditions, and be able to apply costs as necessary into the cost estimate.

General and Specification Requirements

The estimator should be familiar with and account for all necessary costs to be included in the estimate. The different cost elements that need to be accounted for are either listed in Division 01 “General Requirements” or in the specific sections of specifications that pertain to the system for which the estimate is being prepared, which in this case would be found in “Engine Generators” 26-32-13. It can require a lot of time and attention to detail to go through the list of items, which could be fairly extensive. Once the estimator has some experience and knows what major items to look for, it can become less time consuming. Some of the major items to be aware of and to look for are warranty periods that exceed the standard factory warranties, required scheduled maintenance, spare parts, fuel, equipment for offloading and setting the generator, testing and commissioning requirements, availability of factory technicians for emergencies, submittals, operation and maintenance manuals, as-built drawings, BIM Coordination requirements, seismic requirements, safety requirements, extensive field test reports and on site equipment training. Usually, costs for most of these items will be part of the generator supplier’s quote. It is the estimator’s responsibility to identify and account for any costs that are not part of the supplier's quote and include them as line items in the estimate.

Section 4 - Overview of Labor, Material, Equipment, Indirect Costs and Approach to Markups

It is the estimator's responsibility to perform all take-offs and prepare the estimate in a clear and organized fashion. The most important part of an estimate is to identify ALL costs. The best way to do this is to review the entire set of construction documents. This includes drawings, sketches, details, specifications, schedules, sample contracts and any other documents that may come with the RFQ (request for quotation) from the General Contractor or Owner. Pay special attention to items that may affect your work, even if they are shown on another discipline's drawings or specifications. Use a method to make note of these items, whether it be marking up the drawings, or using a separate notepad, so that you can go back and address each item and decide whether or not it needs a value assigned to it in the estimate. Site conditions should be reviewed and taken into consideration. This will determine whether or not there are on-site storage areas, lay down areas for storage of materials, space for an office trailer for site supervision and parking for employees. The next step is to set up and structure your estimate to be able to provide accurate costs for any bid forms, unit costs, special breakouts, additive or deductive alternates or SOV (schedule of values) requested by the General Contractor or Owner. This could be as simple as a lump sum price total, or extremely complicated if several bid items or breakouts are requested. Most contractors use some form of estimating software that is trade specific that will assist them with structuring and assigning costs to the applicable breakouts.

The labor, material and equipment costs for an electrical estimate are usually determined by doing a detailed item by item quantity take-off. The estimator should determine what material items will require a quoted price from a specialty vendor or a subcontractor. This is usually a good place to start, as it will give your vendors and subcontractors the opportunity and necessary time to review the contract documents and make sure their quoted price includes everything that is shown on the drawings and listed in the specifications. It is good practice to send your vendors and subcontractors the same set of documents that you have been given, as well as a detailed BOM (bill of material) that will provide them with your counts for the items you want them to include in their quoted price. The specifications will usually include a list of approved manufacturers for the generator. It is common practice to solicit quotes from at least three of the approved manufacturers. This will ensure that the quotes you receive are competitive. If the specifications only list one manufacturer, the estimator will have to trust that the sole sourced manufacturer will provide competitive and aggressive pricing.

The required materials will be accounted for by counting and measuring each individual item for which the estimate is being prepared. Usually these counts and measurements will include common assemblies that include the necessary parts and pieces to form a complete electrical assembly. When measuring distances, always check and double check the scale listed on the drawings. Make sure that you always use the right scale. If there is ever a question, the estimator can usually find a measurement on another drawing, such as an architectural drawing, to which they can double check and calibrate the scale. Other critical items to include when measuring are the vertical drops and rises between the floor and ceiling and the device or component elevations. The floor to floor elevations and the mounting heights for different items can usually be found in the architectural section of the drawings. As the estimator counts and measures, they should always use the same method to highlight or otherwise mark an item showing that the item has in fact been counted or measured. This is also the time to enter the items into the estimating software, if that is how the estimate is being prepared. For this estimate, we will use Accubid Pro by Trimble as the estimating software, and LiveCount by Trimble for the on-screen take-off. By using both programs, the estimator is able to count, measure and export the take-offs into the estimating software, which will generate an extension and apply the appropriate labor units and material costs. The labor units and material costs used for each estimate are stored in a database that is proprietary to each company, and has been thoroughly reviewed and the values adjusted to represent the costs that the company expects to incur for each item. Usually, a company will reference popular publications such as NECA (National Electrical Contractors Association) or RS Means to establish the baseline for the labor units that are applied to each item. If the company has good historical information on labor units and actual installation rates, these might be used instead of what is recommended by NECA or RS Means, and should make the estimate more competitive.

After the take-off is complete, the estimator should start reviewing the extension to make sure that everything has been accounted for and has a value assigned for both labor and material dollars. There are some basic calculations that the estimator can use to determine if there are any mathematical errors that are very obvious or that need to be corrected. For example, if the specifications call out for a conduit support every 8 feet, the estimator can take the total footage of conduit, divide the total footage by the number of conduit supports and see how close to 8 the calculation is. The estimator should develop other methods to make sure that there aren't any major mathematical errors in the estimate.

After reviewing the extension, the estimator should have a good idea what equipment will be necessary for the electrical installation. If the excavation for the underground conduits will be self performed, the estimator will need to include costs for a backhoe, compactor, imported backfill material and possibly a dump truck. This will depend on the specifications and how the estimator plans on dealing with the spoils from the trenching. A crane will be required to set the generator. Wire pulling equipment will be needed to install all of the feeder conductors. The estimator will need to determine the durations required for company owned equipment or rental equipment, depending on what is available to the company.

The estimator should now evaluate the quotes received for the specialized equipment that is necessary for the installation of the emergency backup system. The estimator should thoroughly review each quote and compare them to the BOM that was previously sent out. The estimator should also carefully go through and make sure that all of the requirements listed in the specifications are included in the quote. Make sure that the vendor has included the appropriate sales tax and the shipping costs. Freight on board (FOB) to the project site is the most widely used shipping method. Read through the quote and make sure the vendor has included the production and turnaround time for processing and delivery of the generator and accessories. If the project schedule requires the equipment to be on site before it can be manufactured, the estimator will need to know what the cost to expedite the process will be. If the equipment will be ready and shipped before the hospital is ready for the installation, the estimator will need to include costs in the estimate to store the equipment in a secure location. Check the quote to see if fuel is included. If it is not included, the estimator will need to know how big the tank is, what the testing requirements are and how much fuel will be consumed during this time, and then get a quote for a vendor to deliver the fuel to the site for the initial fill, and then to refill the tank after the testing is complete.

There are other indirect costs that need to be included in the estimate. Permits, bonding, temporary facilities, temporary power, non-productive time for the foreman to ensure the project is properly installed and all of the required forms are submitted, safety supervision, mobilization, clean up and overhead. Overhead is usually a cost that won't be determined by the estimator. It is normally left up to the company's management team and is based on the historical financial data. Overhead costs consist of office staff salaries, office rental, utilities and other costs that can't be directly related to any single project, but are necessary for the company to operate.

After all costs have been calculated, all the appropriate labor rates assigned to each item in the extension and all other direct, indirect and overhead costs have been figured into the total cost estimate and the actual cost is determined, the management of the contractor will consider the different profit scenarios. It is critical that the estimator involve the management of the company in determining what percentage of the project's cost they hope to earn as profit. There are many factors that can potentially play into this decision, such as current backlog of work, number of competitors that might be bidding on the same project, and whether or not the contractor really needs the work and has the manpower necessary to complete the project on time. If the estimator has been able to identify potential risks on the project, the management may decide that a higher markup is appropriate. If the estimator feels that there is a lower level of risk, the management may decide that a lower markup is appropriate. Profit or markup decisions are highly variable and need to be decided upon with a team approach that includes the estimator, who is familiar with the requirements of the project and the management team, who is familiar with the needs of the company at any given time.

Section 5 - Special Risk Considerations

Emergency backup systems can range from a simple system that includes minimal specialty equipment, to large and complex systems that can include multiple generators, paralleling switchgear, multiple ATS's, and backup batteries. The estimator will be required to read and fully understand the specifications that address the emergency power backup system and become familiar with the details of each part of the system. If there are components of the system that are specified by the engineer to be by others, such as the intake air ducting, exhaust system or other mechanically oriented parts, the estimator will need to make sure that these components are actually going to be purchased and installed by whomever is specified. It is the estimator's responsibility to ensure that there aren't any scope gaps in the estimate. If there are, the financial consequences could be damaging to the contractor and the projected profit could be substantially less than expected.

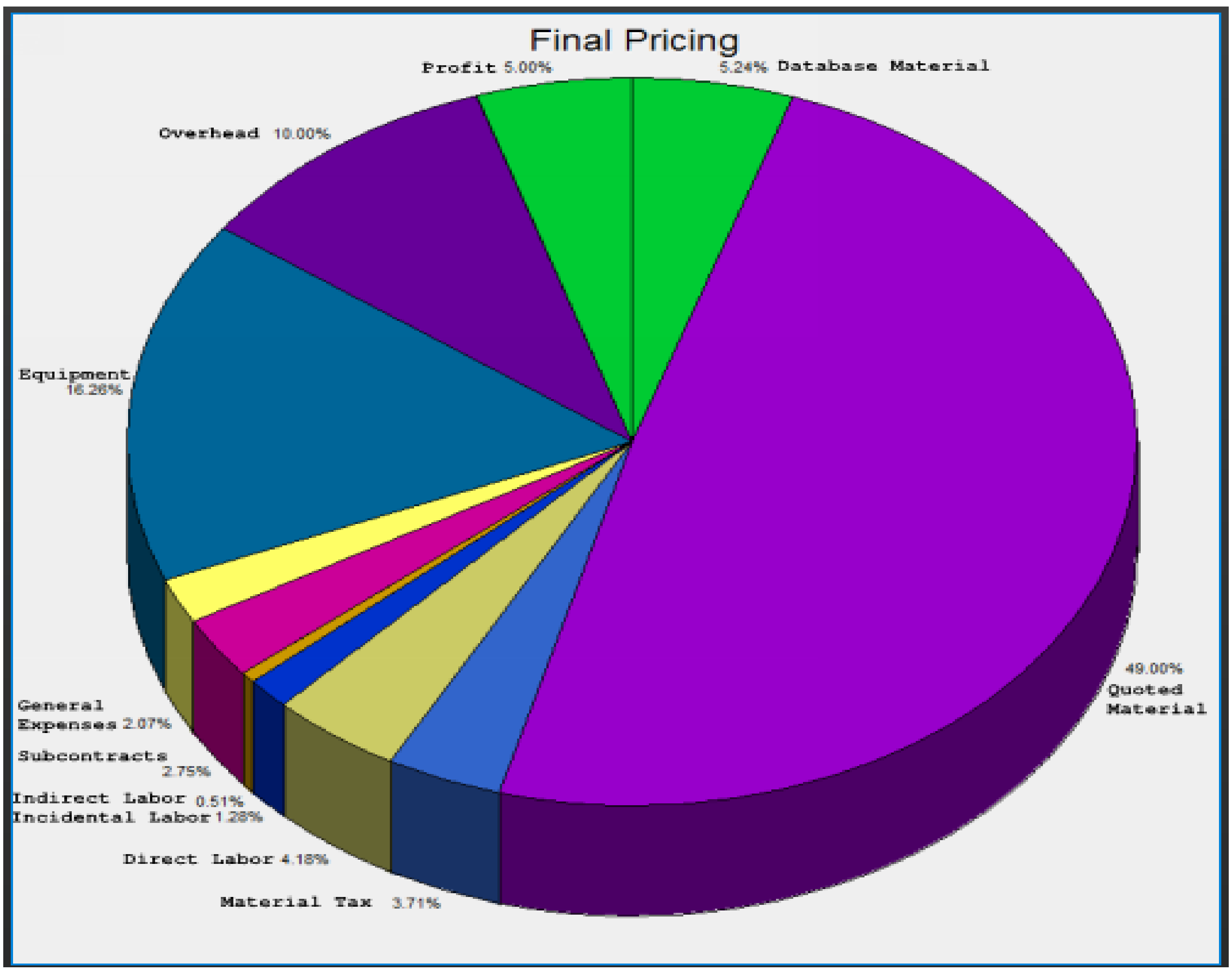
The estimator should be familiar with all of the applicable codes that govern the installation of an emergency backup power system. NEC Article 700 "*Emergency Systems*" along with several NFPA publications, such as NFPA 99-2005, "*Standard for Health Care Facilities*", NFPA 101-2009, "*Life Safety Code*" and NFPA 110-2010, "*Standard for Emergency and Standby Power Systems*", provide specific information on the installation requirements for an emergency backup power system in a hospital. If the estimator is not familiar with these codes, the contractor will still be responsible to install the system to meet these specific codes, whether they are accurately depicted on the contract documents or not, and could be costly to the electrical contractor.

Another risk consideration to take into account is the actual movement and installation of the generator unit. Depending on the size of the unit, the logistics of the building and the space available in which to maneuver the unit into place, the contractor might decide to hire a specialty rigging subcontractor that has specialty equipment and more experience moving larger pieces of equipment. If this is the case, the estimator should solicit quotes from qualified rigging subcontractors and include the costs in the estimate.

Section 6 - Ratios and Analysis – Testing the Bid

There are several resources that the estimator can utilize to analyze the bid before the final price is submitted. The historical data of a well established electrical contractor that has completed several of these types of projects would be the most accurate. It is also good practice to compare certain parts of the estimate to other estimates that the company has produced, even if they weren't the successful bidder.

This can give the estimator an idea of where the final costs need to be in order to capture the work. Make sure that the labor rates included in the estimate are comparable to actual installation rates and production rates that the company should be tracking. Compare the quoted generator and other specialty equipment to other projects that the company has completed. Check the percentages, as shown in the graph below, to see if they are comparable to the company's historical data for these types of installations. The graph shows that the quoted materials on this project make up the majority of the costs, which would be in line with a typical emergency backup generator system.



Finally, have the entire estimate reviewed by other estimators. They can make sure that all of the costs are covered, that there aren't any holes in the estimate and that the mathematical calculations are correct. Another set of eyes is always a good idea when it comes to estimating.

Section 7 - Other Pertinent Information

The estimator should stay current and knowledgeable with any other special requirements that are needed for each different estimate that is prepared. A thorough knowledge of the NEC will help the estimator to know if the project has been designed and engineered to meet the code requirements. The estimator must be able to read and comprehend all of the technical information that is provided, have an in-depth knowledge of installation practices and material requirements so that he can visualize how the project will be installed. The estimator must be familiar with all of the AHJ requirements in different jurisdictions for which the estimates are prepared. If there are discrepancies in the documents or insufficient information to accurately prepare a cost estimate, the estimator should be actively involved with the pre-bid RFI process that should include the General Contractor, the Engineer or Architect as well as the Owner. If the answers to the questions or requested information are not received in a timely manner, the estimator must be able to qualify the estimate in writing to clarify any items that have been excluded from the bid. If there are addenda issued prior to the project bidding, the estimator must be able to incorporate the changes that are issued and still meet the scheduled time and date for submitting the bid.

Section 8 - Sample One Line Riser Diagram

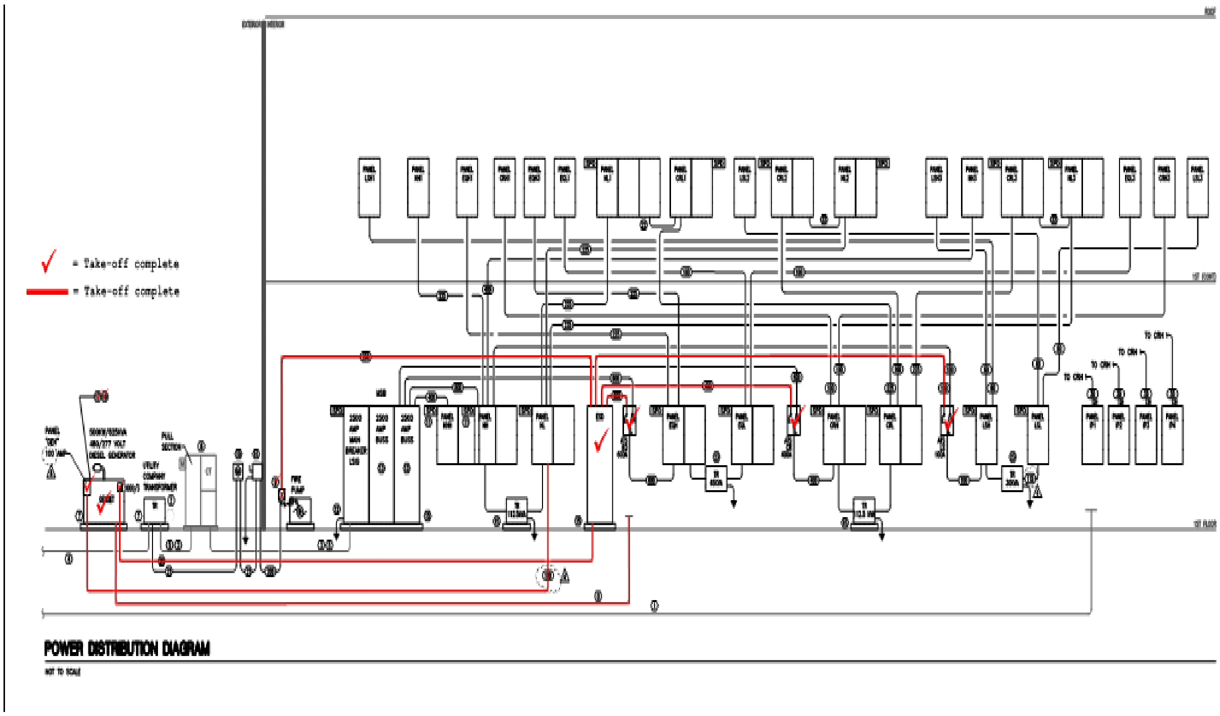


Figure 1

On this page we see the sample one-line riser diagram that shows the generator, emergency distribution switchboard, automatic transfer switches, and the conduit and wiring that make up the emergency backup power system for a hospital. The reader should be able to understand what has been included in the estimate by the red checkmarks and the red lines. (See PDF version for a clearer version of this diagram.)

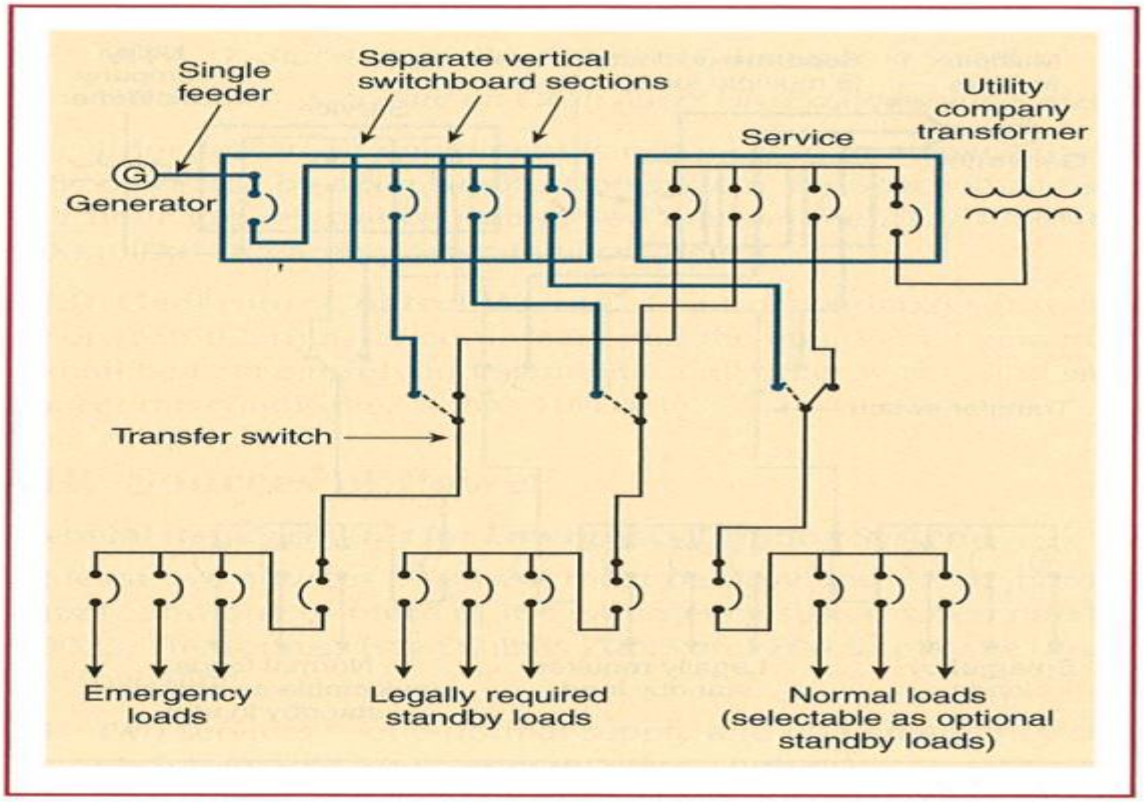
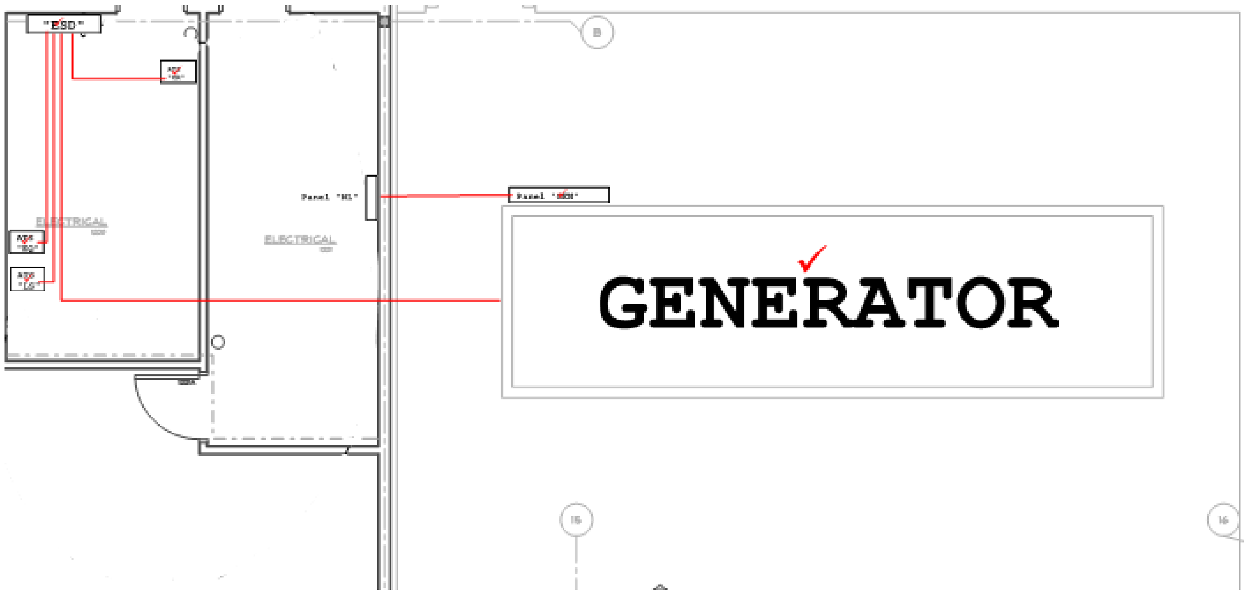


EXHIBIT 700.2 *Illustration of a single feeder that supplies separate vertical sections of the switchboard.*

Figure 2

This exhibit which is shown in the 2014 edition of the NEC (National Electrical Code) Handbook is one of the better illustrations that show the intent of the design for the emergency backup system for this particular hospital. Instead of having separate vertical switchboard sections, the emergency system for this projects is run through a single switchboard section and then out to the three different Automatic Transfer Switches which serve the different loads that are required by Article 700.

Section 9 - Sample Floor Plan – Typical Emergency Power Backup System Equipment Layout



(See PDF version for a clearer version of this sample floor plan.)

Section 10 - Sample Take-Off, Extension and Pricing

ASPE Sample Take-Off

	Audit Trail Description	Length	Count
1	500KW GENERATOR (COMPLETE ASSEMBLY)		1
2	600A ATS "EQ"		1
3	400A ATS "CR"		1
4	100A ATS "LS"		1
5	1000A DISTRIBUTION SWBD "ESD"		1
6	INSTALL FIRE PUMP CONTROLLER & ATS (PROVIDED BY OTHERS)		1
7	100A PANEL "GEN" NEMA 3R		1
8	REMOTE GENERATOR ANNUNCIATOR PANEL		3
9	1 1/2" PVC - 4#3 #8 (CU) - PNL "GEN" - PNL "NL"	36	1
10	2" PVC - 4#3/0 #6 (CU) - SWBD "ESD" - FIRE PUMP CONTROLLER	40	1
11	1 1/2" PVC - 4#3 #8 (CU) - SWBD "ESD" - ATS "LS"	14	1
12	(2) - 2 1/2" PVC - 4#3/0 #3 (CU) - SWBD "ESD" - ATS "CR"	10	2
13	(2) - 3" PVC - 4#350 #1 GND (CU) - SWBD "ESD" - ATS "EQ"	12	2
14	(3) - 4" PVC - 4#400 #2/0 (CU) - SWBD "ESD" - GENERATOR DISCONNECT	50	3
15	(6) - 1" PVC - 8#14 - GENERATOR - ATS INTERFACE THROUGH ANNUNCIATOR PANELS	50	6
16	#4/0 BARE COPPER - GROUNDING ASSEMBLY	100	1

Sample Extension

	Description	Quantity	Trade Price	Unit	Disc	Net Cost	Labor	Unit	Total Material	Total Hours	Material Condition
1	INSTALL FIRE PUMP CONTROLLER & ATS	1	$ -	E	0	$ -	4	E	$ -	4	Quoted
2	1000A DISTRIBUTION PANEL ESD	1	$ -	E	0	$ -	30	E	$ -	30	Quoted
3	600A ATS EQ	1	$ -	E	0	$ -	15	E	$ -	15	Quoted
4	400A ATS CR	1	$ -	E	0	$ -	12	E	$ -	12	Quoted
5	100A ATS LS	1	$ -	E	0	$ -	7	E	$ -	7	Quoted
6	500KW GENERATOR	1	$ -	E	0	$ -	46	E	$ -	46	Quoted
7	100A PANEL "GEN" NEMA 3R	1	$ -	E	0	$ -	4	E	$ -	4	Quoted
8	REMOTE GENERATOR ANNUNCIATOR PANEL	3	$ -	E	0	$ -	5	E	$ -	15	Quoted
9	1" GRC (GALV)	40	$ 1,040.06	C	85	$ 156.01	7	C	$ 62.40	2.8	Normal
10	1 1/2" GRC (GALV)	20	$ 1,649.54	C	85	$ 247.43	9	C	$ 49.49	1.8	Normal
11	2" GRC (GALV)	10	$ 2,023.21	C	85	$ 303.48	11	C	$ 30.35	1.1	Normal
12	2 1/2" GRC (GALV)	40	$ 3,790.42	C	80	$ 758.08	15	C	$ 303.23	6	Normal
13	3" GRC (GALV)	15	$ 4,253.47	C	75	$ 1,063.37	30	C	$ 159.51	4.5	Normal
14	4" GRC (GALV)	20	$ 6,036.94	C	75	$ 1,509.24	21	C	$ 301.85	4.2	Normal
15	1" GRC COUPLING	12	$ 279.00	C	40	$ 167.40	0	C	$ 20.09	0	Normal
16	1 1/2" GRC COUPLING	4	$ 452.00	C	40	$ 271.20	0	C	$ 10.85	0	Normal
17	2" GRC COUPLING	2	$ 822.00	C	40	$ 493.20	0	C	$ 9.86	0	Normal
18	2 1/2" GRC COUPLING	12	$ 1,435.00	C	40	$ 861.00	0	C	$ 103.32	0	Normal
19	3" GRC COUPLING	4	$ 1,859.00	C	40	$ 1,115.40	0	C	$ 44.62	0	Normal
20	4" GRC COUPLING	6	$ 2,579.00	C	40	$ 1,547.40	0	C	$ 92.84	0	Normal
21	1" GRC 90 DEG ELBOW	12	$ 991.00	C	50	$ 495.50	50	C	$ 59.46	6	Normal
22	1 1/2" GRC-12" RAD 90 DEG ELBOW	4	$ 3,876.00	C	50	$ 1,938.00	75	C	$ 77.52	3	Normal
23	2" GRC-24" RAD 90 DEG ELBOW	2	$ 8,243.00	C	50	$ 4,121.50	100	C	$ 82.43	2	Normal
24	2 1/2" GRC-24" RAD 90 DEG ELBOW	12	$ 11,231.00	C	50	$ 5,615.50	150	C	$ 673.86	18	Normal
25	3" GRC-24" RAD 90 DEG ELBOW	4	$ 14,768.00	C	50	$ 7,384.00	200	C	$ 295.36	8	Normal
26	4" GRC-36" RAD 90 DEG ELBOW	6	$ 27,241.00	C	50	$ 13,620.50	300	C	$ 817.23	18	Normal
27	1" STEEL LOCKNUT	12	$ 99.91	C	70	$ 29.97	13	C	$ 3.60	1.56	Normal
28	1 1/2" STEEL LOCKNUT	4	$ 208.95	C	70	$ 62.69	20	C	$ 2.51	0.8	Normal
29	2" STEEL LOCKNUT	2	$ 279.22	C	70	$ 83.77	27	C	$ 1.68	0.54	Normal
30	2 1/2" STEEL LOCKNUT	6	$ 771.58	C	70	$ 231.47	33	C	$ 13.89	1.98	Normal
31	3" STEEL LOCKNUT	4	$ 982.75	C	70	$ 294.83	40	C	$ 11.79	1.6	Normal
32	4" STEEL LOCKNUT	6	$ 2,089.35	C	70	$ 626.81	53	C	$ 37.61	3.18	Normal
33	1" MALL GRDG LOCKNUT	12	$ 342.00	C	70	$ 102.60	25	C	$ 12.31	3	Normal
34	1 1/2" MALL GRDG LOCKNUT	4	$ 630.00	C	70	$ 189.00	40	C	$ 7.56	1.6	Normal
35	2" MALL GRDG LOCKNUT	2	$ 849.00	C	70	$ 254.70	50	C	$ 5.09	1	Normal
36	2 1/2" MALL GRDG LOCKNUT	6	$ 1,707.00	C	70	$ 512.10	60	C	$ 30.73	3.6	Normal
37	3" MALL GRDG LOCKNUT	4	$ 2,157.00	C	70	$ 647.10	70	C	$ 25.88	2.8	Normal
38	4" MALL GRDG LOCKNUT	6	$ 4,531.00	C	70	$ 1,359.30	95	C	$ 81.56	5.7	Normal
39	1" PVC	300	$ 62.30	C	50	$ 31.15	3.75	C	$ 93.45	11.26	Normal
40	1 1/2" PVC	50	$ 104.32	C	50	$ 52.16	4.25	C	$ 26.08	2.12	Normal
41	2" PVC	40	$ 132.22	C	50	$ 66.11	4.5	C	$ 26.44	1.8	Normal
42	2 1/2" PVC	20	$ 224.39	C	50	$ 112.20	4.75	C	$ 22.44	0.95	Normal
43	3" PVC	24	$ 270.36	C	50	$ 135.18	5	C	$ 32.44	1.2	Normal
44	4" PVC	150	$ 381.39	C	50	$ 190.70	5.5	C	$ 286.05	8.25	Normal
45	1" PVC FEM ADAPTER	12	$ 101.84	C	70	$ 30.55	18	C	$ 3.67	2.16	Normal
46	1 1/2" PVC FEM ADAPTER	4	$ 161.96	C	70	$ 48.59	25	C	$ 1.94	1	Normal
47	2" PVC FEM ADAPTER	2	$ 194.12	C	70	$ 58.24	30	C	$ 1.16	0.6	Normal
48	2 1/2" PVC FEM ADAPTER	12	$ 478.84	C	70	$ 143.65	40	C	$ 17.24	4.8	Normal
49	3" PVC FEM ADAPTER	4	$ 543.08	C	70	$ 162.92	50	C	$ 6.52	2	Normal
50	4" PVC FEM ADAPTER	6	$ 733.98	C	70	$ 220.19	80	C	$ 13.21	4.8	Normal
51	4" LT FLEX	18	$ 4,462.00	C	70	$ 1,338.60	50	C	$ 240.95	9	Normal
52	4" LT INSUL STRAIGHT CONN	6	$ 40,468.00	C	70	$ 12,140.40	96	C	$ 728.42	5.76	Normal
53	#14 THHN BLACK	3,120.00	$ 198.18	M	55	$ 89.18	5	M	$ 278.24	15.6	Normal
54	#8 THHN BLACK	80	$ 748.78	M	55	$ 336.95	9	M	$ 26.96	0.72	Normal
55	#6 THHN BLACK	55	$ 1,280.00	M	60	$ 512.00	11	M	$ 28.16	0.6	Normal
56	#3 THHN BLACK	371	$ 2,478.76	M	65	$ 867.57	15	M	$ 321.87	5.57	Normal
57	#1 THHN BLACK	54	$ 4,012.62	M	65	$ 1,404.42	19	M	$ 75.84	1.03	Normal
58	#2/0 THHN BLACK	195	$ 6,031.60	M	65	$ 2,111.06	24	M	$ 411.66	4.68	Normal
59	#3/0 THHN BLACK	420	$ 7,566.80	M	65	$ 2,648.38	26	M	$ 1,112.32	10.92	Normal
60	#350MCM THHN BLACK	216	$ 16,273.20	M	65	$ 5,695.62	38	M	$ 1,230.25	8.21	Normal
61	#400MCM THHN BLACK	780	$ 18,326.10	M	60	$ 7,330.44	41	M	$ 5,717.74	31.98	Normal
62	#4/0 BARE COPPER	100	$ 8,885.50	M	60	$ 3,554.20	50	M	$ 355.42	5	Normal
63	3/4"x10' CU CLAD GRD ROD	3	$ 36.45	E	60	$ 14.58	1.6	E	$ 43.74	4.8	Normal
64	3/4" GRD ROD CLAMP	3	$ 4.39	E	60	$ 1.76	0	E	$ 5.28	0	Normal
65	GK204C 3" IPS - #4/0	3	$ 76.19	E	45	$ 41.90	0.8	E	$ 125.70	2.4	Normal
66	KC28B1 SPLIT BOLT #4/0	3	$ 11,268.00	C	45	$ 6,197.40	180	C	$ 185.92	5.4	Normal
67	DISTRIBUTION SUPPORT	1	$ 15.00	E	0	$ 15.00	4	E	$ 15.00	4	Normal
68	CONTROLS SUPPORT	1	$ 15.00	E	0	$ 15.00	2	E	$ 15.00	2	Normal
69	BRANCH PANEL DISTRIBUTION SUPPORT	4	$ 15.00	E	0	$ 15.00	3	E	$ 60.00	12	Normal
70	GENERATOR DISTRIBUTION SUPPORT	4	$ 50.00	E	0	$ 50.00	3	E	$ 200.00	12	Normal
	TOTALS								$ 15,137.59	418.37	

(See PDF version for a clearer version of this extension view)

Final Pricing Sheet

Final Pricing	Calculated (%)	Modified ($)	Modified (%)	% Final Price
Database Material (Extension)		$ 15,137.59		4.657
Quoted Material		$ 167,416.00		51.506
Material Tax	6.85	$ 12,504.92	6.85	3.847
Material Total		$ 195,058.51		60.011
Direct Labor		$ 18,179.23		5.593
Incidental Labor		$ 3,476.20		1.069
Indirect Labor		$ 2,215.85		0.682
Labor Total		$ 23,871.28		7.344
Subcontractors		$ 7,435.00		2.287
General Expenses		$ 5,900.12		1.815
Equipment		$ 44,018.75		13.543
Total Cost		$ 276,283.66		85
Database Material Overhead	8	$ 1,283.22	8	0.395
Quoted Material Overhead	3	$ 5,370.55	3	1.652
Labor Overhead	20	$ 4,774.26	20.00	1.469
Subcontractors Overhead	6	$ 446.10	6	0.137
General Expenses Overhead	4	$ 236.01	4.00	0.073
Equipment Overhead	4	$ 1,760.75	4.00	0.542
Adjustment Overhead		$ 18,633.88	6.74	5.733
Total Overhead	5.021	$ 32,504.77	11.77	10
Database Material Markup	4	$ 692.94	4.00	0.213
Quoted Material Markup	2	$ 3,687.78	2	1.135
Labor Markup	13.5	$ 3,867.15	13.5	1.19
Subcontractors Markup	4	$ 315.24	4	0.097
General Expenses Markup	3	$ 184.09	3	0.057
Equipment Markup	3	$ 1,373.38	3	0.423
Adjustment Markup	1.712	$ 6,130.96	1.985	1.886
Total Markup	5.2	$ 16,251.54	5.263	5
Selling Price		$ 325,039.97		100

Section 11 - Glossary of Terms and Abbreviations

AHJ – Authority Having Jurisdiction. In construction, the authority having jurisdiction is the governmental agency which regulates the construction process. In most cases, this is the municipality in which the building is located. However, construction performed for supra-municipal authorities are usually regulated directly by the owning authority, which becomes the AHJ.

Architectural scale – A specialized ruler designed to facilitate the drafting and measuring of architectural drawings and orthographic projections. Because the scale of such drawings are often smaller than life-size, an architect's scale features multiple units of length and proportional length increments.

ATS – Automatic Transfer Switch is an electrical switch that automatically switches an electrical load between two sources, usually the utility and a backup power source. As well as transferring the load to the backup generator, an ATS may also send a signal through a controller to start the backup generator based on voltages monitored.

BOM – Bill of Materials. A bill of materials or product structure is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product.

Davis Bacon – The Davis-Bacon Act of 1931 is a United States federal law that establishes the requirements for paying the local prevailing wages on public works projects. It applies to contractors and subcontractors performing on federally funded or assisted contracts in excess of $2,000.00.

Digitizer – A mechanical device used to measure or count quantities, lengths, areas or volumes that will convert the information to digital form for automatic input to computerized estimating software.

Emergency System – National Electrical Code Article 700.1 defines emergency systems as "those systems that are legally required and classed as emergency by municipal, state, federal or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life."

FOB – Freight on Board is a term used to explain that when a factory loads the "freight on board" the commercial freight delivery truck, they are no longer responsible for any damages. The trucking or freight company then assumes responsibility and requires that all claims be submitted to the trucking or freight company.

KVA – A Kilo-volt ampere is equal to one thousand volt-amps, which is the unit used for apparent power in an electric circuit.

KW – A Kilo-watt is equal to one thousand watts and is typically used to express the output power of engines and the power of electric motors, tools, machines and heaters.

NEC – The National Electrical Code, or NFPA 70, is a regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States. It is typically adopted by states and municipalities in an effort to standardize their enforcement of safe electrical practices.

NECA – The National Electrical Contractors Association is a trade association in the United States that represents the $130 billion per year electrical contracting industry. NECA supports the businesses that bring power, light, and communication technology to buildings and communities. Through advocacy, education, research and standards development, NECA works to advance the electrical contracting industry.

NFPA – The National Fire Protection Association is a United States trade association that creates and maintains private, copyrighted standards and codes for usage and adoption by local governments. NFPA defines its mission as follows: "To reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training and education."

Ohm's Law – Ohm's law states that the current through a conductor between two points is directly proportional to the potential difference across the two points. Introducing the constant of proportionality, the resistance, one arrives at the usual mathematical equation that describes this relationship: $I=V/R$, where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms.

RFI – Request for Information is a formal document submitted to another party requesting further information. Usually this is a specific question with some sort of reference to the contract documents that may be unclear or to an engineer's change.

Rotometer – An analog or digital mechanical device used to count quantities or lengths.

Section 12 - References

NEC 2014 National Electrical Code

NECA Manual of Labor Units 2013-2014

RS Means Electrical Cost Data – Online Version 5.1

Accubid Pro and LiveCount Estimating Software by Trimble

Wikipedia