PRILIMINARY REPORT ON THE
ACCIDENT AT RANTAMBE – 132 KV
SWITCHYARD – 21ST FEBRUARY 2011

DGM (MAHAWELI COMPLEX OFFICE)
CEYLON ELECTRICITY BOARD
MAHAWELI COMPLEX
07th  MARCH 2011
Detail of Accident

The bus coupler R phase current transformer (CT) exploded in the 132 kv Rantambe switchyard at 17:30 hrs on 21\textsuperscript{st} February 2011. Mr. G.M.T. Bandara (Electrical Superintendent) Mr. Sarath Vithanage Electrical Fitter and Mr. S.M. Upul (Unskilled Field Service) were working at the Bus Coupler circuit breaker control cubicle on the ground close to the exploding R phase CT got injured. Mr. Bandara received extensive burn injuries from the burning splash of oil while the other two workmen were partially covered from the exploding CT by the open panel door, and had comparatively minor burn injuries only. All injured persons have been transported while giving basic first aid in CEB vehicle to the nearest Hospital which is Mahiyabgana base hospital.
**Conditions prior to accident:**

Operation of the Rantambe switchyard have been on the main bars (AH1) on that day. The bus coupler circuit is used only when change of bus bars are needed and that need has been rare at Rantambe. The operations undertaken that day is to energize the reserve bus bar under system control requirement. The bus coupler circuit breaker has not operated remotely from the control room and the maintenance staff were sent to the switchyard to locate the fault. While the staff were attending to the fault at the control cubicle of the circuit breaker, the bus bar CT closest to the cubicle has exploded.

**Details of the failed equipment:**

Rantambe switchyard has been constructed in 1984 and all equipment in the switchyard are of the same age. However, the R phase bus coupler CT has been damaged during construction of Rantambe dam and has been replaced in 1986. Hence, the failed CT is two years younger than all CTs in the switchyard. The name-plate details are –

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<th>Manu.</th>
<th>BBC</th>
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<tr>
<td>Country of manufacture</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Type</td>
<td>AOK 145 HC</td>
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<tr>
<td>Serial No.</td>
<td>HA 445336</td>
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Name plate details of CT
Casualty Evacuation:

Mr. Bandara has been rolling on the ground to put out flames on his body when observed and station staff has put out flames by covering him and with splashing drinking water Mr. Sarath Vithanage had burnt injuries in the side of his head and Mr. Upul had burns on his shoulder back. All persons were transported to Mahiyanganaya base hospital where first aid treatment had been immediately started. Plans were to take Mr. Bandara who was reported to be 80% burnt to Colombo Accident Ward the next day. However, on the request of Mr. Bandar’s relations he was transferred to Badulla Base Hospital. On Doctors’ advice, critical first aid was completed before he was air lifted on 22nd February, 2011 to Nawaloka Hospital – Colombo on the instructions of AGM (Generation) and Chairmsn – CEB and obtaining treatment todate. Other two workmen were treated at Mahiyanganaya and Badulla Base Hospitals and have been released from those Hospitals by now.

Observations made on site on 22nd February, 2011:

1. The CT porcelain bushing had burst into small pieces and flang almost to the other end of the switchyard (approx. 80 m) few pieces in the immediate vicinity.
2. The CT head had burst open and separated from the base and hanging from the overhead conductors.
3. Several other post insulators had been damaged with the impact from the bursting CT.
4. Burnt conductor and pieces of rubber was found on the ground near the burnt CT.
5. Except for small tools and short step ladder no long tools were in the accident area.
6. The bus coupler circuit breaker had been released for maintenance after isolation from both busbars and for testing purposes isolators have been test operated by the maintenance staff and finally isolated after the explosion.
7. When the CT burst the circuit breader has been in the open position.
8. It has rained with thunder at Rantambe after the accident occurred in the night.
9. The CT has been energized when exploded but no load current could have flown first as the CB was opened and further the reserve bus bar was not connected to any line.
10. The workmen had been working on the breaker control panel and that side door was open. The CT terminals come to the back side of the panel and the door of which was closed and no flame marks inside.

System Restoration:

Post insulators of generators no.02 circuit and bus coupler were damaged due to the impact of exploding insulator pieces with a minor chipping of a post insulator in the bus bar 1 which was temporarily repaired. After checking all insulators in the switchyard and isolating damaged lines the bus bars were energized at 10.35 hrs. on 22nd February, 2011 and supply to distribution lines were restored at 11.36 hrs. and one generator unit was started at 13.53 hrs. on 22nd stopping spilling at Rantambe. Again a switchyard release was obtained on 23rd February, 2011 to replace all damaged post insulators and both generators and all lines were restored by 17.22 hrs. on 23rd February, 2011. The bus coupler was isolated from both bus bars.
Possible causes of CT failure considered:

1. Breakdown of internal insulation of the high voltage winding inside CT head causing an arc igniting the oil resulting pressure inside causing explosion of the CT porcelain part.
2. Outside flashover of the insulator and causing it to shatter and subsequent flashover of CT winding causing fire due to oil and oil wet insulation.
3. Inadvertent opening of the CT secondary winding causing arcing of the secondary terminals igniting the oil in the CT and subsequent explosion.
4. Lightening surge travelling along R phase causing flashover of primary winding to earth inside CT resulting in fire and subsequent explosion.
5. Wrong handling of tools causing external flashover resulting in breakage of the CT busing and subsequent fire.

Analysis of Possible Causes:

Cause 1:

An internal pressure causing explosion is indicated by the fact that the porcelain insulator has broken to small pieces and travelled almost 80 m from the position of the current transformer. It is also shown by the broken CT head and bellow part. However, inside of the CT head could not be inspected as the magistrate court inquiries are pending and to Govt. Analyst is due to visit site which has not yet happened. A definite spark over cannot be seen to establish this cause beyond doubt.

Photo of insulator piece
**Cause 2:**

Outside flashover can happen due to unclean insulator surface or wrong handling of long equipment like ladders, etc. In case of such outside flashover, it is most possible that porcelain insulator first fail and high voltage flashover occur due to loss of insulation oil. Hence, the majority of insulator pieces should be in close vicinity, which was not the case here. Hence, this cause can be ruled not possible.

**Cause 3:**

In the event of open – circuit of the secondary of the current transformer at primary voltage of 132 kV a secondary voltage of (7 – 12 kV) can develop when the CT exploded, the CT was energized from the main bus bar but open at the bus coupler Circuit Breaker. Failure is not possible if the circuit was subsequently loaded and CT windings could be saturated and generate high heat. But in this case the circuit was open, hence, only flashover due to high voltage in the secondary is possible. Even if this happened the flashover would most probably occur at CT secondary terminals which are outside the device and cannot cause the resulting fire. Further there was no work done on the side of the panel where CT terminals arrive and possibility of open CT secondary is remote.
**Cause 4:**

There has been no report of fighting at Randenigala/Rantambe when the accident occurred on 21\textsuperscript{st} February, 2011 but it has rained in the night in a few hours. There is a possibility of lightning activity but no record is present in protection or otherwise of lightning surge activity. Hence though breakdown of insulation due to a lightning surge is present it is a remote case to be considered.

**Cause 5:**

The maintenance staff have gone to the switchyard to attend to a control fault in the bus bar circuit breaker cubicle and there was no need for long equipment like ladders. No such equipment were observed in the site early morning of 22\textsuperscript{nd} Feb. 2011. The failure mode of the CT bushing also indicated an explosion generated by high internal pressure. A faulty tool handling can cause an outside flashover and effects of such was discussed earlier and are not consistent with the observation made in the case. Hence, this cause cannot be considered as an explanation.

**Conclusion of fault analysis:**

In the absence of an opportunity of locating the fault point inside the CT head due to Magistrate inquiries and being unable to obtain the main evidence of the supervising officer, Mr. Bandara (ES) as he is still in the Intensive Care, conclusion have been made on circumstantial evidence gathered at site and analysis of possible causes.

It should be noted that the failed CT is the newest pieces of equipment manufactured in 1986 compared to all others manufactured in 1984, installed at Rantambe switchyard.

The probable cause of failure is breakdown of insulation of the high voltage winding. This can happen due to ingress of moisture through seals. This current transformer has been replaced in 1986 due to the original CT in the bus coupler getting damaged in rock blast at the construction of Rantembe dam. There is no record of commissioning the later CT. After this the bus coupler has not been energized except for change of bus bars which are very rare at Rantembe. At this instance of failure it has been energized for a period of approximately 2 hours before failure.

It is ironic that this type of accident should occur at the station, where it has received a merit award for industrial safety in 2010.

**Recommendations:**

1. To immediately embark on a programme to test remaining current transformers in the switchyard.
2. To review surge protection in the switchyard and incoming lines.
3. Pay special attention to Safety Precautions in Switchyard and make possible improvements.