ASSESSMENT OF THE ELECTRICAL ASPECTS OF LAMMA IV

by

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of

D E P T. O F E L E C T R I C A L E N G I N E E R I N G

H O N G K O N G P O L Y T E C H N I C U N I V E R S I T Y

6 March, 2013

PREAMBLE

At about 20:20 hrs on 1st October 2012 off Shek Kok Tsui, northwest of Lamma Island, there was a collision between a high speed passenger ferry *Sea Smooth* and a company passenger launch *Lamma IV*. The incident resulted in the death of 39 passengers travelling on the launch. It is understood that the ferry *Sea Smooth* (owned by Islands Ferry Company Limited, a subsidiary of Hong Kong & Kowloon Ferry Holdings Limited) was carrying 95 passengers on its way from Central to Yung Shue Wan, Lamma Island when it collided with *Lamma IV,* a launch owned and operated by The Hongkong Electric Company Limited. The latter vessel was carrying 127 passengers and 3 crew members. It is understood that *Lamma IV* was leaving Lamma Island and heading towards the Victoria Harbour in order to watch the National Day firework display. Passengers were to disembark at Central. After the collision, the ferry *Sea Smooth* remained afloat while the launch *Lamma IV* sank stern first within a few minutes. The vessel came to rest almost vertically with its stern on the sea bed and its bow and forward section protruding above the water. Many persons on board *Lamma IV* fell into the sea or were trapped inside the vessel.

The undersigned was instructed by Mrs. Gloria Abdullah of Lo & Lo Solicitors & Notaries (solicitors acting for the Commission of Inquiry into the Collision of Vessels near Lamma Island on 1st October 2012) to comment specifically on the following:

1) where power supply is from the main engine generator (by turning the dial of the switch on the Navigation Light Distribution Board to ñ1ò / ñTRANSFORMERò), the possible scenario or scenarios in which the switches for the navigation lights and the circuit breaker for them would be positioned as shown in the photographs of the navigation light D/ST board and 24 DC main switch board located in the wheelhouse of *Lamma IV* (see Marine Bundle 12, Item 77a, pp. 4899 - 4901) (the ñPhotographsò) ;
2) where power supply is from the auxiliary battery (by turning the dial of the switch on the Navigation Light D/ST Board to ñ2ò / ñBATTERYò), the possible scenario or scenarios in which the switches for the navigation lights and the circuit breaker for them would be positioned as shown in the Photographs ; and
3) how the mute switch on the Light Distribution Board operates, in particular whether the sound alarm would be muted by switching to ñonò or ñoffò.

It should be noted that the opinion and conclusions which are set out in this Report were formed on the basis of the evidence provided to the Commission (and the documents were supplied to me by Messrs Lo & Lo as set out in Appendix 2 to this report) and observations and site inspections made by the undersigned on 2nd and 4th March, 2013. My curriculum vitae is annexed to this Report as Appendix 1. It is declared that the appearance of the undersigned as an independent expert for the Commission is unrelated to any other work that has been undertaken by the undersigned for any parties involved in this incident.

SITE VISIT

A site visit was made on 2nd March, 2013 on *Lamma IV* at the Government Dockyard at Stonecutter Island. Upon inspecting the circuit breakers at the Wheelhouse, it was observed that

1) The power to the various circuits could be obtained from either the generator (designed as ñ1ò or ñTransformer) or from the Batteries (designed as ñ2ò or ñBatteriesò). When the selector is in the middle position, there is no power supply to the light circuits.

Photo 1 Power to the various light circuits can be obtained either from the Generator or from the Batteries Pack. There should be no differences in the functionality of the circuits no matter where the supply was derived. However the power from the generator would be more stressful to the components (such as lamps) if the voltage rises above a certain threshold value. For example, if a 24 V lamp is fed from a 26 V source, there is more power pumped into the lamps, thereby shortening the life expectancy of the lamps.

2) There were Indicator Lamps (each with its associated Circuit Breaker that controlled the power supply to the external lights) to indicate the status of the external lights. The physical layout of the Circuit Breakers associated with the Indicator Lamps on the cover of the Distribution Box was as shown below:

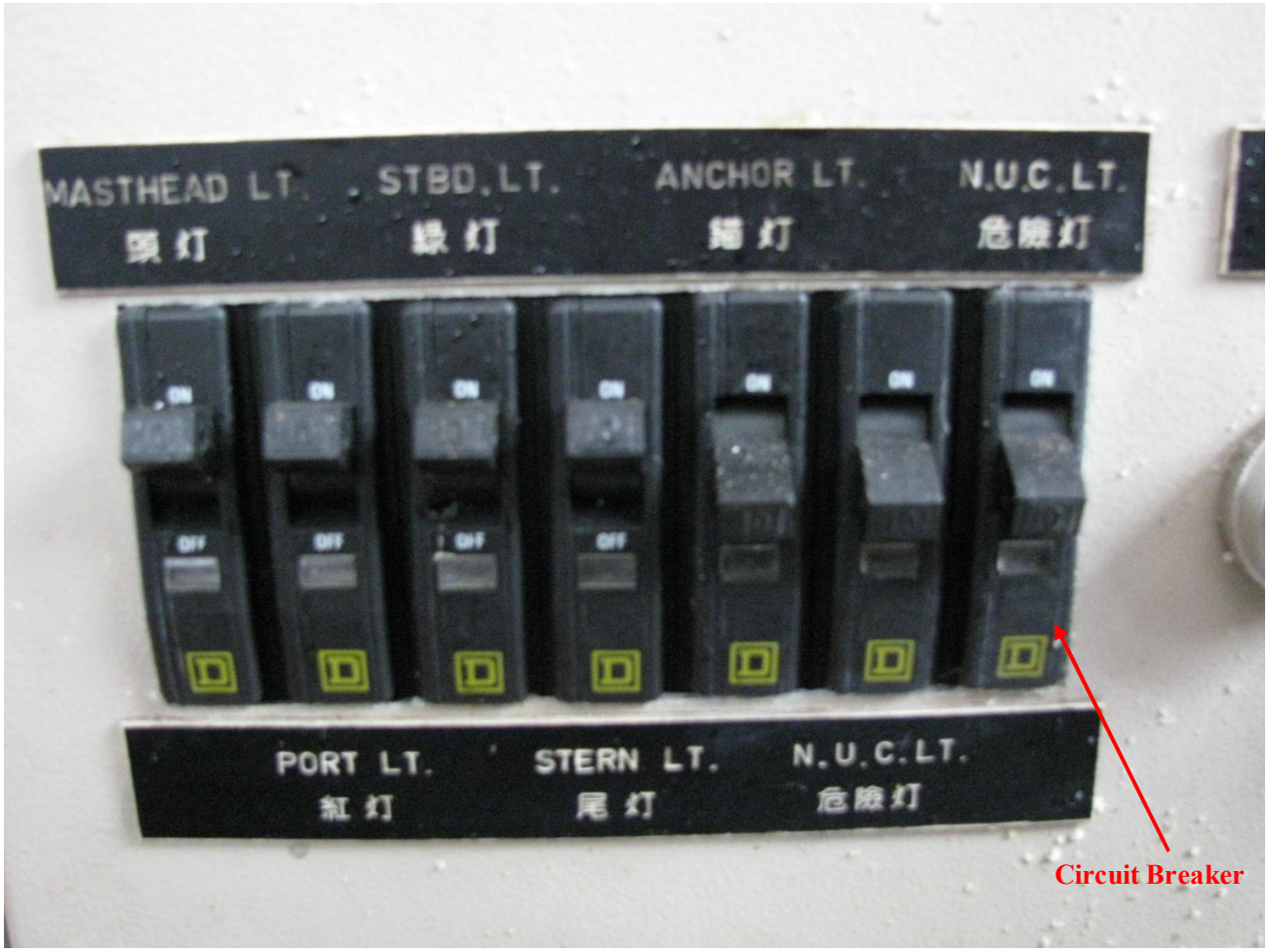


Photo 2 Circuit Breakers controlling the various lighting circuits

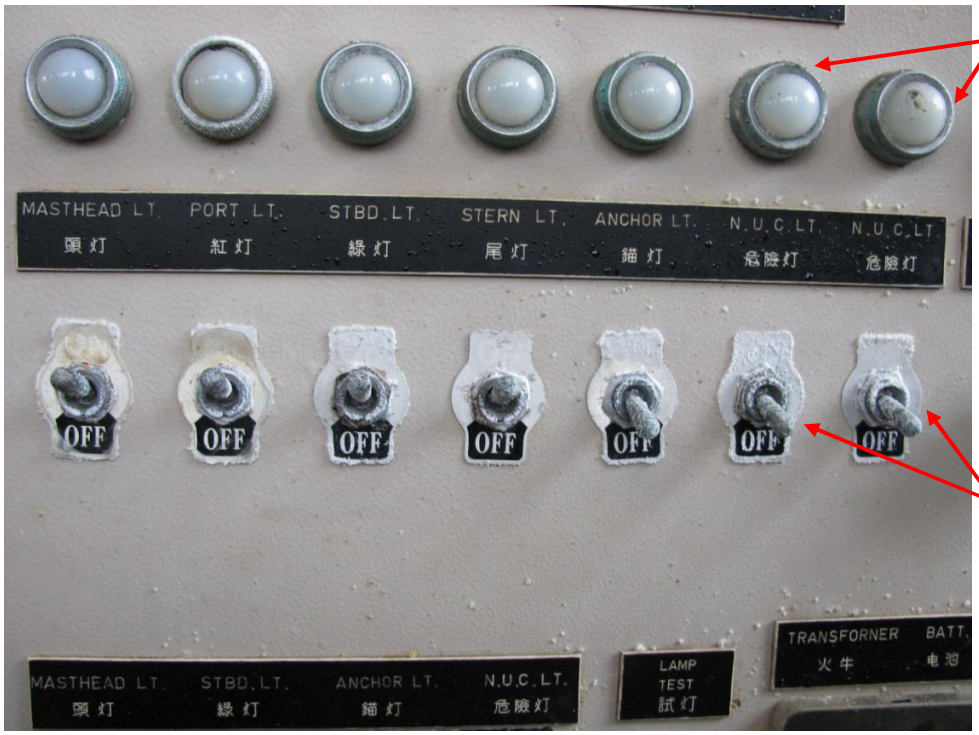
It was further noted that electrical circuits are commonly protected against over-current by means of either a fuse (which is a non-resettable device which contains a fusable element which melts when a current higher than a designated value flows through the element) or a Circuit Breaker (which is shown in Photo 2 and which would be tripped to open-circuit if a current higher than a designated value flows through the Circuit Breaker. Circuit Breakers, like those shown in Photo 2, can be mechanically or manually reset to the ON state after being tripped to the OFF position. If the current which trips the Circuit Breaker is too high, the Circuit Breaker would be damaged and it would become non-resettable in that it could not be tripped to either the ON or OFF position). In Photo 2 the Circuit Breakers for the Stern Light, Anchor Light and the N.U.C. Light on the far right of Photo 2 were malfunctioning in that they could not be tripped positively one way or the other. This is typical for Circuit Breakers which had been tripped by a very large current. It is noted that the Circuit Breakers in Photo 2 were used to control the power supply to the various external lights. If, for example, the Circuit Breaker for the Masthead Light was clicked to the OFF position, the Masthead Light would receive no power

supply and it would not be energized at all. In other words, the Masthead Light would definitely be switched OFF if the Circuit Breaker for the Masthead Light in Photo 2 was clicked to the OFF position.

It is noted that the Circuit Breakers for the Masthead Light, Port Light, Starboard Light and Stern Light were seen to have been clicked to the ON position at the material time of the visit on 2nd March, 2013. If the observed Circuit Breaker status were the same as that at the material time of the accident, then all the four navigation lights as mentioned earlier would be energized, unless there is no power connected to that particular circuit or the light bulbs were blown. If, however, there was NO power feeding into the Distribution Board in Photo 2, then the light bulbs would remain to be DARK even if its associated Circuit Breaker was switched ON (and remains ON regardless of whether power was fed to the Distribution Board, as Circuit Breakers can be clicked to either ON or OFF positions manually) because, for example, we can click the light bulb switches in our flat to the ON position but the light bulbs will remain DARK if the power company has cut off the power supply to the flat. The last three Circuit Breakers, namely those for the Anchor Light and the two N.U.C. Lights were clicked to the OFF position in Photo 2 and these Lights had therefore been switched OFF altogether (if these Circuit Breakers were clicked to the OFF position prior to the accident).

It is further noted that the Circuit Breakers for the Masthead Light, Port Light and Starboard Light were functioning ñnormallyò as they could be set positively to either the ON or OFF position. The Circuit Breaker for the Stern Light was however malfunctional and this is indicative that this Circuit Breaker had previously been tripped to the OFF position by a heavy current. In other words, this Circuit Breaker should not stay at the ON position as seen in Photo 2. The fact that the Circuit Breaker was clicked to the ON position was probably because it could have been clicked to such position by an unknown person (as the Circuit Breaker would not return to the ON position automatically after being tripped to the OFF position) during inspection and investigation, for example.

3) There were Lamp Indicators indicating the status of the external lights as shown in Photo 3. The Indicator Lamps could also be turned off by the switches as shown in Photo 3 as well.



Indicator Lamps

Switches of the Indicator Lamps and they can be clicked to the OFF position to turn off the Indication Lamps without affecting the status of the external Lights

Photo 3 The indicators of the Lights can be switched off without affecting the actual lighting circuit outside. The light intensity can be controlled by a dial as shown in Photo 4.

Buzzer

Dial to control the light intensity of the Indicator Lamps

Mute Switch in the ON position

Photo 4 The intensity of the Indicator Lamps can be controlled by the dial as shown in the photo

4) The intensity of the Indicator Lamps can be controlled by a variable resistor as shown in Photo 5.

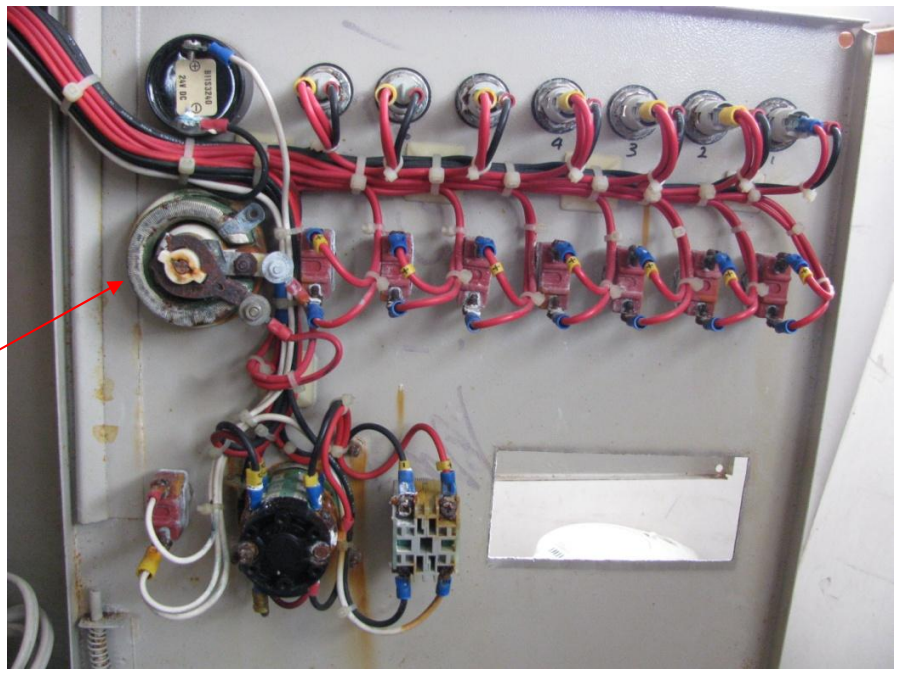


Photo 5 Upon removal of the cover, one can see the wiring of the Indicator Lamps together with the Switch for each Light Indicator.

The Dial as shown in Photo 5 actually is a variable resistor which controls the current that flows into the Indicator Lamps. Basically, the supply circuit to the Indicator Lamp is as shown below:

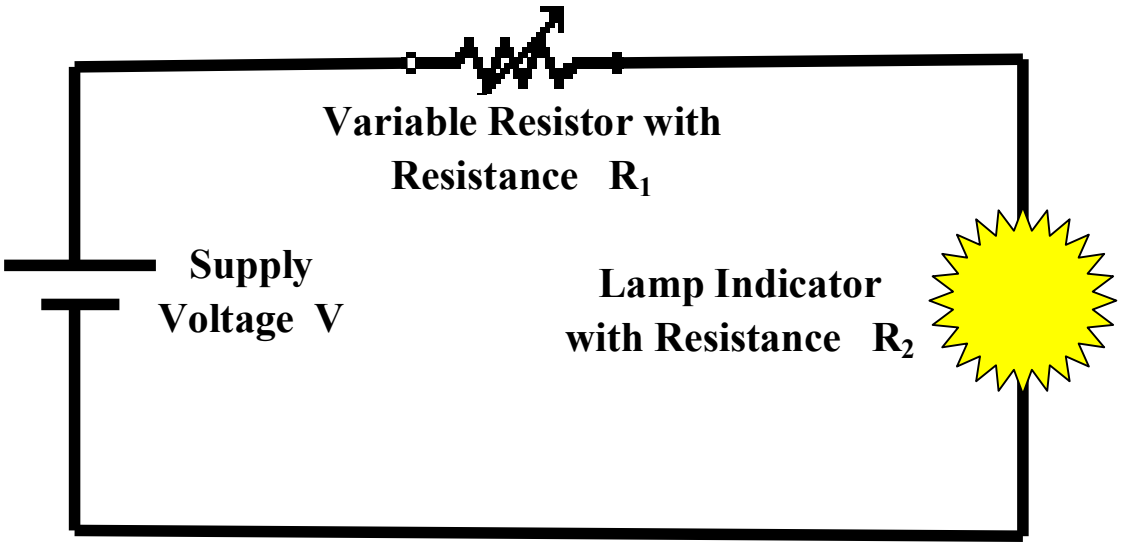


Fig. 1 Schematic circuit diagram of the Lamp Indicator

Basically, the Supply Voltage (V) is 24 V for the Lamp Indicator circuit. The current that flows in the circuit is governed by Ohm's Law which states that

Voltage = Current x Resistance in the circuit

or $V = I \times (R_1 + R_2)$ or $I = V / (R_1 + R_2)$

The light intensity of the Indicator Lamp is dependent on the power absorbed by the resistor R_2 and which is equal to (Current x Current x R_2). This means the light intensity of the Indicator Lamp is proportional to $\frac{V^2 R_2}{(R_1+R_2)^2}$. In other words, when the variable resistor R_1 is set to zero, the power absorbed by the Lamp Indicator (represented by R_2) is $\frac{V^2}{R_2}$. If R_1 is set to be equal to 5 times R_2, then the power absorbed by the Indicator Lamp will become $\frac{V^2(R_2)}{(6R_2)^2}$ or $\frac{V^2}{36R_2}$, meaning the light intensity of the Indicator Lamp will only be about 3 % of its maximum intensity at which R_1 is set to zero.

The undersigned had tried to measure the resistance of R_1 during the site visit on 2nd March, 2013. However it was found that because of rust formed on the surfaces of the variable resistor, it was difficult to measure R_1. It was subsequently found on 4th March, 2013 that there were so much rust on the variable resistor that it was difficult to measure the resistance after the rusts were cleaned by sandpaper. It is likely that the variable resistor needs to be taken back to the University for further cleaning before one can measure the resistance more accurately.

Notwithstanding the fact that R_1 had not been measured, it is estimated that the light intensity of the Indicator Lamp will be less than half of its full intensity when R_1 was set to its maximum value.

5) Upon removal of the cover, it was found that there were relays associated with the lighting circuits as shown in Photo 6.

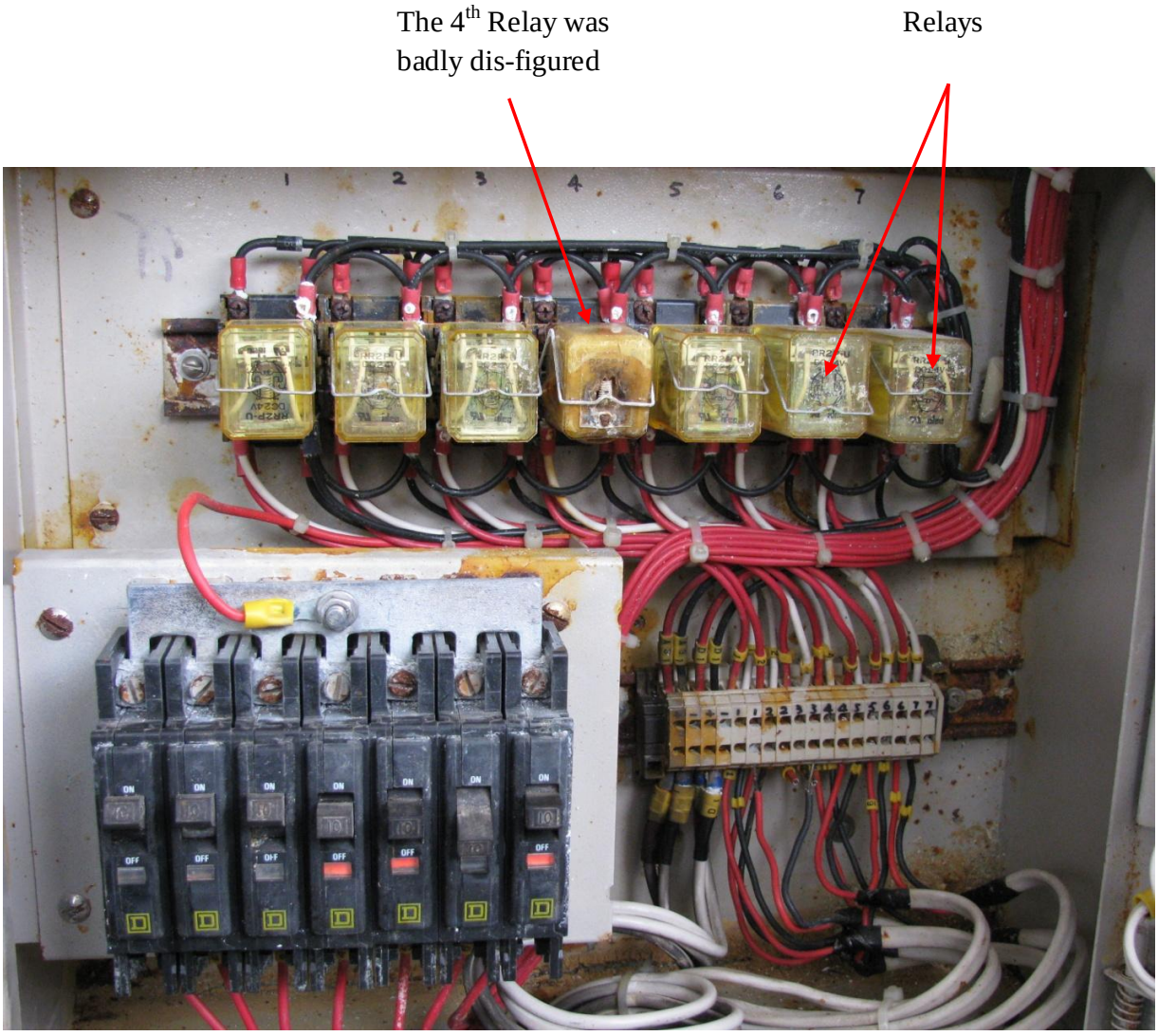


Photo 6 The relays of the seven Lighting Circuits are as shown in the Photo. All Relays, with the exception of the 4th Relay counted from the right hand side, appeared to be ñnormalò.

Since the 4th Relay as shown in Photo 6 was found to be badly disfigured, it was taken down and compared with a ñhealthyò relay as shown in Photo 7.

Photo 7 A badly disfigured relay (on the left) together with a ñhealthyò relay (on the right)

Photo 8 Another view of the disfigured relay and ñhealthyò relay. From the outside appearance of the dis-figured relay, one can confirm that high current had been flowing through the Coil inside the Relay for a prolonged period, of the order of at least several minutes. The reason for such high current was possibly because the devices in series with the Coil inside the Relay had been short-circuited.

It is noted that there are ñred flagsò in Circuit Breakers No. 4, 5 and 7 (when counted from the left) in Photo 6. This is typical in Circuit Breakers indicating the status of the Circuit Breaker being in the ON state. An example from a Circuit Breaker being used at the University is as shown in Photo 9.

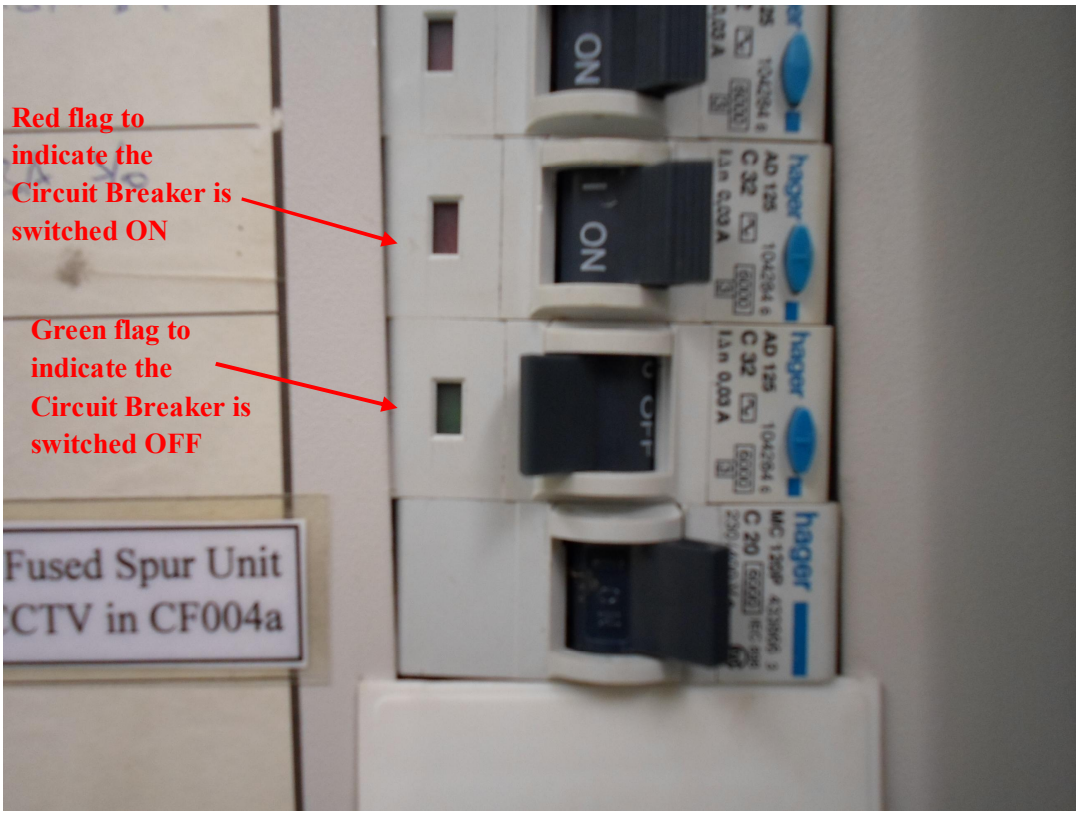


Photo 9 Flags are sometimes used to indicate the status of the Circuit Breakers

6) A further observation was that two wires in the lighting circuit had been cut as shown in Photo 10.

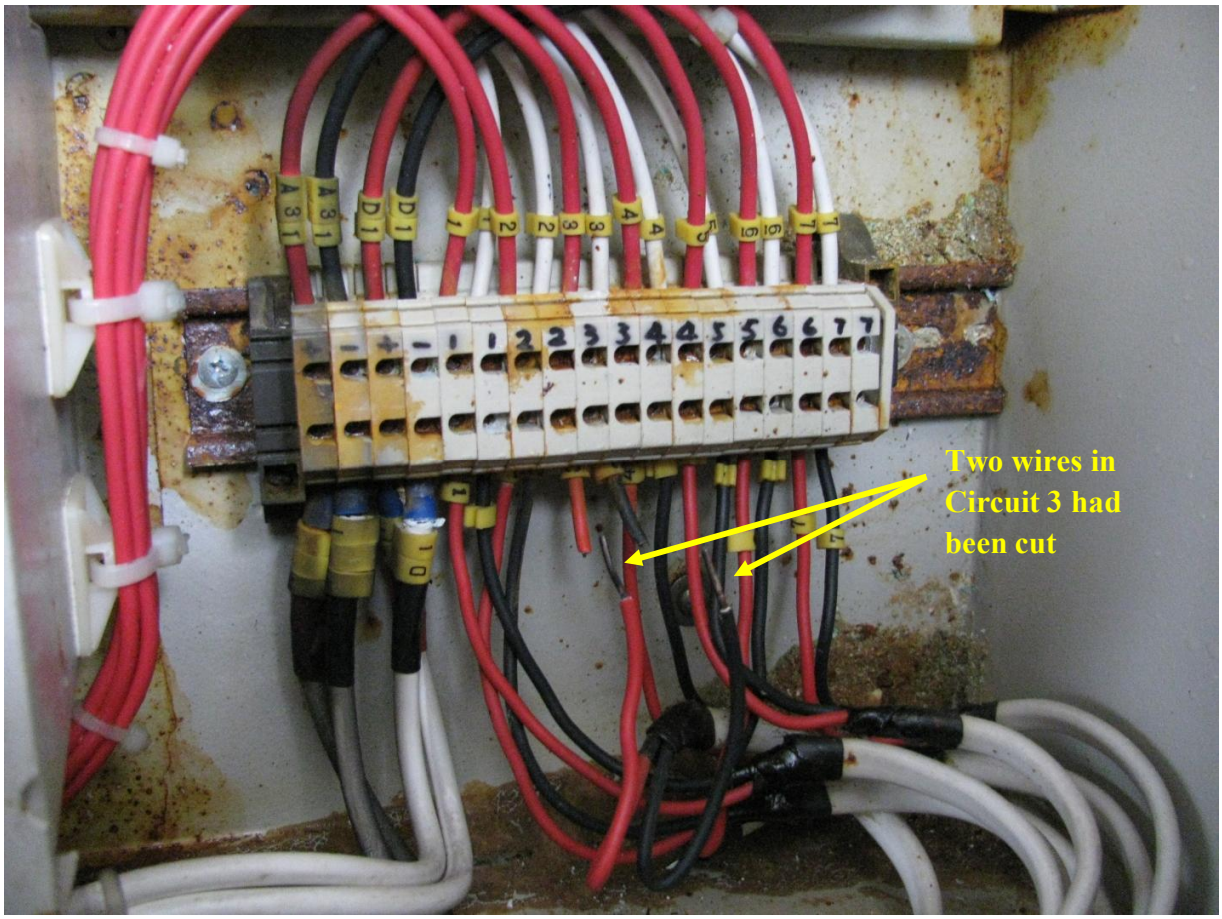


Photo 10 Two wires in Circuit 3 (believed to be in the circuit of Starboard Light Circuit) were found dangling in air after the cover of the Distribution Board was removed. If the circuit for the Starboard Light Circuit had indeed been cut, then there should be no power to the Starboard light bulb and hence it would not be lit. However it was confirmed subsequently that the wires were cut by Mr Szeto Yiu Kuen of Mardep for the purpose of marine accident investigation.

7) In order to confirm the circuit, a further inspection of Lamma IV took place on 4th March 2013 with the assistance of 5 marine police officers. A simple test was carried out to identify the wiring of the circuits as shown in Fig. 2. In essence, if Circuit 3 in Photo 10 was marked as the circuit for the Starboard Light, then Wire 1 will be connected to point A as shown in Fig. 2. Similarly Wire 2 will be connected to location B. A 12 V battery was then connected to the wires at the Distribution Board as shown in Photo 11. If the markings on the wires are correct, then the Test Light Bulb would be lit up.

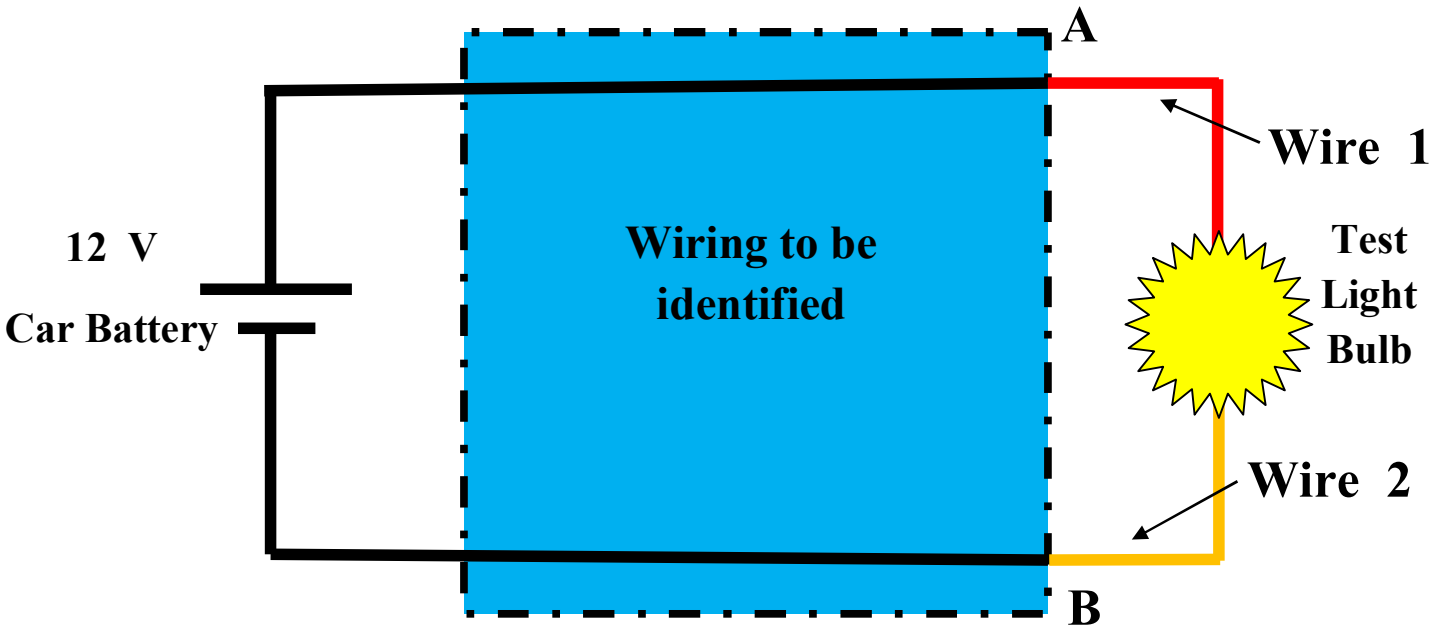


Fig. 2 Schematic circuit diagram of the Test Circuit to find the identity of the wires

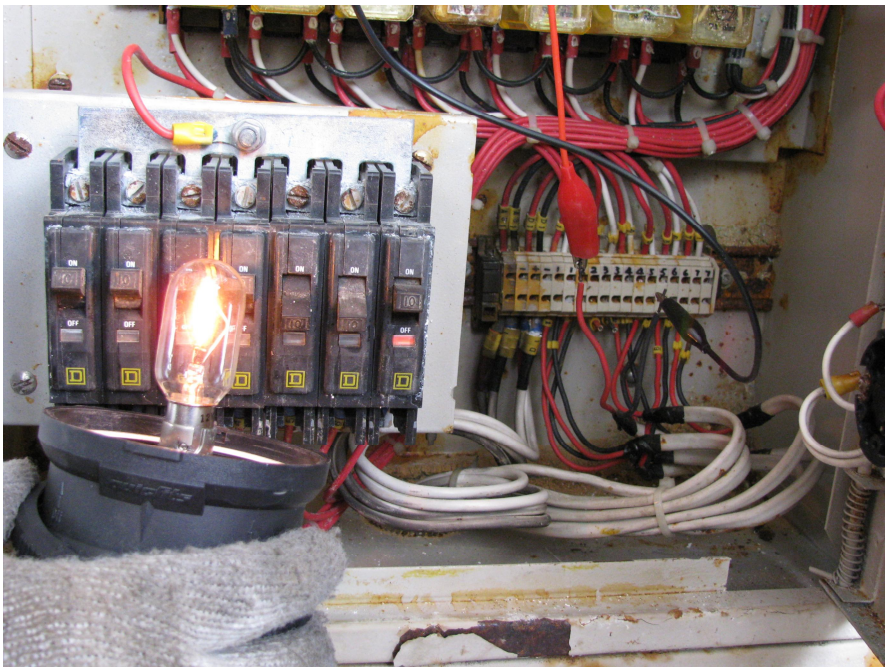


Photo 11 When a 12 V power supply is connected to the two cut wires identified as Circuit 3 and with the light bulb connected to the holder terminals of the Starboard Light, the Test Light Bulb was lit up, thereby confirming the cut wires were connected to the Starboard Lighting Circuit.

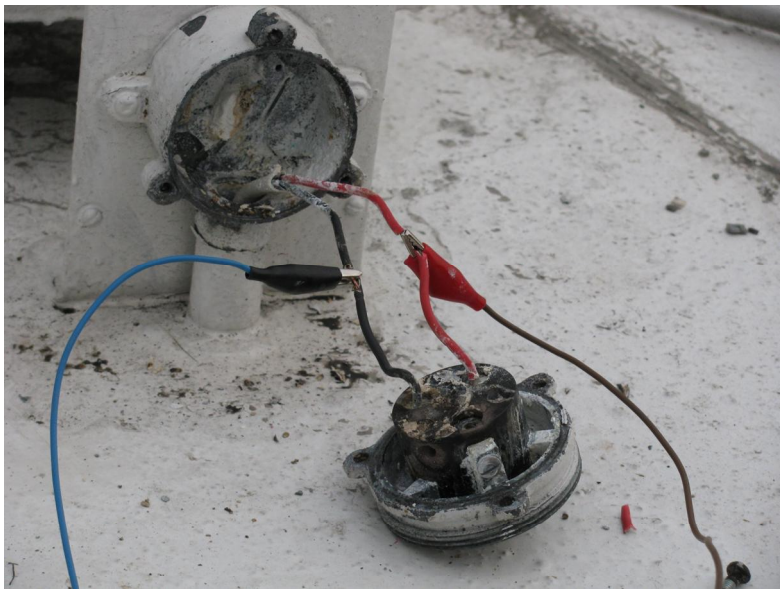


Photo 12 Two crocodile clips were used to connect two wires from the Test Light Bulb to the Starboard wires. It was found that the two wires (marked as Circuit 3) which have been cut in the Distribution Board were wires of the Starboard Light.

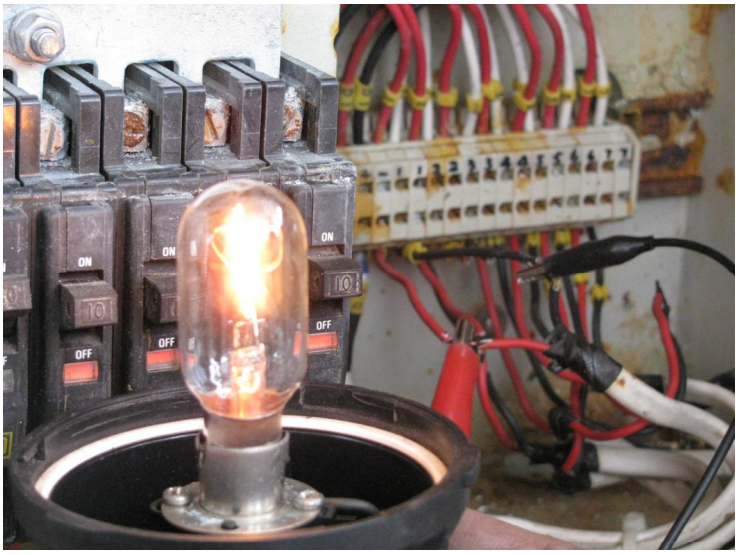


Photo 13 The insulation of wires in Circuit 2 was stripped to allow the connection of the 12 V power supply to the test circuit. Upon connecting the Test Light Bulb to the Port Light circuit, the Test Light Bulb lit up to confirm positively that this circuit is the circuit for the Port Light.

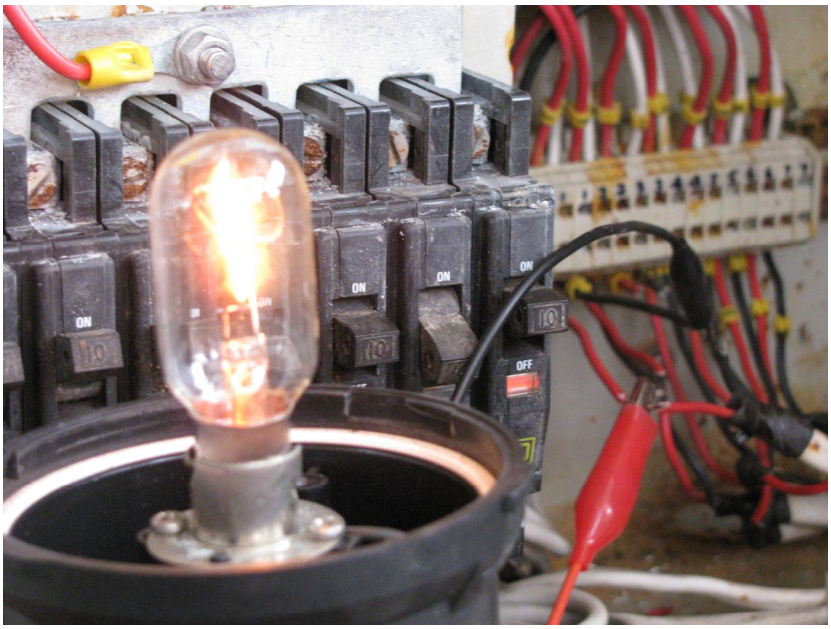


Photo 14 The insulation of wires in Circuit 1 was stripped to allow the connection of the 12 V power supply to the test circuit. Upon connecting the Test Light Bulb to the Masthead Light circuit, the Test Light Bulb lit up to confirm positively that this circuit is the circuit for the Masthead Light.

Photo 15 The insulation of wires in Circuit 4 was stripped to allow the connection of the 12 V power supply to the test circuit. Upon connecting the Test Light Bulb to the Anchor Light circuit, the Test Light Bulb lit up to confirm positively that this circuit is the circuit for the Anchor Light.

However the circuit to the Stern Light was found to be discontinuous as the Test Light Bulb could not be lit up. This however is understandable as the Stern sank to the seabed and one would not be surprised to see that the wirings were broken and discontinuous.

8) One further observation was that the cables to the Masthead Light and Anchor Light were cut open as shown below.

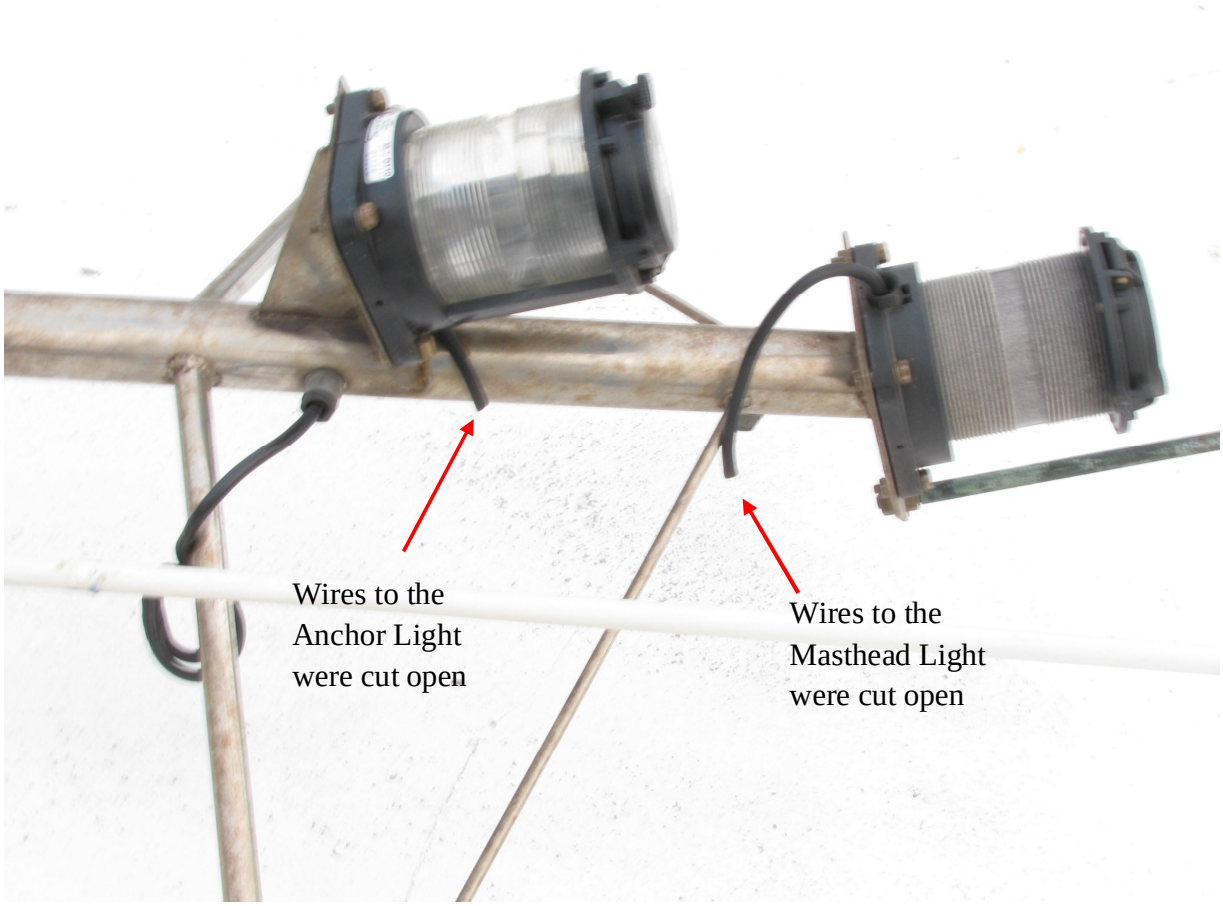


Photo 16 Wires connecting to the Anchor Light and Masthead Light were found to be cut open during the second inspection on 4th March, 2013. However it was confirmed from Photographs 45 to 61 (pp.300-316) of Police Photo Album V dated 15th October 2012 that the wirings were intact, hence ascertaining that there was nothing untoward in the wiring connections for the Anchor Light and Masthead Light.

9) In addition, it was found that most circuit breakers shown below were malfunctional.

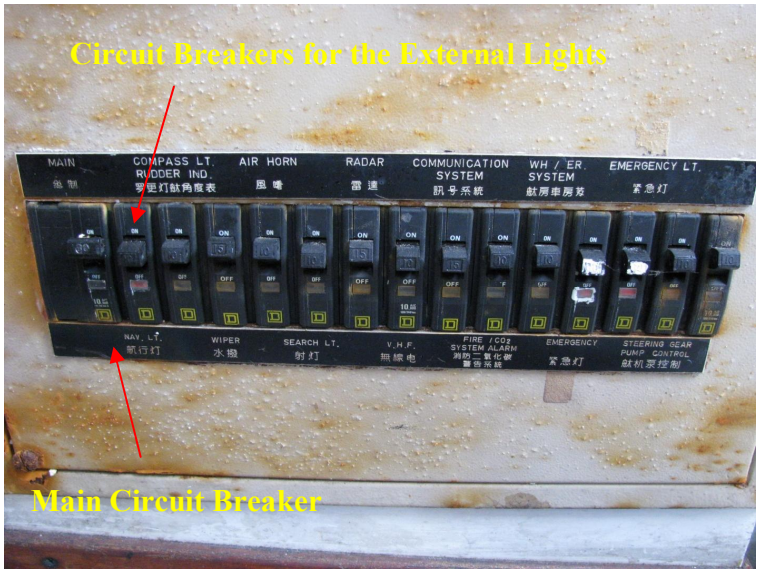
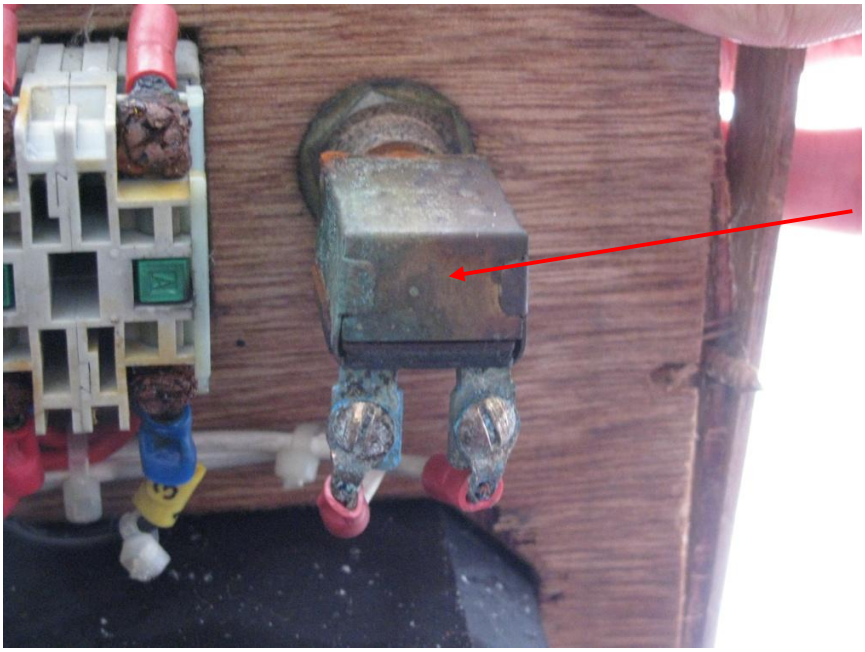


Photo 17 All the circuit breakers, with the exception of the Main Circuit Breaker (the first Circuit on the left) and the two marked with white paint on the handle were malfunctional, indicating that large current had flowed and tripped the circuits. The Circuit Breaker for the external Lights controlled the power supplied to the Seven Light Circuits and hence the turning off of this Circuit Breaker would cut off the power supply to all the external Lights Bulbs (including the corresponding Indicators)

10) It was also observed that there was a button on the coxswainôs deck marked with the description of ñHORNò as shown in Photo 18.

Photo 18 The controls of the various circuits, including the one marked with the description of ñHORNò. It is understood that by pressing the ñHORNò button, a loud HORN would be produced to alert other vessels.

It was however found that there were some rust on the switch associated with the ñHORNò button as shown in Photo 19. It could cast doubts as to whether the switch could function normally to emit a loud warning to other vessels.



Switch associated with the ñHORNò button

Photo 19 Rusts of copper oxide were observed on the switch associated with the ñHORNò button.

It is also noted that there were lots of copper oxides in the other switches or even on the plastic cables as shown in Photos 20 and 21. Hence one could not conclude whether the rusts were there before the accident in issue.

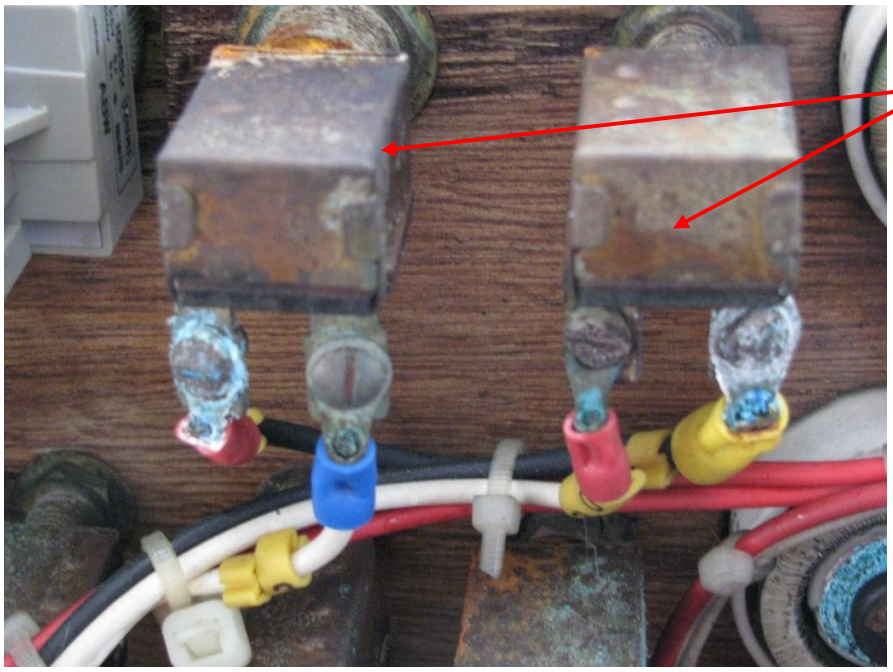


Photo 20 Rusts were found on other switches on the same console

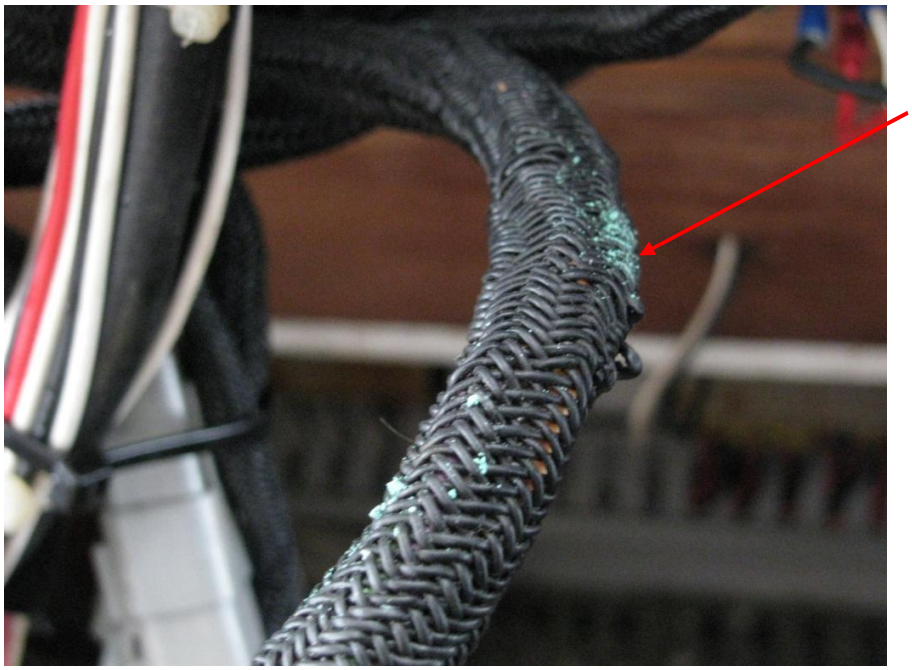


Photo 21 Rusts were found on nylon cables

ELECTRIC CIRCUIT EXPLANATION

For the Lighting Circuits, there were essentially seven electrical circuits coupled together. The seven circuits are the 1) Masterhead Light, 2) Port Light, 3) Starboard Light, 4) Stern Light, 5) Anchor Light, 6) N.U.C. Light and 7) N.U.C. Light. Each of the seven electrical circuits is however independent of each other and a typical circuit for the Starboard Light can be drawn in following figures to illustrate how electric currents flow in the circuit.

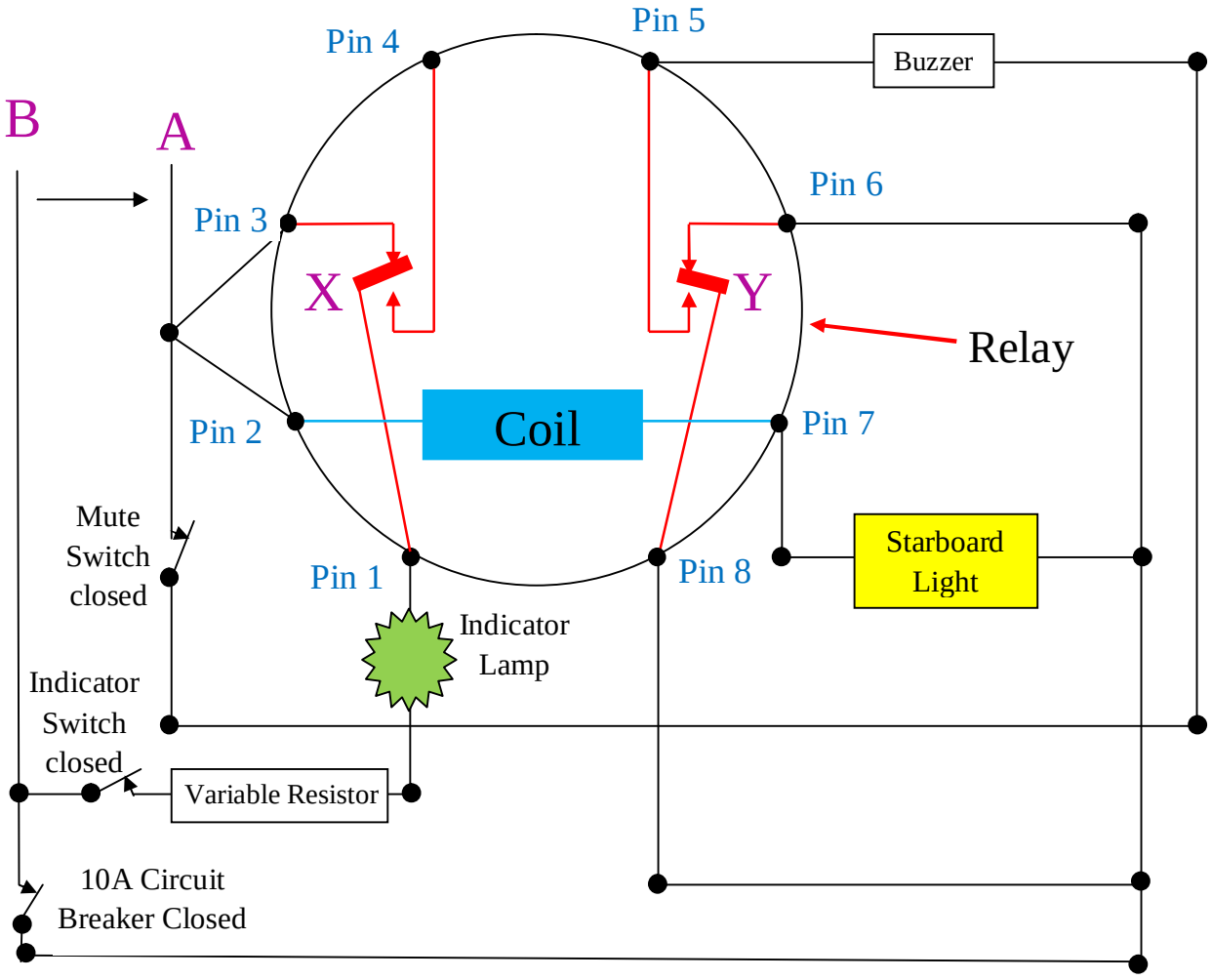


Fig. 3 The 10 A circuit breaker as shown in Photo 2 closes. Current flows from location A into the path comprising Pin 2, the Coil, Startboard Light via the closed 10 A Circuit Breaker to return to the power supply at B. As current flows through the Coil, the relay contacts at X and Y are as shown in Fig. 3. Electric current also flows from location A into another path comprising Pin 3, the Indicator Lamp, the Variable resistor and then back to the power supply at B. There is no current through the Buzzer as the circuit is broken at contact Y. Note here that if the Starboard Light Bulb had been short-circuited, then very high current would flow through the Coil inside the Relay.

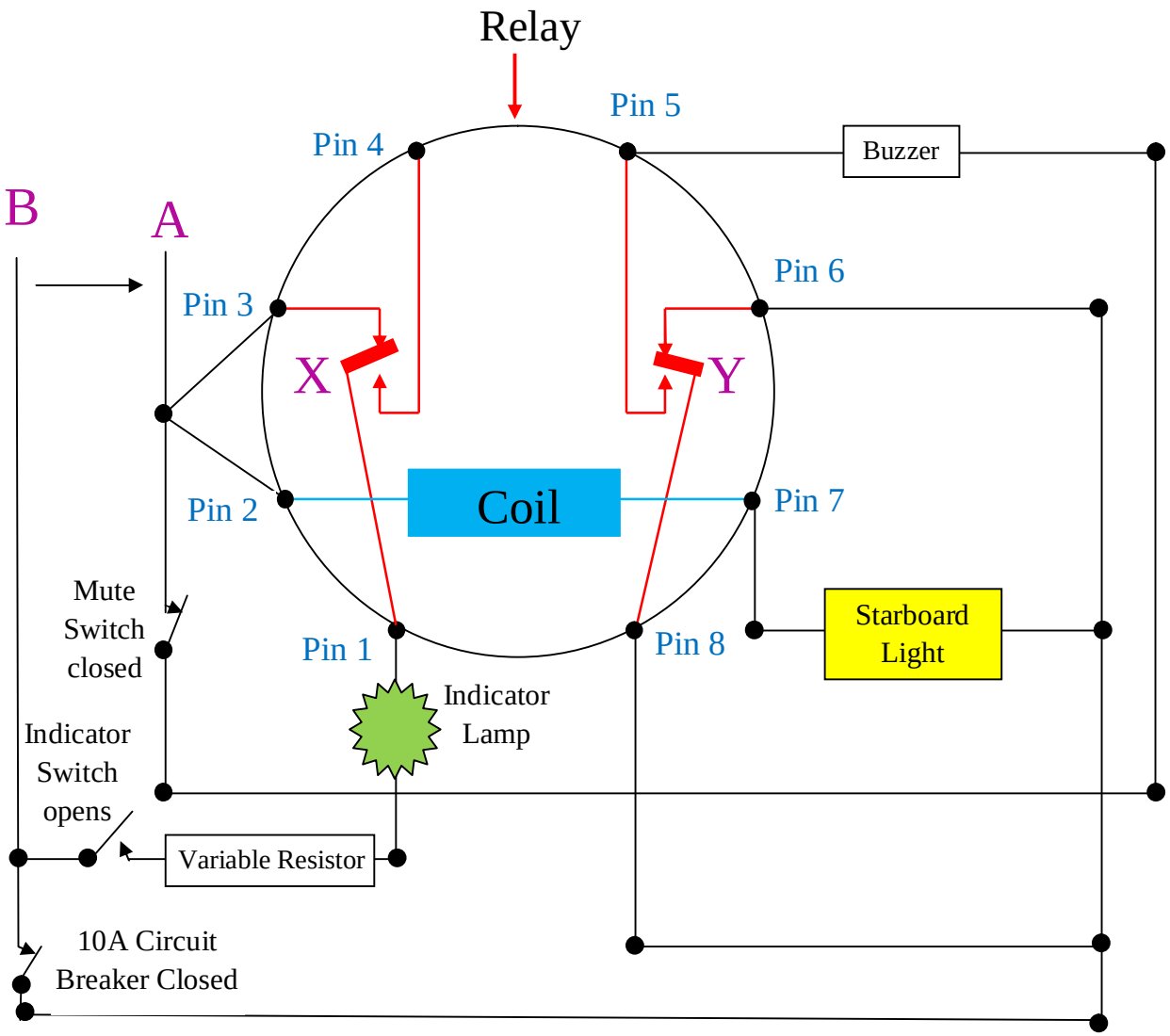


Fig. 4 The 10 A circuit breaker as shown in Photo 2 closes. Current flows from location A into the path comprising Pin 2, the Coil, Startboard Light via the closed 10 A Circuit Breaker to return to the power supply at B. As current flows through the Coil, the relay contacts at X and Y are as shown in Fig. 4. Electric current however cannot flow from location A into another path comprising Pin 3, the Indicator Lamp and the Variable Resistor because the Indicator Switch is opened. There is no current through the Buzzer as the circuit is broken at contact Y.

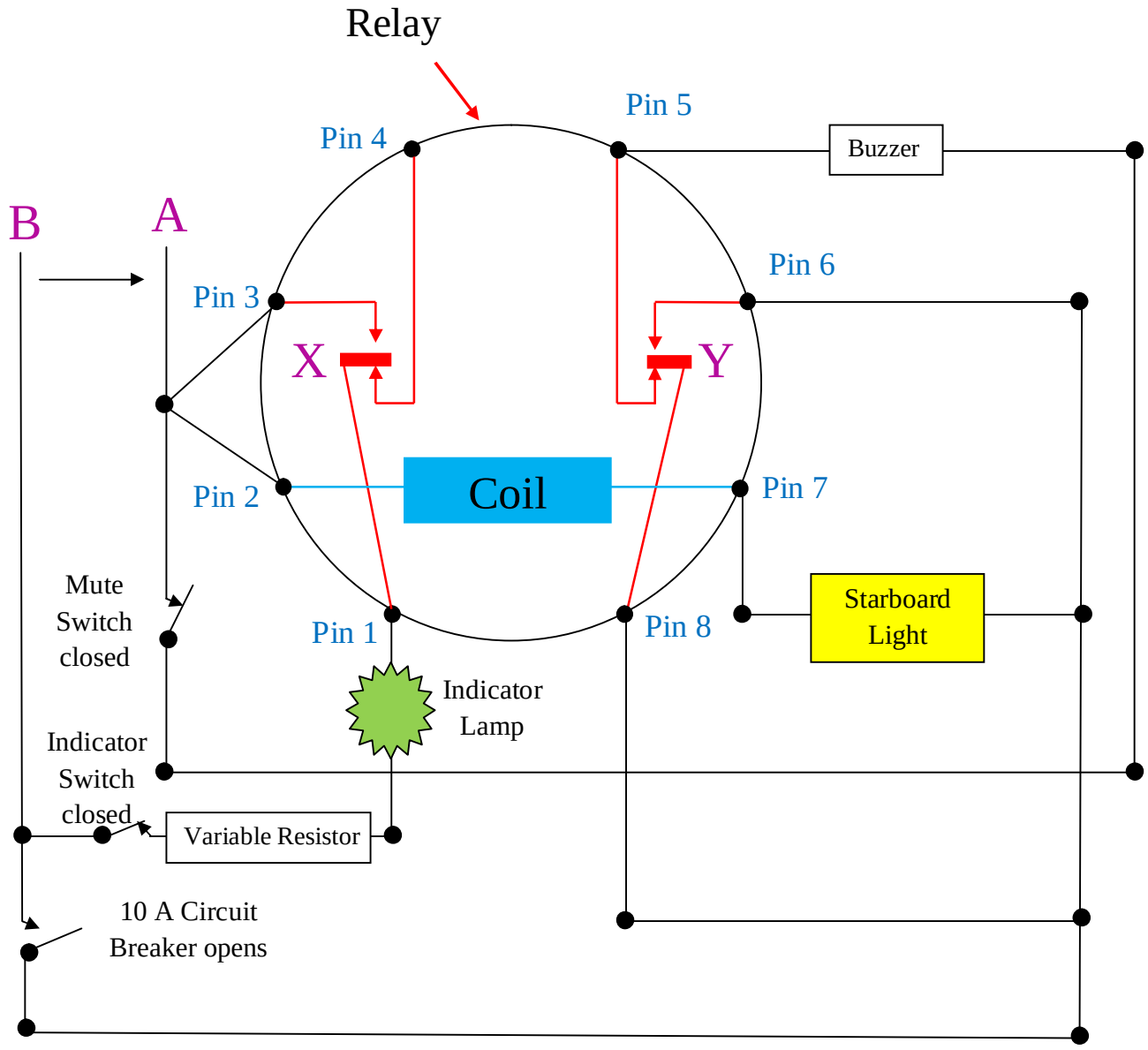


Fig. 5 The 10 A Circuit Breaker as shown in Photo 2 opens. Current cannot flow from location A into the path comprising Pin 2, the Coil, Startboard Light as the 10 A Circuit Breaker is open circuited. As no current flows through the Coil, the relay contacts at X and Y are as shown in Fig. 5. Electric current also cannot flow from location A into another path comprising Pin 3 and the Indicator Lamp because the circuit is broken at the relay contact X. There is no current flowing through the Buzzer either.

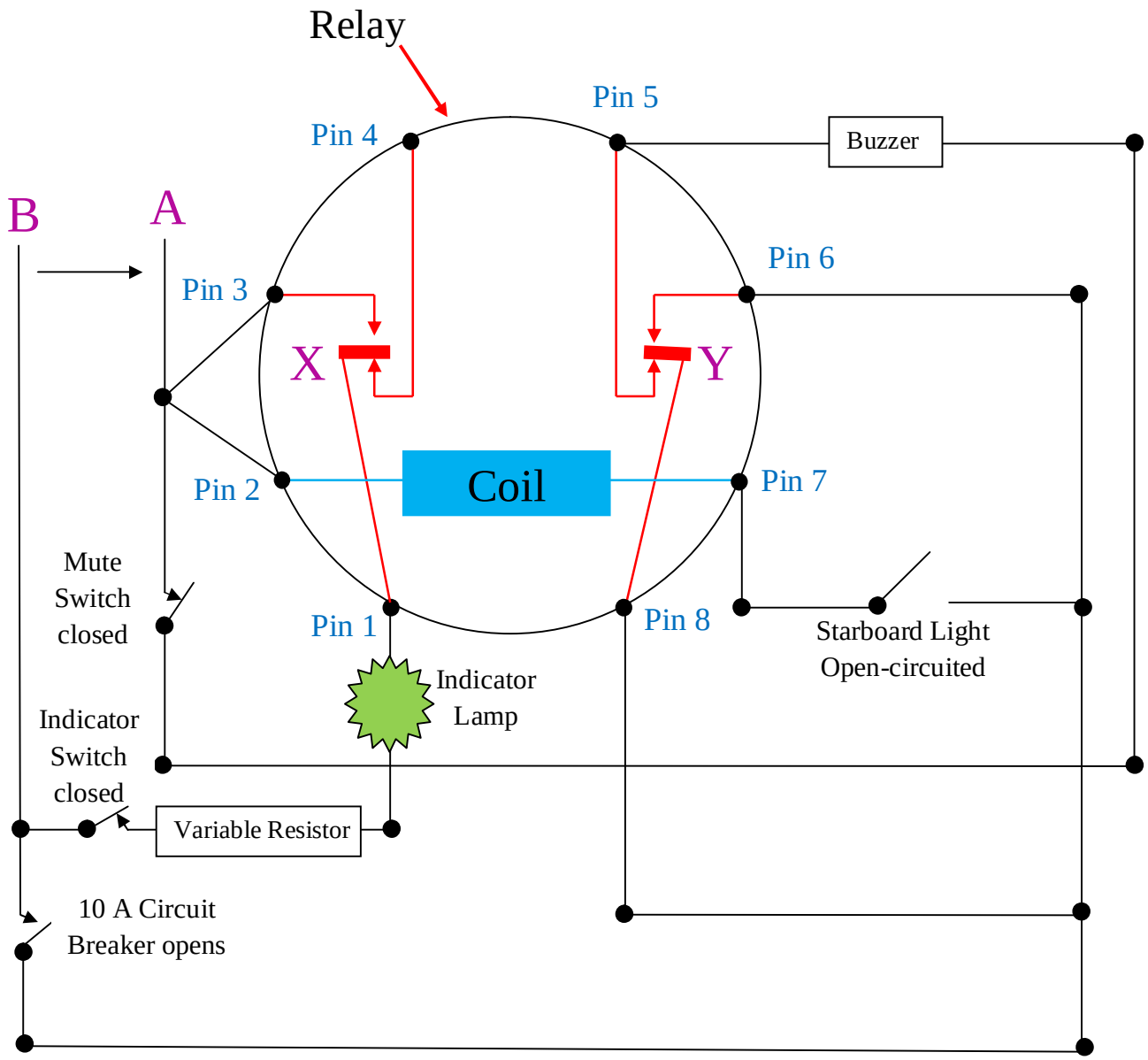


Fig. 6 The 10 A Circuit Breaker as shown in Photo 2 opens. The Starboard Light is also open-circuit due to a blown lamp bulb. Current cannot flow from location A into the path comprising Pin 2, the Coil, Startboard Light as both the 10 A Circuit Breaker and the Starboard Light Lamp Bulb are open circuited. As no current flows through the Coil, the relay contacts at X and Y are as shown in Fig. 6. Electric current also cannot flow from location A into another path comprising Pin 3 and the Indicator Lamp because the circuit is broken at the relay contact X. There is no current flowing through the Buzzer either.

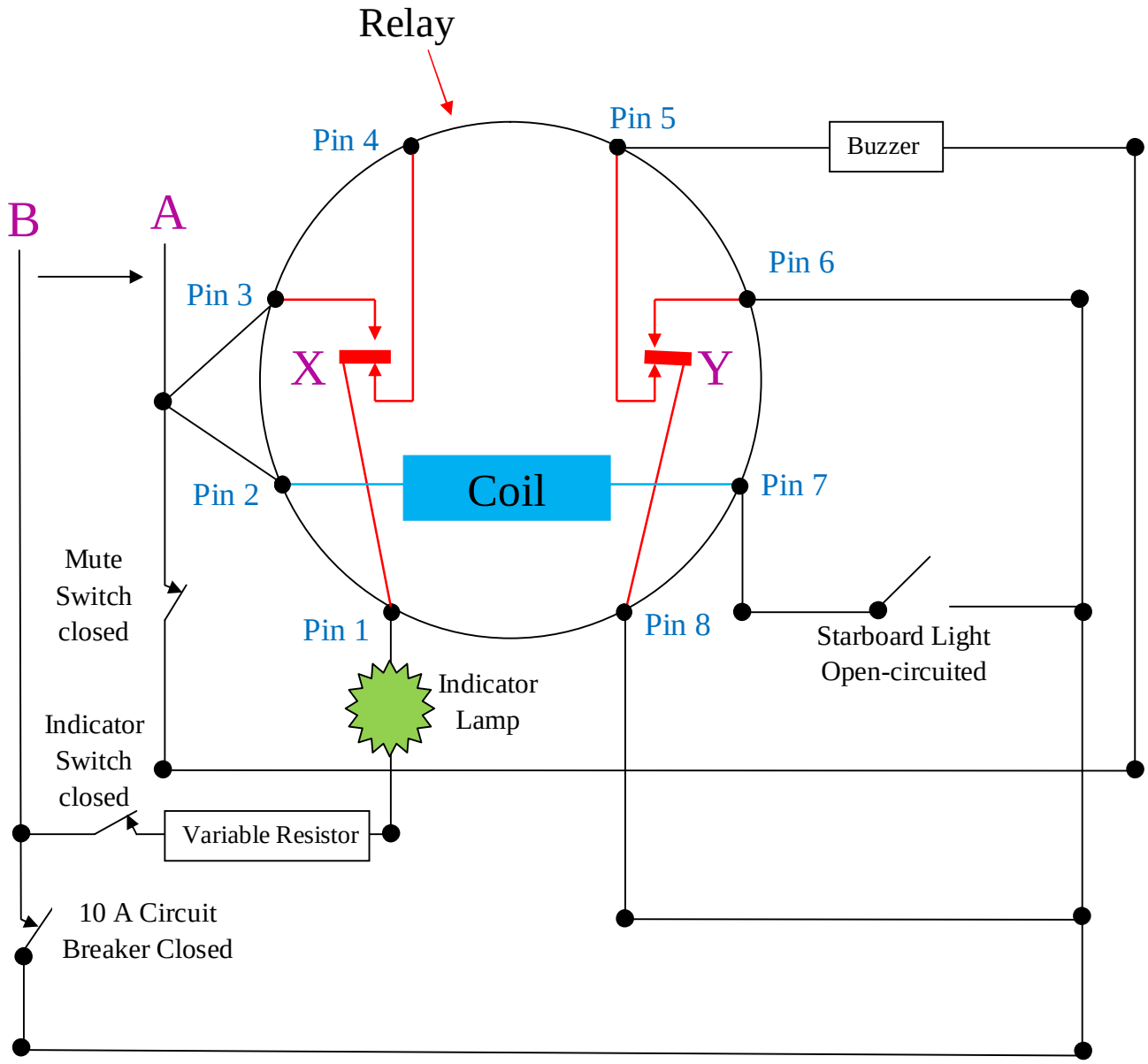


Fig. 7 The 10 A Circuit Breaker as shown in Photo 2 is closed. The Starboard Light is however open-circuit due to a blown lamp bulb. Current cannot flow from location A into the path comprising Pin 2, the Coil, Startboard Light as the Starboard Light Lamp Bulb is blown and becomes open circuited. As no current flows through the Coil, the relay contacts at X and Y are as shown in Fig. 7. Electric current also cannot flow from location A into another path comprising Pin 3 and the Indicator Lamp because the circuit is broken at the relay contact X. Current will however flow in a path comprising of A, the closed Mute Switch, the Buzzer, Relay contact Y, Pin 8 and then returns to B via the closed 10 A Circuit Breaker.

RESPONSES TO THE QUESTIONS GIVEN TO THE UNDERSIGNED

1. The first question raised was ñwhere power supply is from the main engine generator (by turning the dial of the switch on the Navigation Light Distribution Board to ñ1ò / ñTRANSFORMERò), the possible scenario or scenarios in which the switches for the navigation lights and the circuit breaker for them would be positioned as shown in the Photographsò. The responses were that the generator in the Engine Room was supposed to generate electricity to supply power to various devices/appliances onboard of *Lamma IV*. When the generator fails, then the Reserve Batteries would come in to provide power to essential elements such as Light Bulbs for illumination. Other non-essential appliances such as air-conditioners would however be switched off to reduce the demand of power from the reserve batteries. It is not clear whether the change-over from powering up the appliances from the generator to the batteries were automatic or not, because insufficient circuit diagrams were given to the undersigned. By noting that there is a switch as shown in Photo 1, it looks like that the change-over was done manually (because the switch as shown was a manual switch) and hence the coxswain or the chief engineer could decide where the power supply was to be obtained to drive all the essential appliances (such as the radar, the Starboard Lights, etc). It is understood that the switch was always switched to Position 2 (i.e. power was drawn from the batteries) because when Mr. Chow Chi-Wai was asked whether the selector was sometimes switched to position 1, he gave a lengthy explanation and the Chairman of the Commission then summarized and said ñAre you saying that at some stage in the past, there was this phenomenon of the light going out about twice a week, and it was found out that it was because the switch had been switched to "1", and thereafter, the engineer told you to switch to "2", battery 1 power. And after this practice of switching to "2" has been installed, there were no more incidents of lights going out. Would that be a fair way of putting your evidence?ò, then Mr. Chow said it was correct (pp. 44 to 45 of the transcript of Day 36, hearing date 20th February, 2013).

   In any case the two generators inside the Engine Room would charge up the batteries to provide power to the Lamp Bulbs according to Mr. Leung Pui-Sang who agreed that he had said ñWhen the 'genset' (ie the generator of the auxiliary engine) is turned on it can charge up, directly or through the charger, the four sets of batteries on board the vessel. As far as I am aware *Lamma IV* was delivered from the shipbuilder with this battery system already installedò (p.18 of transcript of Day 37, hearing date 21st February, 2013). Hence it suffices to say that electrical power would be available to power up the Lamp Bulbs on the outside of *Lamma IV*. The issue is whether there are chances for power not being made available to the Lamp Bulbs. The answer to this question is : i) if the batteries were not given sufficient charge from the generator, then there would not be sufficient power to light up the Lamp Bulbs, but it appears from the schematic circuit diagram that as long as the generator is generating and the electronic converters are functioning, the

batteries should have sufficient energy to power up the batteries; ii) if the selectors in Photo 1 was set to position 0, then there is no power to energy the Lamp Bulbs; iii) if the Lamp Bulbs are blown, they could not be lit up; iv) if the electric wires are discontinuous, then no power could be delivered to light up the Lamp Bulbs; v) if the Circuit Breakers were switched to the OFF position, then there would be no power supply to light up the Lamp Bulbs.

2. The response to Question 2 raised at the beginning of this report is hence similar to the descriptions given above, since once power is available from the source, the Lamp Bulbs should light up unless there were faults/switching as mentioned in the preceding paragraph.

3. As explained before, if there were power available to the circuits and if there were discontinuities in any of the circuits which lead to either one of the Lamp Bulbs not lighting up or any of the Lamp Bulbs (such as the Starboard Light or Port Light) not lighting up, the buzzer would give out an audio signal. However if the buzzer circuit was muted, then the buzzer would fail to sound out the alarm, and those parts of the circuit which were healthy would continue to function and the faulty path would continue to be faulty without alerting the crew members on board of *Lamma IV*.

4. One further observation is that if the volume of the light intensity of the Lamp Indicators was turned to the lowest level, the intensity of the light could be quite weak. However one do not know how weak the light becomes until the variable resistor is examined in details, possibly at the University if field test at *Lamma IV* proves to be difficult for the undersigned to do the resistance measurement. Moreover, it should be note that the Light Indicators are the visual aids to the Officers onboard of *Lamma IV* only. The turning OFF of the Indicator Lamps or the dimming of the Indicator Lamps have no effect on the status of the external light. The external lights such as Port Light would remain ON even though the Indicator Lamp of the Port Light was turned OFF, for example.

5. The Circuit Breaker on the Panel shown on Photo 17 was the ñmasterò switch to control whether power is available to the Panel of Circuit Breakers shown in Photo 6. The turning OFF of the ñmasterò Circuit Breaker on Photo 17 would not however affect the set position of the Circuit Breakers in Photo 6 as all Circuit Breakers mentioned in this report were mechanical Circuit Breakers which could only be set manually.

6. The seven Circuit Breakers as shown in Photo 2 (and Photo 6) controlled the powering of the Light Circuits. It can be seen in the Photo that the Circuit Breakers for the Masthead Light, Port Light, Starboard Light and Stern Light were all switched to the ON position. Hence these four light should be energized and lit up if the light bulbs were healthy. It

should also be noted that Circuit Breaker that controlled the power to the Stern Light was damaged (i.e. malfunctional) and this, when viewed together with the damaged Relay as shown in Photo 7, is a strong indication that there were power supplied to the Stern Light circuit. Whether the Stern Light was lit at the material time of the incident would depend on whether the Stern Light Bulb was healthy or not.

7. There were seven switches that controlled the Indicator Lamps as shown in Photo 3. The first four (counted from the left) were all switched to the ON position and these four lamps were the Lamp Indicators for the Masthead Light, Port Light, Starboard Light and Stern Light. The remaining switches were in the OFF position which means the Indicator Lamps of the Anchor Light and the two N.U.C. Lights were turned OFF. Hence the status of the Anchor Light and the two N.U.C. Lights could not be seen by the Officers inside *Lamma IV*.

8. It is difficult to interpret the meaning of the ON position for the Mute Switch which controlled the operation of the Buzzer because it was badly damaged. If confirmation is to be sought, then one could pay a visit to similar vessels such as *Lamma II* to ascertain the meaning of the ON position for the Mute Switch. The On position of the Mute Switch (as seen during the visit on 2nd March, 2012) was likely to be the ñClosedò position in which the Buzzer would send out an audio sound when any of the seven external Light Circuits were abnormal (i.e. if there were blown Lamp Bulbs externally). However the Indicator Lamps could be turned off and hence the Buzzer would not sound out any audible warning even though there were faults on the external Lights. In a similar manner, if the Circuit Breaker for the Starboard Light shown in Photo 6 was switched to the OFF position, the Buzzer would not emit sound either because the circuit of the Starboard Light had been switched off altogether.

9. It is noted that some of Circuit Breakers had a red flag and some had no red flag, even though they all appeared in the ON position in Photo 17. It is likely that those Circuit Breakers that had a red flag were those that were switched to the ON position. Those which do not have a red flag, even though they were in ON position, were probably because they had been damaged. Since it is difficult to buy the same model of Circuit Breakers from the market, one can confirm the above information through a visit to a similar vessel such as *Lamma II*.

10. The Circuit Breakers shown in Photo 17 were mostly damaged as they could not be tripped positively one way or the other. It is likely that these Circuit Breakers were tripped because of short-circuits which occurred on 1st Oct., 2012. However one could not rule out the possibility that some of the Circuit Breakers had been damaged before the accident.

Statement of Truth

I confirm that I have made clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. I believe that the opinions expressed in this report are honestly held.

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Professor S. L. Ho

Chair Professor of Electricity Utilization

6th March 2013