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"The Use and Abuse of Bypass Switches"

by

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THE USE AND ABUSE OF BYPASS SWITCHES

THIS PAPER WILL EXPLORE THE USE OF BYPASS SWITCHES ON MOVABLE BRIDGES. IN MANY CASES THE OWNER'S OPERATOR IS PUT IN A POSITION OF OPERATING THE BRIDGE WITHOUT PROPER SAFETY PROCEDURES. CERTAIN DESIGN CONSIDERATIONS SHOULD BE CONSIDERED IN THE DESIGN PHASE AS WELL AS PROPER LABELING OF EACH DEVICE. IN ADDITION PREVENTION CIRCUITS SUCH AS RELAY INTERLOCKING AND ONE SHOT PLC CIRCUITS WILL BE EXPLORED.

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Almost all movable bridges have some sort of bypass switches installed on the control desk. In most cases these switches bypass a failed interlock circuit or limit switch that is needed to continue bridge operation. However I wonder if the user and designer have given any thought to the use and abuse of these switches especially in today's litigious society.

On a typical two leaf bascule span there might be the following bypass switches installed on the desk.

Traffic light bypass

Traffic gate bypass

Barrier gate bypass

Span lock bypass

Fully seated bypass

Brake hand crank bypass

Brake released bypass

On a swing or lift bridge there are additional functions to be bypassed such as jacks , wedges and skew circuits.

As can be seen from above, if all the bypass switches are placed in the bypass position, the bridge span can be operated with little or no safeties. Is this what we really want as users and designers? This is the point of this paper. We must rethink what we want to accomplish, what we are doing and the end result of what can happen.

I have not been able to find when the first bypass was used but having been on more than a few bridges, I can attest to the cheater wires or bypass switches that are installed to make a bridge operational. My favorite was a swing bridge that will be unnamed that had a strip of wood with a number of switches mounted on it. This block was mounted behind the motor control center. When the maintenance contractor was called to get the bridge moving, he just flipped all the switches on his cheater board and -voila- the bridge would move. Sometimes, if he was real busy, the switches would remain in the bypass position until he had time to come back and correct the problem. If an accident occurred, a lawyer would have a field day with all the people involved with the bridge. You know the old joke about hiring an engineer and putting a lawyer to work.

On another bridge, the general contractor had all the bypass switches in the bypass position during construction. He tore off the span locks of the span and wondered how it happened. Does this scare you? It should as there is a liability involved every time a bypass switch is used.

The first question to be asked is why do we need bypass switches? They are a result of the Coast Guard's requirement of keeping the water way open to boating traffic. As most of the owners here know, the Coast Guard becomes very uptight when a bridge fails to operate when it is supposed to. Major shipping channels carry not only pleasure boats but also ocean going freighters that are time sensitive. We are allowed to build a bridge over a waterway as long as boats have an unimpeded use of that waterway. Bypass switches allow the operator or maintenance department to continue the operation of the span until the problem can be located and rectified. While this helps the waterway traffic, it presents certain problems to the owner of the bridge.

Many failures on a bridge are the result of a limit switch failure. This failure can be the result of a failed limit switch, a broken wire, gunk that fouls up the limit switch or just plain old age. In all cases we must be able to operate the control circuit and therefore the bridge. Without bypass switches, this major cause of bridge failure would prevent operation with the attendant backup of boating and vehicular traffic. So to answer the first question, bypass switches are a necessary evil that are needed to permit continued operation of the span. We may not like the idea, but it is something that we have to live with.

This leads me to my next question. If bypass switches are a necessary evil, then who should have responsibility for the actual operation of the bypass switch? In some states, the bridge operator has the freedom to utilize the bypass switch. In other states, only the maintenance department is authorized to use the bypass. The owner has it's own internal limitations whether it be union restrictions, location of maintenance personnel, operator ability or coast guard restrictions. The owner must set up procedures that determine when a bypass switch is to be used and by whom. The owner has to reexamine who is authorized to use the bypass switches and how much time is allowed to get the bridge in operation again. The problem is compounded by the fact that if the bridge is under any type of construction or renovation, the contractor normally has control of operation and therefore is at liberty to use any switch as it deems necessary. This sometimes leads to damaged equipment or to lawsuits if someone is injured. Contract specifications should be examined to see where the liability rests.

Where should the bypass switch be physically located?. Should they be on or in the desk or perhaps somewhere else? Should they be locked? Should they be accessible to the operator? Again, there is no easy answer. This question needs some real exploring as the safety of the bridge and those around it depends upon it. Most bypass switches are located on the operators desk. Some are located inside the desk while others are located on the motor control center The general consensus is to locate them on the control desk so that they may be easily accessed if needed. However, is this placement too convenient? A number of years ago, vandals broke into an unoccupied bridge and were able to raise a leaf six feet by randomly setting various bypass switches as well as other controls. An automobile crashed into the raised leaf causing serious injury.

If bypass switches are to be mounted on the desk, then they should be locked and sealed closed. Why a seal? If an accident occurred, the seal could be used to verify the operators log to determine if in fact the bypass switch was used. Again, I have seen where a logbook has been falsified to cover up an operator error. The seal can only be replaced by an authorized supervisor. A key is a great preventative measure but it is not fail safe. If everyone has a key or if it is hung on the wall, then it is practically useless. We are trying to prevent unintended operation. We want the person who is using the switch to have to go to a great effort in order to operate it. It is not a normal operating control but only to be used in case of emergencies. Typically, a bypass may be used once or twice a year as a problem arises. Should it be as accessible as a normal operating control? I cannot answer this, but it is a question that should be asked and addressed by the owners design guidelines.

We now turn our attention to the nameplate on the bypass switch. There is a tremendous state of confusion in the industry as to how these switches should be marked. Some switches are labeled as to the function or device being bypassed while others are labeled as to the operator function. The problem is that when a new control system is put in use or when an operator unfamiliar with the bridge is on duty, there is no familiarity with what the bypass switch actually does. The result usually is multiple bypasses being thrown until the operator can get the span to move. This situation is dangerous. For example, a switch is labeled "Traffic Gate Bypass". What does the nameplate mean? Am I bypassing the traffic gate to allow operation of the barrier gates or span locks or am I bypassing the red signal interlock to allow operation of the traffic gates or am I bypassing the barrier gate limit switches to allow traffic gate operation? There is enough ambiguity in the brief description to cause problems. I am not advocating a common design for all bypass switch circuits being used by various designers as the operating philosophy is different from firm to firm and I do not want to start an argument as to the design. However, I will have some recommendations as to the design and implementation later. Possible operator error should be considered in the design. One way to approach this is with a bypass schedule on the desk.

The bypass nameplate problem is compounded by the fact that there normally is not enough space on or near the switch to put a suitable nameplate describing the active function of the switch. In designs where the bypass switch shorts out or opens a limit switch contact, should the label read what device is being bypassed. For example" Traffic Gates Down Limit Switch Bypass". In other circuits, the bypass switch is used in the control interlocking circuits to bypass relay contacts used in the interlocking function. For example, "Traffic Gates Down Bypass" would possibly be used in a barrier gate circuit as well as span lock circuit. If I operate a "Traffic Gates Down Bypass" , I am allowing a permissive in both the barrier gate circuit as well as the span lock circuit. Choice of nomenclature is critical in defining the function.

If the desired information cannot fit on a nameplate or be attached to the bypass switch, a suitable lamacoid about six by six inches could be put on the control desk to explain the functions of the individual switches (see exhibits A & B). The nameplate should show the switch nomenclature, the device being bypassed and the permissive interlock that is allowed to function. This nameplate would make the operators job much easier when a bypass must be used. As can be seen from exhibits A and B there is a marked difference in how the particular bypass switch operates in the circuit. For example, look at the traffic gate bypass switch function on exhibit A and B. Both switches have the same nomenclature but the action of the switch is quite different. In one case, the switch bypasses any interlocking functions that would prevent operation of the traffic gate. In the other case, the switch bypasses the traffic gate down limit switch to allow another device to operate. In like manner, the other bypasses shown in exhibits A and B can be mistaken in how they operate from the nameplate information shown.

The largest problem in using bypass switches is one of safety. Since a permissive is being bypassed, there is a danger that a mechanical device will be out of position. In other words, it may not be a limit switch problem. A span lock may be hung up between positions or a gate stuck between full closed and full open. In either case, in using a bypass switch, the device being bypassed must be visually verified as to position and operation before the bypass is utilized. In some cases such as span locks and brakes, using the bypass switch can damage equipment or endanger people if the device has not been visually checked and found to be in proper position. I cannot stress this point too much.

Too often, a bypass switch is utilized without checking the position of the device being bypassed. Visual checking of a traffic gate or barrier gate is easy since they are in direct view of the control house. However, traffic lights, span locks, wedges and brakes are not visible and therefore need visual confirmation for proper position before the span operation can continue. Yes, there is the pressure of time. But safety should be paramount. There is also a danger, in once the device has been shown to have failed, to try and move it by means of a hand crank or other suitable device. This can be extremely dangerous as the bridge control circuit may still be active and once the device starts to move, it may take off on it's own and cause injury. Department guidelines as to operator procedure must be reviewed as to the likelihood of accidents or in the time pressures of the moment that the operator can do something that was not supposed to be done.

How are bypass switches designed into the circuit? We can look at the two types of control circuits now in use, relay logic and PLC logic. In using relay logic, we are limited in the level of protection that can be afforded. The attached sketch, exhibit C, shows some of variations in the logic. Notice that in some cases, the bypass switch shorts out more than one function which can leave the bridge vulnerable to accidental operation. We have to examine the design from a point of view that if it can happen, it will happen.

Normally, the bypass switch shorts out a limit switch contact or relay permissive circuit. There is not much additional protection that can be added without adding a good deal of complexity to the circuit. However, there is a way to prevent multiple bypasses from being used simultaneously. If we add and additional contact to the bypass switch and take this contact in a series string to feed a relay, then the output of this relay could in turn feed a master permissive or UV circuit. Please look at exhibit D1. If we split the bypass switches into two permissive circuits assuming six bypass switches, then if three of the associated bypass are used, the permissive relay will energize and prevent operation until one of the switches is opened. A more basic level of protection would be to take an additional contact off of each bypass switch and wire them in series to one permissive relay. This would prevent operation if all the bypass switches are on, exhibit D2. While this does not prevent some of the problems that we have discussed, it does address the problem of all the bypasses being on.

When PLC logic is being used, it gives the designer greater flexibility. The PLC can be programmed to look at the bypass switch as a one shot device. Designed this way, the device being bypassed by the bypass switch is only circumvented for one operation of the span even if the switch is left in the bypassed position. After the span has completed it's operation, the bypass switch must be turned off and then on again in order to be utilized. The PLC can also be programmed to look at the number of bypass switches in the on position and take appropriate action or prevent action.

In either case, the owner must convey the guidelines to the designer for this to happen. Neither the designer or the system integrator can implement any of these concepts unless the owner is aware of the problem and has reviewed internal guidelines in how to best address the problem.

In summary, an obligation falls upon the owner and designer. There has to be a set of written procedures of what can and cannot be done regarding the use of bypass switches at the bridge on the desk. Considerable thought must be given to the location of the switches, labeling, how the bypass switches will be implemented and under what circumstances they can be operated. How much flexibility will be given to the operator as to use? What other safety considerations such as unintended operation must be considered?

If a bypass switch is a necessary evil, then a great deal of thought should be used in it's design and implementation. While there is no argument as to it's utility, there is a downside risk that must be understood, designed for and accepted. There is no conclusion to this presentation as there are many approaches to the problem, each one with it's advantages and disadvantages. My purpose was to make us think of what we are doing and to be aware of the problems.

BYPASS NAMEPLATE	DEVICE BEING BYPASSED	FUNCTION
TRAFFIC LIGHT BYPASS	RED LIGHT TIMER OR RELAY	ALLOWS TRAFFIC GATES TO LOWER WITHOUT RED LIGHT CONFIRMATION
TRAFFIC GATE BYPASS	TRAFFIC GATE DOWN LIMIT SWITCH	ALLOWS BARRIER GATES AND OR SPAN LOCKS TO BE OPERATED IF THE TRAFFIC GATE DOWN LIMIT FAILS.
BARRIER GATE BYPASS	BARRIER GATE CLOSED LIMIT SWITCH	ALLOWS SPAN LOCKS TO BE PULLED IF BARRIER CLOSED LIMIT SWITCHES ARE NOT MADE.
BARRIER GATE BYPASS	BARRIER GATE OPEN LIMIT SWITCH	ALLOWS TRAFFIC GATES TO RAISE IF BARRIER GATE UP LIMIT SWITCH IS NOT CLOSED.
SPAN LOCK BYPASS	SPAN LOCK DRIVEN LIMIT SWITCH OR RELAYS	ALLOWS THE TRAFFIC GATES OR BARRIER GATES TO OPERATE IF THE SPAN LOCK LIMIT SWITCH DOES NOT INDICATE DRIVEN.
SPAN LOCK BYPASS	SPAN LOCK PULLED LIMIT SWITCH	ALLOWS THE OPERATION OF THE SPAN WITHOUT SPAN LOCK PULLED CONFIRMATION.
FULL SEATED BYPASS	FULLY SEATED LIMIT SWITCHES	ALLOWS OPERATION OF THE SPAN LOCKS TO BE DRIVEN WITHOUT CONFIRMATION OF SPAN BEING CLOSED.
BRAKE HAND RELEASE BYPASS	BRAKE HAND CRANK LIMIT SWITCHES	ALLOWS SPAN TO BE MOVED WITH BRAKES IN MANUAL RELEASE

EXHIBIT A

BYPASS NAMEPLATE	DEVICE BEING BYPASSED	FUNCTION
TRAFFIC LIGHT BYPASS	RED LIGHT TIMER OR RELAY	FORCES RED TRAFFIC LIGHT ON.
TRAFFIC GATE BYPASS	BARRIER GATE OR SPAN LOCK LIMIT SWITCHES	ALLOWS TRAFFIC GATES TO BE OPERATED IF THE BARRIER GATE CLOSED OR SPAN LOCK DRIVEN LIMIT FAILS.
BARRIER GATE BYPASS	TRAFFIC GATE CLOSED LIMIT SWITCHES OR SPAN LOCK LIMIT SWITCHES	ALLOWS BARRIER GATES TO BE OPERATED IF THE TRAFFIC GATE OR SPAN LOCK LIMIT SWITCHES ARE NOT MADE.
SPAN LOCK BYPASS	TRAFFIC GATE AND OR BARRIER GATE OR FULL CLOSED LIMIT SWITCHES	ALLOWS THE SPAN LOCKS TO OPERATE IF THE CLOSED GATE LIMIT SWITCHES ARE NOT MADE OR IF THE FULL CLOSED LIMIT SWITCH DOES NOT INDICATE BRIDGE CLOSED.
BRAKE HAND RELEASE BYPASS	BRAKE HAND CRANK LIMIT SWITCHES	ALLOWS SPAN TO BE MOVED WITH BRAKES IN MANUAL RELEASE

EXHIBIT B

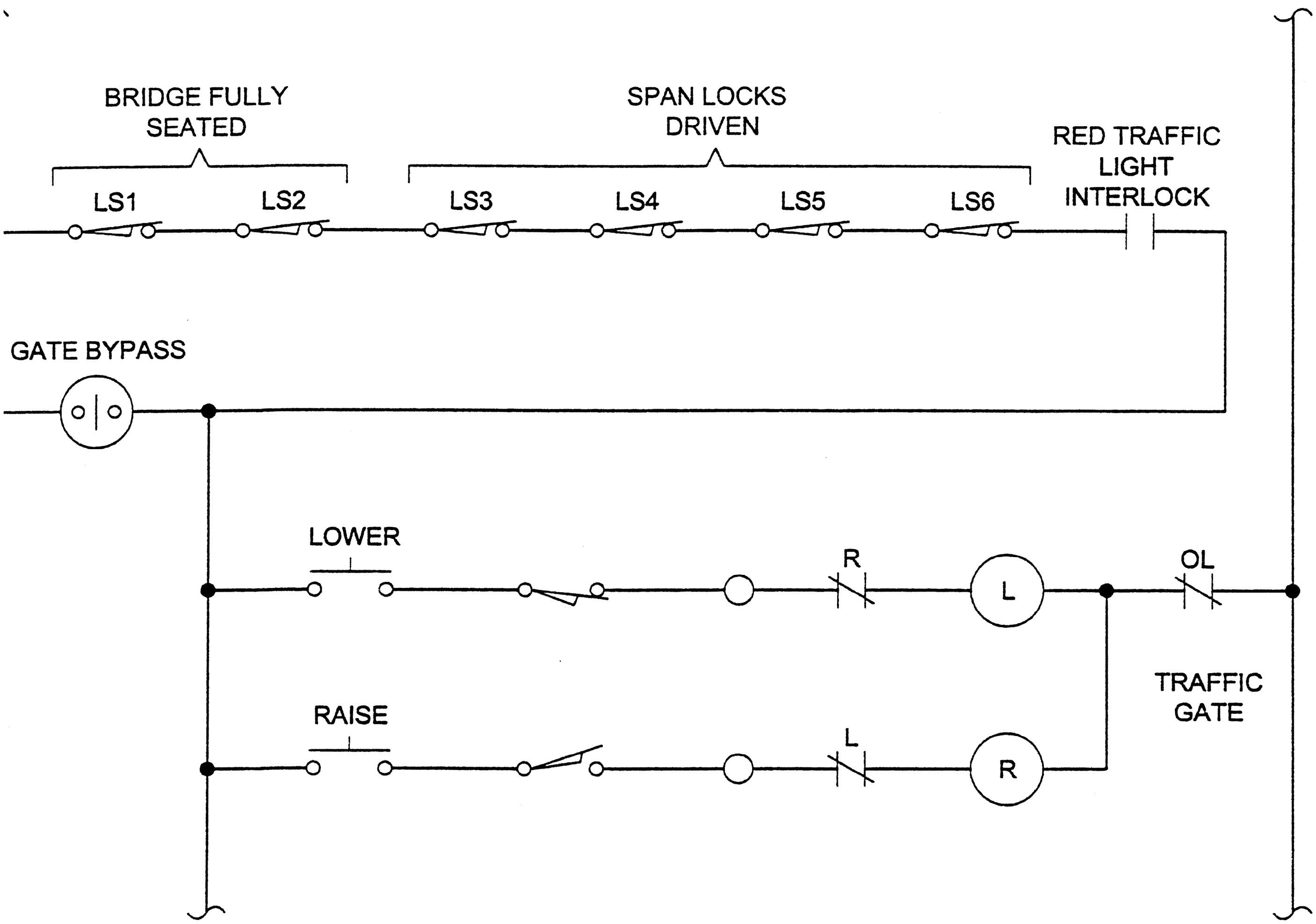

BRIDGE FULLY
SEATED
SPAN LOCKS
DRIVEN
RED TRAFFIC
LIGHT
INTERLOCK
LS1
LS2
LS3
LS4
LS5
LS6
GATE BYPASS
LOWER
R
L
OL
TRAFFIC
GATE
RAISE
L
R

EXHIBIT C

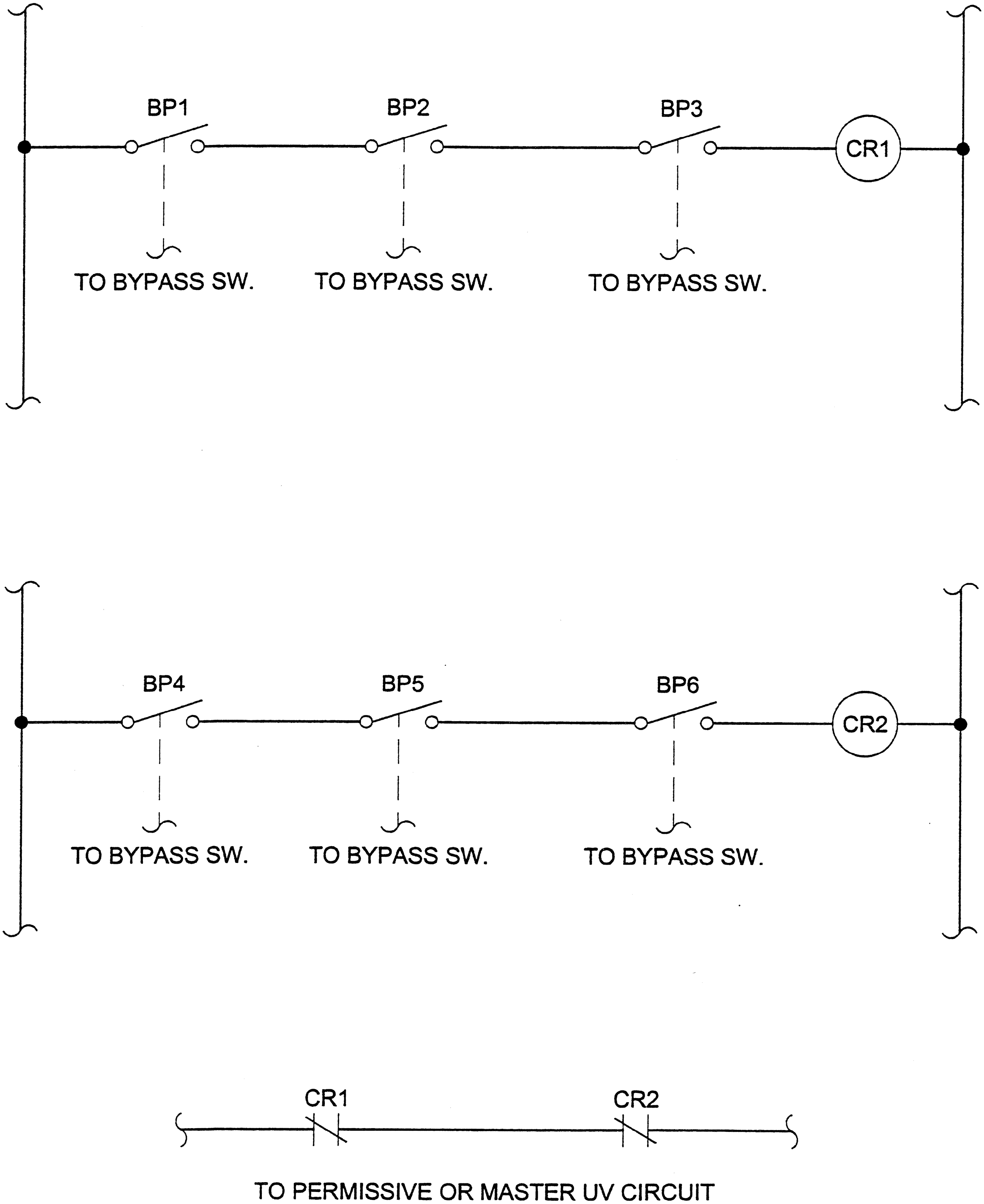
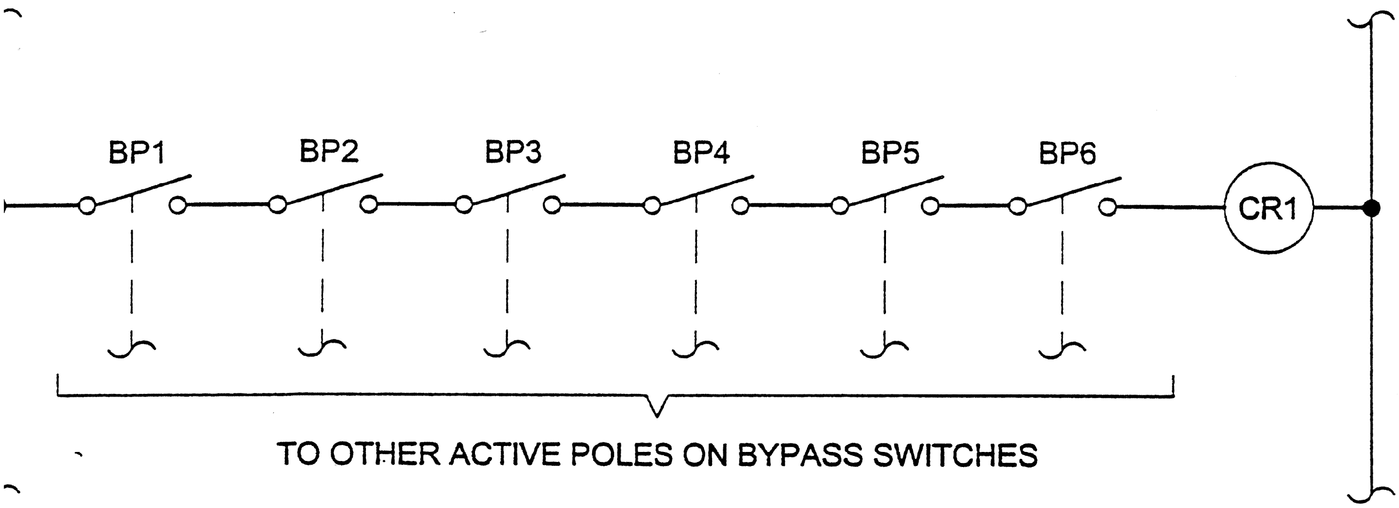

BP1
BP2
BP3
CR1
TO BYPASS SW.
TO BYPASS SW.
TO BYPASS SW.
BP4
BP5
BP6
CR2
TO BYPASS SW.
TO BYPASS SW.
TO BYPASS SW.
CR1
CR2
TO PERMISSIVE OR MASTER UV CIRCUIT

EXHIBIT D1


BP1
BP2
BP3
BP4
BP5
BP6
CR1
TO OTHER ACTIVE POLES ON BYPASS SWITCHES

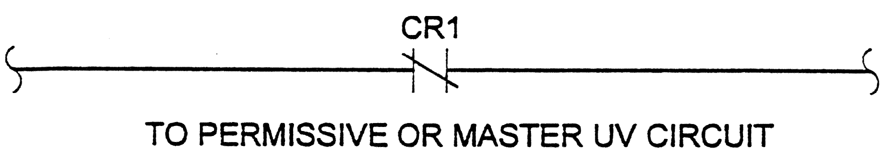

CR1
TO PERMISSIVE OR MASTER UV CIRCUIT

EXHIBIT D2