

**HEAVY MOVABLE STRUCTURES, INC.
TWELTH BIENNIAL SYMPOSIUM**

November 3-6, 2008

Developing Quality Electrical Design Plans

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ORLANDO, FLORIDA**

Introduction

The development of any design plans requires the plans be developed in a manner that will provide the contractor with an adequate level of information and detail that will result with a bridge that can be constructed with a minimum of problems, be durable in design to provide a long service life, designed to be as easy to maintain as possible and give the owner a product to be proud of. As with anything in the field of engineering, how to achieve these end goals will likely result in opinions that will equal in number to the number of individuals that are offering those opinions. This is just as true for electrical design plans on movable bridges. What should be included in a quality set of electrical design plans. This paper will present one point of view on what it takes to development quality design plans and how to develop them.

What Are Quality Plans and Specifications?

The development of quality design plans require good forethought and planning before the actual design process begins. First and foremost, the needs and desires of the client should be explored and determined. Some clients will know precisely what they want for the electrical system on their bridge while others only know that they have a movable bridge that need to be rehabilitated or replaced and have no concept of what technologies are available. Discussions should be held with the client on the different types of control systems and drive systems that are available and if possible, maintenance personnel should be included in these discussions. Many times, input from maintenance personnel can provide the designer a history of the existing structure that have resulted in problems that made a particular maintenance item difficult. These discussions with the client and/or maintenance personnel may also show that some technologies that could be applied to an electrical design result with an end product that the owner would not be able to adequately maintain or repair without include specialized training of their maintenance personnel in with the construction contract.

Once the desires of the client have been determined and the design features for the electrical system have been agreed to, it's time to begin the design. The designer needs to have an good understanding of what will be shown on the design plans and how to formulate the design plans so that the end produce will provide enough information of what the designer's intent for the end product will be so that the contractor can prepare a good bid for the construction of the electrical system. This requires the designer to prepare a set of plans that are organized and provide good detailed drawings of equipment installations where specific or unique installations would be required.

Design drawings should been drawn to scale with the scale indicated wherever possible. This is especially true for equipment details and plan drawings showing the location of equipment layouts in the control towers, machinery areas and on approach plans. Why is this necessary? Two important reasons can be made, the first is to insure that what is being shown on the drawings for the equipment layouts will in fact fit as shown on the drawings and can be installed in the field during construction. The designer needs to think thorough the installation of the electrical equipment as the design is prepared. This would be applicable to both new designs and especially for rehabilitations. It can be embarrassing to get a call during the construction from the contractor informing you that the equipment layout shown on the drawings will not work because the cabinets are bigger that what was shown on the drawings or that that equipment can not be installed in the building because the access openings are not big enough for the

equipment to fit through. The result of this type of poor planning during design will likely result in extra work claims, delays in the construction or both.

Scale drawings are critical to any bridge design including the electrical design. Drawings present in scale, with the scale noted on the drawing will insure that all electrical equipment shown on the drawings will be able to be installed as shown on the bridge structure without the concern of improper fit or a lack of space for the installation. In addition, drawing show to scale will provide a means for the contractor to prepare his material take off and submit a much more accurate bid price for his work. When the contractor does not have scaled drawings, then allowances must be put into the bid price to cover the contractor's cost to either complete the design of the electrical installation or to provide enough money in the bid price to the various unknown issues that will likely come about after the construction starts.

Details of electrical cabinets should be provided as part of the design drawings. This is important for several reasons. By showing a detailed drawing of each major electrical cabinet with all equipment laid out to scale within the cabinet, will give the designer assurance that the equipment needed for the control system will indeed fit within the cabinet sizes that are shown on the drawings or called out in the specifications. Detailing these cabinets will also provide a give the designer the size of the cabinets required for the design, and therefore allow for the placement of the equipment within a room verifying that the cabinet placement will comply with all code requirements for proper clearances.

Coordinate with other disciplines is critical in the preparation of the electrical design plans. This includes bridge structural, architectural and mechanical. Structural coordination is necessary when it becomes necessary to mount electrical equipment to a structural member on the bridge, such as a limit switch, electrical cabinets or light fixture. Clearances can become critical, especially if the component is mounted near the moving structure. Accessibility for maintenance needs to be considered whenever an electrical component is mounted to the bridge structure to insure that maintenance personnel will be able to easily and comfortably gain access to the equipment. If a piece of equipment is left in a position that can not be easily accessed or if the maintenance person is not comfortable while performing the maintenance, then it is very likely that the maintenance will not be done until it becomes a crisis situation and the bridge fails to operate properly. Of course, there are times when easy access is not obtainable on a bridge, but accessibility should be considered at all times. Many times, the only thing needed is for a service platform or access ladder to be provided in the structural design.

Coordination with the architectural design is necessary to insure that adequate floor space is being provided for the placement of the electrical equipment that will be provided. Since the designer can not always predict the final size of a piece of electrical cabinetry or electrical equipment, the space that is being provided should also include some growing space to accommodate a larger cabinet or to accommodate a piece of electrical equipment that may need to be included with the electrical system but was not anticipated during the design process.

Coordination with the mechanical design could be said to be one of the most important in the development of the electrical design. It is, after all the electrical equipment that will be operating the machinery that is lifting the bridge. Just what type of coordination is needed with the mechanical design includes the motor rpm, the motor loads for each of the design loads for both starting of the motors as well as the running of the motors, if operation of the span will use a single drive motor or dual drive motors during operation, the operating time of the drive motors, the motor and machinery brakes to be

used and the connection of the span control equipment (rotary limit switch and position resolver) to the operating machinery. The machinery designer needs to be fully aware of the overload limits of the drive controllers that will be provided. Most drive controller manufacturer's state a drive controller is limited to an overload condition of 150% for a duration of 1 minute and that operating a drive motor that exceeds the full load capacity for each operation or for extended periods of time is not recommended as a normal design practice.

Who Should Prepare Electrical Design Plans

It has been widely accepted in our industry that electrical contractors are the installers of the designs for movable bridge electrical systems, but as installers, these electrical contractors need to be given adequate and thorough direction on how to install the electrical system. This direction comes from a well produced and detailed set of construction plans and it is the design engineer that holds the responsibility to develop and prepare the design plans. The more information contained in the design plans, the better the bids will be for the owner of the bridge structure. In addition, the more detailed the design plans and specifications are, the likelihood for extra work claims will be reduced that can be attributed to a lack of information shown on the plans or in the specifications. When the design plans are lacking in detailed information that will be needed for the construction, the contractor will be required to add money to his bid price in order to protect his company from taking significant losses on the project. He can not depend on getting the additional compensation for these efforts when making extra work claims or to depend on getting a full compensation for the additional work performed.

In a prior time, there were companies such as General Electric, Westinghouse and Cutler Hammer that had a team of engineers on their staff that would design a movable bridge control system and drive system based on the requirements that would be shown on the consultant's design plans. In this same time period, the electrical contractors were much more willing to take on the additional design tasks that were required to install the electrical system. Unfortunately, this is not the case in today's industry. The engineering staffs from the "big three" of the electrical suppliers no longer exist and the contractors are no longer willing to do the installation design needed for the installation of the electrical system. The design consultant is now expected to prepare these types of design plans and take on the responsibility for the quality and detail of that design. It is for this reason that a detailed and complete set of design plans must be prepared for each bridge electrical control system and drive system. One obstacle that can hamper the level of design shown on the plans is that nearly all movable design projects are being funded by "public" money which requires the designer to produce a set of plans that are "generic" in nature and such a manner that the control system or the drive system components will not be "sole sourced" to a single manufacturer. This means that the design plans must be broad enough to be open to more than one manufacturer but yet tight enough and with a quality level that directs the contractor to use the type of equipment and to install this equipment in a way as to provide the owner with the best control system and drive system he can get. The bids must be kept competitive in insure that the owner will get the best price for the system that is being provided.

Summary

The production of a set of design plans is something that is learned like most other things in the movable bridge profession. The learning comes from the teaching by your mentors, the experience in the preparation of the design plans, seeing the design constructed, learning from the problems that were incurred during the construction and then seeing the project put into operation at the start up. As times have changed over the years, the designer is expected to provide more direction to the contractor and his sub contractors by the information and detail put into a set of design plans. The time when the design engineer could produce a basic set of design plans and expect the contractor to perform the additional design tasks to actually bring the project to completion by assuming that the contractor was an experienced installer of electrical systems is rapidly becoming a thing of the past. The more the designer leaves out of his/her design, the more likely the qualified contractors will either not bid on the project or because of his experience, will submit a bid with additional money to cover his time and effort to do the design that is not already in the plans which usually has these bids at higher cost than the contractors with less experience. The result of this is that the lower experienced contractor will submit a bid with a lower cost not knowing the level of effort that will be needed, then realize after being awarded the contract, realizing that his bid price was much to low. This then leads to either a poorer quality end product for the client or the more likely the submission of numerous extra work claims in an attempt to get back the costs that he left on the bidding table. If the design plans do not provide the level of detail or an adequate amount of design, then the contractor most likely will win any claim for extra work pushing up the overall end cost of the electrical system above what the client had originally budgeted for the project. Should only experienced contractors submit bids for the electrical installation, then it is most likely the bid prices will be higher that necessary in order for the contractor to provide the additional design required before he begins his work on the project. Even if the contractor provides the additional design, there is still the likely possibility that extra work claims would be submitted and granted bringing the electrical construction cost higher that what the owner had budget. With owners watching their own construction budges more closely today that has been in the past, the owner may seek to have some or most of the extra cost incurred paid for by the design consultant.

It might be argued that if the contractor provides some of the design, then the overall cost of the project would be the same since the design would be done anyway whether it be by the design consultant or the contractor. But is this actually an accurate statement? It is the designer that is the most familiar with what is expected for the construction of the project and with this familiarity, it would seem the most cost effective that the design consultant could do this design cheaper and faster than the contractor. The contractor, after all, will need to bring his level of knowledge about the project to the same as the design consultant, which requires time and effort that the contractor must include in his bid price.

With a lower level of design plans for the contractor to use for the installation, the engineer will not have the same amount of strength in stating that an installation is not what it should be since it was the contractor's design and not the engineer's design for the end product.

In order for the design engineer to provide a level of control on the final end project, the more information shown on the design plans, the better the bid prices will be, the fewer extra work claims will be submitted and the happier the owner will be with the end product, which most likely results in more work from this client on future projects.