MAINTENANCE PROCEDURES FOR ELECTRICAL CONTROLS ON MOVABLE BRIDGES

PRESENTED AT THE SYMPOSIUM AND
EXHIBITION ON MOVABLE BRIDGE
DESIGN AND TECHNOLOGY

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The owner of a movable bridge must recognize that even in the best designed electrical systems that potential problems exist due to the very nature that electrical components have a finite life. These components will fail while the movable bridge is expected to open or close. How is the user going to minimize the potential problems that will occur when the bridge fails to move? The only way is to be prepared before the bridge fails. This preparation can be divided into three classifications: 1. Knowing all the components and their application, 2. Personnel training for quick, responsive corrections get the system operational as soon as possible, and 3. Proper documentation covering not only the manufacturers supplied information but also component histories, sequence flow charts and availability and location of parts.

Any moving part be it a motor, contactor, brake or limit switch has a minimum useful life as designed by a manufacturer. It has been our experience that component failure occurs not only from reaching this minimum useful life but also from external forces such as dirt, misalignment, exposure to the elements and lack of proper preventative maintenance. I have visited bridge installations where the bridge is forty to fifty years old and the bridge has another twenty years of useful life. Similarly, other bridges under the same cirucmstances may not open on the next try. What is the difference? Mainly it is due to preventative maintenance or the lack thereof.

To give a few examples, motors must be checked for alignment, thrustor operated brakes must have their oil reservoir and linings checked, limit switches their contacts and operational linkage checked. When was the last time the emergency generator was exercised and put under load? Is the concrete dust from the original installation still on the bottom of the control cabinets? How many bulbs are burned out on the control desk?

The consultant engineer will normally specify the types of equipment installed on the movable bridge. In writing these specifications he must not only be aware of the design limitations that the manufacturers impose but also in how the equipment under consideration must be applied. Many times a certain device may be proposed other than that which is specified. The question is not is it as good but will it work in the particular application specified. This problem can be seen for example in limit switches where a standard oil tight limit switch may be proposed to replace a railroad type limit switch. Even though the railroad switch is more expensive by a factor of ten, its design both from a mechanical and electrical point of view is far superior in certain applications and over its useful life will more than offset the original difference in price.

Certain other devices such as programable controllers and thrustor operated brakes should be applied with the certain limitations in mind. The thrustor operated brake has a suitable application in bridge control systems. However the consultant must consider its application such as on Rolling Bascule Bridge, where its rotation off of horizontal is limited by the manufacturers design. In addition the environment cannot be ignored and certain additions such as corrosion resistant fittings, enclosures, low temperature oil and anti-condensation space heaters must be considered.

Similarly if the design is going to incorporate programmable controllers, the engineer must consider the environment from both an atmospheric and electrical point of view. A programable controller has limited operational temperature ranges as well as preferred humidity ranges as determined by the individual manufacturer. In addition, from an electrical point of view, the designer must consider lightening protection, electrical noise, the use of surge suppressors and the physical limitations of proximity to other electrical devices in his design. Also many experienced maintenance personnel can jury-rig an electromechanical device to make it work on a temporary basis. However this cannot be done as readily to a solid state programmable controller. Any designer who does not consider the application of devices is courting a major problem that may not show up for years after the original installation.

It is a calm Sunday morning and the sailboats are beginning to line up to come down the channel. When the bridge operator attempts to open the bridge nothing happens. The maintenance person assigned to that bridge has determined that maybe a 400A fuse has blown or that a solid state printed circuit card is defective. On a Sunday morning where is he going to obtain the needed part?

This question should not be asked on Sunday morning but rather should be answered at the time the owner accepts the bridge from the contractor. The availability of replacement parts is critical to keeping a bridge in operation. Normally a certain stock of replacement parts is supplied by various manufacturers, if it is specified in the contract specifications. However these parts may not be enough to cover all possible contingencies. It is the responsibility of not only the user but also the designer to anticipate component failures and make recommendations.

In addition the maintenance staff and the users purchasing department must have a stocking source for these parts for many of them have long lead times. Another question that must be answered is the physical location of these parts and how are they marked. To open a locker or crate and find a starter contact kit without the proper cross-references and where it can be used is self-defeating. The equipment suppliers should list all the necessary cross references with the parts supplied.

A critical element in this chain of readiness is the roadmap to the system, also known as the wiring diagrams. A typical two leaf Bascule Bridge normally has about twenty "D" size wiring diagrams plus detailed data for the motors, brakes, limit switches and power distribution system. There is a lot of information contained within these drawings.

To look for these drawings when there is a problem or to first open them at the sign of trouble is to put the maintenance personnel at a disadvantage. The schematics should be reviewed and logically broken down into sub-systems before there is any sign of trouble. Again if we look at a typical two leaf Bascule Bridge we can break up the system into such sub-systems as traffic gates, barrier gates, span or tail locks, machinery brakes and the drive system. If each of these sub-systems were examined as a stand alone circuit, you would see a few relays, one or two starters and some pilot devices such as limit switches or pushbuttons. By breaking down the total bridge system this way it becomes easier to trouble-shoot. An average maintenance man with a V.O.M. meter can quickly locate a problem within these components. A neon indicator when placed across a relay contact will indicated if voltage is present or not.

The subject of preventable outages has become one of major importance. Bridge owners are placing more emphasis on equipment reliability and longevity. The attention given to preventative maintenance is of utmost importance if costly and unnecessary shutdowns are to be avoided. This can only be accomplished by having a program of systematic maintenance. Regular inspection and testing of the electrical system is vital to system reliability.

The major components of the electrical system should be examined to see where the greatest potential for problems will occur. An effective preventative maintenance program should include a thorough visual examination, replacement of worn or questionable parts and operational check.

This program for maintenance should start before the project is completed. The startup and de-bugging procedures as performed by the manufacturer and contractor offer an invaluable aid to obtain initial test data that will serve as a cross-reference at a later time. When compared to later data, it will allow a comparative analysis to see if there has been a significant change. Performing an insulation test on submarine cable is an example. The value at installation can be matched against subsequent inspections to determine if there has been any deterioration.

This initial inspection can start the preventative maintenance program. The personnel should insure that all equipment has been cleaned and that all debris such as cement particles, wire ends, coffee cups have been removed. In addition, all terminations should be check and recorded for proper torque and connection.

The concept general to preventative maintenance is proper recordkeeping. The initial records started before taking over the project serve as comparative data. A method of recordkeeping and logging should be initiated by the user so that this information is available to the field serviceman. We recommend that individual tags (similar to those found on oil burners) be located at every major piece of equipment so that the history of that device is readily accessible to the serviceman. In addition, a master log should be located at the project site to record all inspections and corrective changes. These notes and records are preferred to the memory of the serviceman. Another reason for these records is the user may have rotating crews whereby the same person may not be the one performing these functions the next time.

Here are some suggestions as to what is required in record keeping.

1. Renewal Parts List - Showing what the replacement parts numbers are and where they are applied. Also on this list should be the source of these parts and a telephone number.

2. Equipment Record - Showing manufacturers serial numbers, factory order numbers and all pertinent information such as voltage, horsepower frequency, R.P.M. and full load current.

3. Maintenance Checklist - Includes items that have to be performed by the service personnel such as inspections, voltage tests, cleaning, etc.

4. Failure Record - Many times the same part will fail. The failure record will highlight the problem part and bring it to management attention.

The best place to start a maintenance program is in the preparation of project specification. The owner and designer must detail the kind of information that is required. The project must be viewed as a system and all maintenance information must fit in to this. The system supplier should as a minimum be required to supply not only wiring diagrams, renewal parts lists and installation instructions, but also a programmed method for preventative maintenance, a systematic approach to locating and correcting failures and a training session for informing all necessary personnel how to operate the bridge.

This training session should not be taken lightly. As a minimum it should last for three days and cover the following:

1. Drive system including drive control, motors and brakes.

2. Control circuit design and analysis from a maintenance viewpoint.

3. Theory of bridge operation.

4. Review of manufacturers operations and maintenance literature.

5. Actual visit to jobsite to familiarize personnel with the equipment and its location.

In addition these sessions should be videotaped for future use. Many times either due to a turnover of personnel or to the type of questions and answers asked at these sessions, the tapes will serve as backup documentation for the project. When a new man is assigned to the bridge he can review the videotape and immediately become familiar with the system he must maintain.

Somewhere, sometime a bridge will fail. Will we be ready for it.

APPENDIX A

In general certain precautions should be observed before performing any inspection of electrical equipment. Power should be disconnected and padlocked off for the maintainer's protection. In addition, there is always the possibility that another source of voltage is present and therefore the device should be checked with a voltmeter to determine if the device is live.

Silver contacts should not be filed or dressed in any way as this action will remove much of the usable silver. Rather a piece of kraft paper or brown bag will serve as a suitable abrasive for cleaning.

Common solvents and degreasers should be used with care. It is possible that they could leave a gummy deposit on the device that could accelerate failure or have a chemical reaction to the device material that would impair usability. In addition, lubricants should not be used unless specifically recommended by the manufacturer.

One of the greatest enemies of electrical controls is dirt and foreign matter. Dirt not only prevents these devices from proper heat dissapation but also can interfere with the normal operation. Dirt can work its way into contact structures, coils and armatures and cause premature failure or arc-over. It is highly recommended that all electrical controls be inspected and cleaned on a normal, scheduled basis.

ROUTINE SCHEDULE FOR INSPECTION

Every three months:

Device:	What to Check For:
Thrustor Brakes,	Control voltage, loose connections, corrosion of metal parts, freedom of moving parts, oil level, oil leaks, excessive heating of thrustor motor or solenoid, condition of brake shoes and brake wheels and dirt

Limit Switches; Drum Controllers	Loose connections, corrosion of metal parts, freedom of moving parts, physical integrity of enclosure and interior, discoloration of contacts indicating excessive heat, condition of movable and stationary contacts, moisture and dirt
Contactors, Starters Relays	Control voltage, loose connections, corrosion of metal parts, freedom of moving parts, discoloration of contacts indicating excessive heat, condition of movable and stationary contacts, hum or noise when the device is energized, physical integrity of device, and dirt
Timers	Control voltage, loose connections, corrosion of metal parts, freedom of moving parts, discoloration of contacts indicating excessive heat condition of movable and stationary contacts, hum or noise when the device is energized, correct timing compared to project requirements, physical integrity of device and dirt
Terminal Blocks	Loose conections, corrosion of metal parts, physical integrity of device and dirt
Pushbuttons Pilot Lights Switches	Loose connections, corrosion of metal parts, freedom of plunger or to GGLE, proper contact of bulb, physical integrity and dirt
Enclosures	Corrosion of metal parts, rust, moisture and dirt
General	Tighten all mounting bolts and connectors

TROUBLE SHOOTING GUIDE

Problem	Cause	Remedy
Contact Chatter	1. Intermittant contact in pickup circuit	Find and replace contact
	2. Low voltage	Correct voltage condition
	3. Broken shading coil	Replace Assembly
	4. Excessive vibration in panel	Tighten all mounting bolts
Short Contact Life	1. Loose connection	Tighten connection
	2. Rapid cycling	Check for loose connection and tighten
	3. Breaking excessive current	Check for binding in controlled device, grounds or shorts
	4. Foreign matter	Clean whole contact structure
Coil Failure	1. Overvoltage/undervoltage	Correct system voltage
	2. High ambient temperature	Vent enclosure
	3. Dirty pole face	Clean armature and coil assembly
Coil Humming	1. Misalignment of magnet assembly	Realign
	2. Low voltage	Check system voltage check voltage drop on motor starting
	3. Dirt or grit on pole faces	clean
	4. Bad shading coil	Replace assembly
Relay Failure	1. Mechanical alignment	Replace relay
	2. Binding	Clean out
	3. Dirt or grit in moving armature	Clean out

Overload Relay	1. Overload trip	Check for shorts and grounds, mechanical binding, check for loose connections
	2. Non tripping due to incorrect heater	Check motor nameplate and heater size
	3. Non tripping due to calibration	Replace relay