Department of **Consumer and Employment Protection**
Government of **Western Australia**

Energy*Safety*

ELECTRICAL INCIDENT REPORT

INVESTIGATION OF WILDFIRE ON 15 DECEMBER 2004 AT LOCATION 1434 WEST ESPERANCE WESTERN AUSTRALIA

4 October 2005

2004-1406

TABLE OF CONTENTS

1 INTRODUCTION

A wildfire occurred at Location 1434, South Coast Highway about 42km west of Esperance on Wednesday 15 December 2004. It was reported by the Fire and Emergency Services Authority (FESA) that the cause of the fire might have electrical origins.

As a result of the notification from FESA an investigation was carried out by Energy Safety, the technical and safety regulator for the electricity industry in WA. This report summarises the findings.

The cooperation and assistance of officers of FESA and Western Power Corporation (WPC) is acknowledged.

1.1 Location of Incident

Location 1434, South Coast Highway, about 42km west of Esperance.

1.2 Time and Date of Occurrence

Approximately 1400 hrs on Wednesday 15 December 2004.

1.3 Notification of Incident

An Officer of FESA notified the Energy Safety Division of the incident on the afternoon of Wednesday 15 December 2004.

1.4 Investigating Inspector

The investigation was carried out by Mr Gary Scott, Senior Electrical Inspector, Energy Safety Division designated Inspector (Electricity).

Mr Scott visited the site on 15, 17 and 23 December 2004.

2 SUMMARY

Energy Safety investigated the cause of the fire at Location 1434, South Coast Highway about 42km west of Esperance and concluded that:

- A 33 kV blue phase conductor came into contact with the underslung running earth conductor, approximately 55 metres west of pole D292 on WPC's Dalyup feeder at Location 1434, west of Esperance. The clashing of the blue phase and earth conductor also caused a flashover between the red and blue phase conductors. This resulted in two flashovers that released hot metal particles, which ignited dry harvested stubble (some 15 metres from the powerline), initiating the wildfire [Photographs, Appendix A].
- At the time of fire the area was subject to strong wind conditions and high ambient temperatures.
- The clashing of conductors resulted in the associated 33 kV Dalyup Feeder protection (D38) recloser operating twice at 13.51 hours on Wednesday 15 December 2004.
- The red and blue phase and earth conductors, when inspected showed signs of burn marks where the conductors clashed. The earthing conductor also had broken strands at the point [Photographs, Appendix A].
- On the afternoon of Wednesday 15 December 2005, WPC carried out repairs to the damaged (broken) strands of the underslung running earth conductor.
- On the 16 December 2004 WPC was issued with an Inspector's Order advising that the powerline was unsafe between Poles D292 & D293 (127M span) of the Dalyup 33 kV powerline. The Order required WPC to install an intermediate pole. This intermediate pole was installed on 23 December 2005. At the same time sample sections of the blue phase, red phase and earth conductors were removed for scientific testing.

3 ORIGIN OF THE WILDFIRE

No witnesses who claim to have seen the actual start of the wildfire have come forward. The first person to notice the fire was a passing motorist travelling along the South Coast Highway who advised the property owner's son.

The origin of the fire was approximately 55 metres west of pole (D292) and approximately 15 metres south easterly from the powerline where there were burn marks on the red phase, blue phase and earth conductors. This is consistent with the 33 kV blue phase and earth conductors clashing.

The property owner estimates that an area of approximately 50 hectares had been burnt. It was evident that the fire was driven by wind in a southeasterly direction away from the clashing conductor point. This is consistent with the fire being driven away from the suspected point of ignition, by wind coming from a northwesterly direction, as was the case at the time of the fire [Photographs, Appendix A]. As the fire occurred downwind and away from the powerline it could not have been the fire which caused the powerline to clash or flash over.

In summary, it was concluded that the fire was ignited when the 33 kV blue phase conductor clashed with the underslung running earth conductor. This action released burning metal particles that drifted in the wind until it fell to the ground and ignited the dry harvested stubble.

4 INVESTIGATION

The property owner stated that the fire started at approximately 1400 hrs on Wednesday 15 December 2004.

4.1 WPC's Equipment

The WPC powerline was constructed as follows:

- Three phase 33 kV arrangement utilising three steel cored aluminium active phase conductors (3 x 6/1/3.00 acsr) with a underslung steel running earth conductor (1 x 7/1.60 FeGz);
- The spans either side of pole D292 were approximately 130 metres to the east (pole D291) and 127 metres to the west (pole D293);
- The feeder supplying this system is called the Dalyup Feeder, which is electrically protected by a circuit breaker (D38) with auto-reclose facility; and
- The spacing measurement of the conductor spacings at poles D292 and D293 are as follows (the earth conductor is on the blue phase side of the pole):

    - Pole D293 - between red and white phase: 1.0 metre
    - Pole D293 - between blue and white phase: 0.97 metre
    - Pole D293 - between white phase and earth conductor: 1.5 metres
    - Pole D292 - between red and white phase: 0.98 metre
    - Pole D292 - between blue and white phase: 0.98 metre
    - Pole D292 - between white phase and earth conductor: 1.5 metres

4.2 Examination and Findings

The following facts were determined from information provided by the property owner's son, Volunteer Fire Control Officer, WPC Esperance depot staff and on site inspection:

- Energy Safety's, Senior Electrical Inspector, Gary Scott, attended the fire scene at approximately 15.00 hours on the 15 December 2005, whilst fire-fighting volunteers were mopping up the remnants of the fire. Damaged/burnt sections of the running earth conductor and blue phase conductor between poles D292 and D293 were identified and photographs taken. Mr Scott also observed that all the active 33 kV steel cored aluminium conductors were sagging abnormally close to the steel underslung earthing conductor as a result of the high temperature. At the time the winds were strong and from a northerly direction.
- At approximately 15.10 hours at the fire scene a Senior Fire Control Officer and neighbour stated the following:
    - Current temperature is 42 degrees C at 7% Relative Humidity;
    - The winds at the time were 12 Km/h from North/North-West gusting to 30 km/h; and
    - The fire appears to have started between poles D292 and D293.
- A WPC repair crew attended the scene at approximately 16.30 hours of Wednesday 15 December 2004 and carried out repairs to the damaged underslung earth conductor [Photographs, Appendix A].
- WPC District Network Officer stated at the interview that the Dalyup feeder three phase powerline is inspected every 12 months by line staff by vehicle or helicopter.

The last two inspections were carried out by helicopter. Aerial patrol inspections are carried out as per WPC's Annual Aerial Patrol Inspection Checklist and cover visual inspections of the structure, pole top hardware, stays, switching devices, conductors, powerline corridor, transformers, sectionalisers, reclosers and circuit breakers.

- The span distance between WPC poles D292 and D293 was approximately 127 metres.
- WPC's Esperance Network's Officer advised Energy Safety by email that the Dalyup Feeder Recloser (D38) had two auto-reclosures at 13:51 on the Wednesday 15 December 2004. The fault current readings were earth phase 160a (amperes), Blue phase 290a, White phase 0a and Red phase 310a. The Dalyup breaker (EHR612.0) also had a reclosure at the same time 13:51. The readings were Earth phase 170a, Blue phase 389a, White phase 30a and Red phase 408a. The operation of the Recloser correlates to the clashing between the blue phase conductor with the running earth conductor and the subsequent flashover to the red phase conductor.

4.3 Weather Conditions

The Bureau of Meteorology provided the following weather information from the Esperance weather station, for 13.30 hours on Wednesday 15 December 2004:

> North/North-Westerly wind at 38.9kmph. Wind gusts of up to 53.7kmph
> Relative Humidity at 11.1%. Air temperature of 40.2ºC

4.4 Independent Scientific Inspection Results

Scientific inspection of the conductor samples (damaged steel earth conductor and active blue phase and red phase conductors exhibiting burn marks) by the CSIRO found:

Steel Cored Aluminium Blue Phase Conductor Sample
The blue phase conductor has high levels of Zinc (Zn) and Steel (Fe) around the discoloured area. This area also has a texture consistent with the evaporative/sputter coating produced due to arcing. Some areas show clear signs of molten steel-zinc impacting on the aluminium conductor sample and then solidifying.

Steel Earth Conductor Sample
The broken ends of the earth conductor sample showed signs that they had melted, which is consistent with what would be expected from arcing or resistive heating. There was no significant Aluminium deposit on this sample.

Aluminium Red Phase Conductor Sample
The red phase conductor sample had no signs of Steel or Zinc contamination.

5 ANALYSIS and SUMMARY

There are a number of factors that occurred on the day of the wildfire that need to be considered. These are summarised below:

- No witnesses, who claim to have seen the actual start of the wildfire, have come forward. However, the property owner's son reported that the fire started at

approximately 1400 hours on Wednesday 15 December 2004 after being alerted by a passing motorist travelling along the South Coast Highway.

- Gusty winds and high temperatures are believed to have contributed to the clashing of the 33 kV blue phase conductor with the underslung earth conductor between poles D292 and D293, resulting in a flashover that released hot burning metal particles. These burning metal particles ignited dry harvested stubble, commencing the wildfire.
- Gusty winds from the north/northwest also caused the wildfire to spread over an area of approximately 50 hectares until FESA volunteers brought it under control.
- Scientific testing of the conductor samples by the CSIRO indicated that the blue phase conductor showed traces of zinc and steel around the discoloured area consistent with the evaporative/sputter coating produced due to arcing. Some areas show clear signs of molten steel-zinc impacting on the steel cored aluminium conductor sample and then solidifying. The broken ends of the earth conductor sample showed signs that they had melted, which is consistent with what would be expected from arcing or resistive heating.
- The clashing of the high voltage conductors resulted in the associated 33 kV Dalyup Feeder protection (D38) operating. WPC's Esperance Network's Officer advised Energy Safety by email that the Dalyup Feeder Recloser (D38) had two reclosures at 13:51 on the Wednesday 15 December 2004. The operation of the Recloser correlates to the alleged clashing of the blue phase conductor with the running earth conductor and the flashover to the red phase conductor.
- It is concluded that the red phase conductor flashed over to the blue phase conductor without making contact after the blue phase conductor came into contact with the earth conductor. This is deduced because no zinc or steel trace was found on the red phase conductor but arc burn marks were evident.
- The associated powerline should have been designed, constructed and maintained to safely operate under the gusty winds experienced on the day of the fire i.e. maintain adequate clearances between conductors to prevent contact under such circumstances.

6 CONCLUSIONS

This investigation has identified that the WPC 33 kV Dalyup distribution line active conductor (blue phase) clashed with the underslung earth conductor. Also the mode of failure is similar to a previous incident at Tenterden (although the detail of this case is not covered in this report), which caused a significant wildfire and loss of human life. It therefore raises real concern about the construction methodology and maintenance of powerlines using dissimilar materials for the active conductors (aluminium) in relation to the underslung earth conductor (steel) with respect to differing expansion factors as temperature increases where high ambient temperatures and gusting winds may be expected.

Wester Power is currently surveying and addressing this long (>135 metres) bay high voltage aerial powerline issue to ensure compliance with the *Electricity (Supply Standards and System Safety) Regulations 2001* on its South West Interconnected System (SWIS). However, given the above it is clear that Western Power also needs to consider shorter span lengths of greater than 100 metres and powerlines outside of the SWIS to ensure adequate safety clearances are maintained across its entire network.

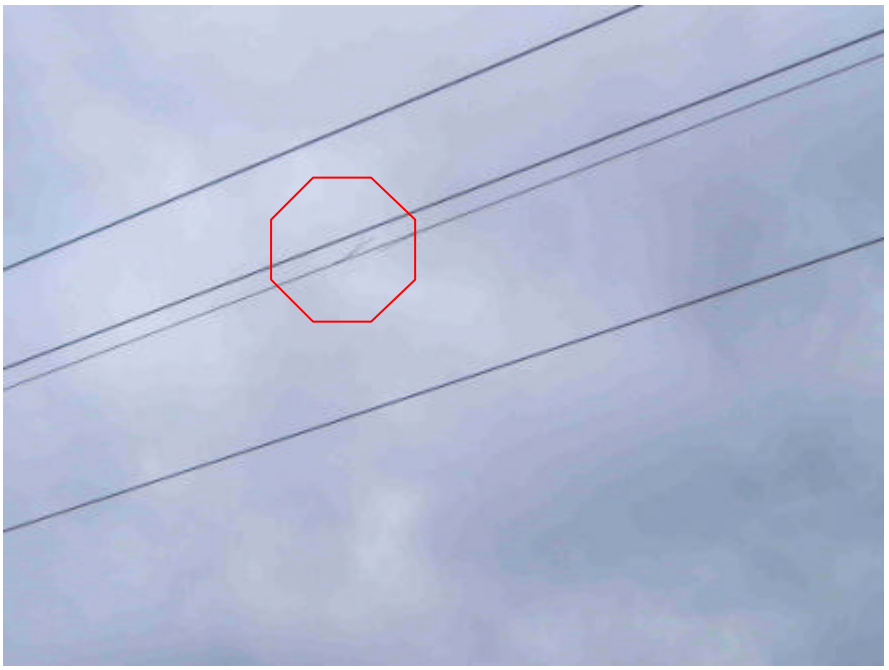
APPENDIX A - PHOTOGRAPHS

Photograph number 1: View of the Fire Scene looking toward WPC Pole D292

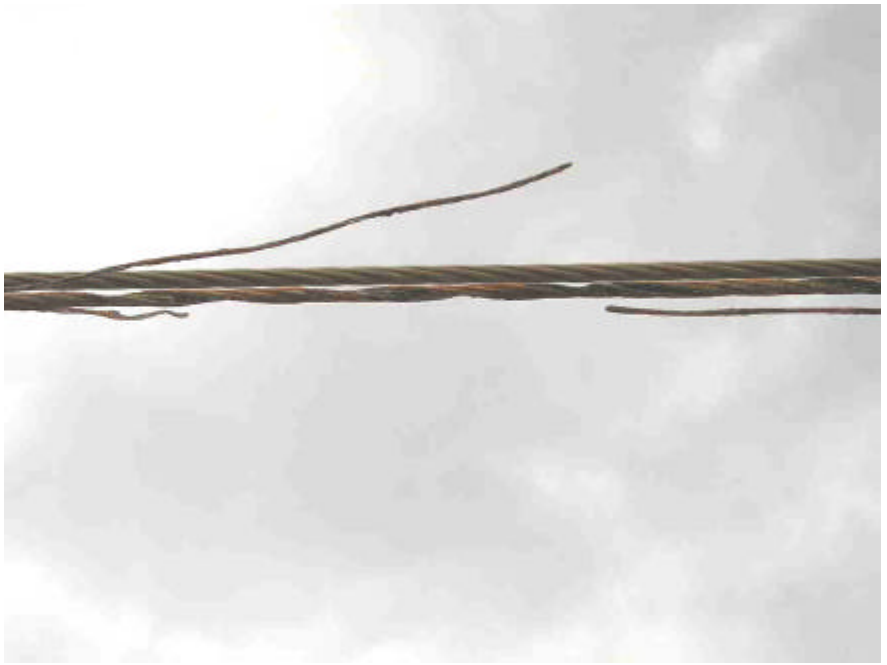
Photograph number 2: View of the fire scene looking south

The bottle is situated directly under the point where the conductors clashed on the powerline.

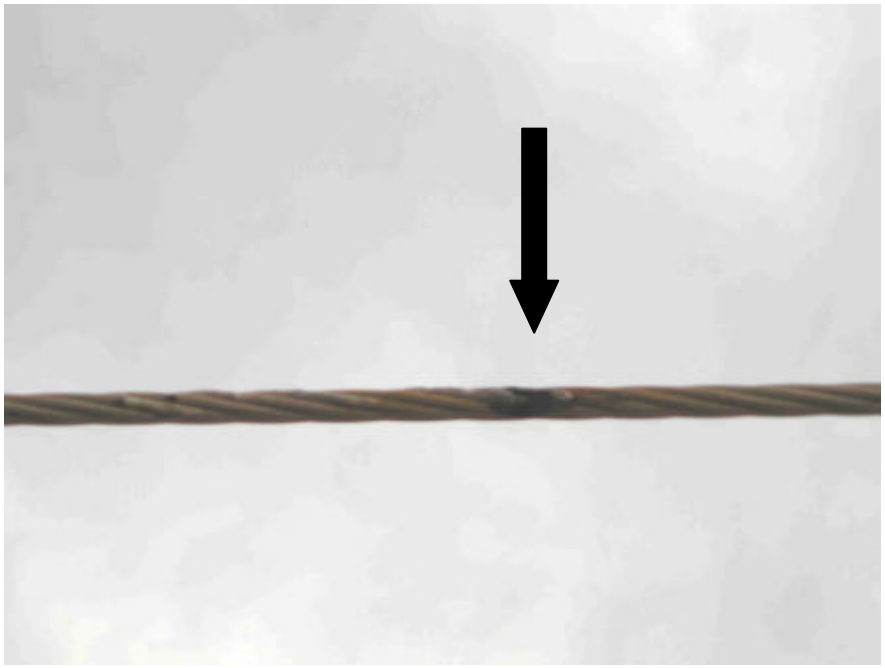
Photograph number 3: Damaged underslung earth conductor



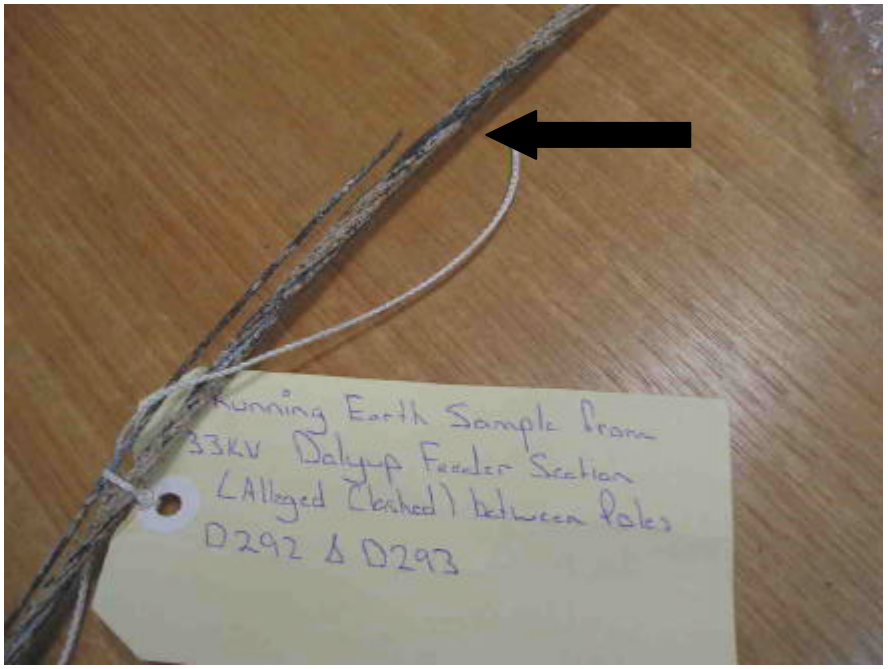
Photograph number 4: Damaged underslung earth conductor



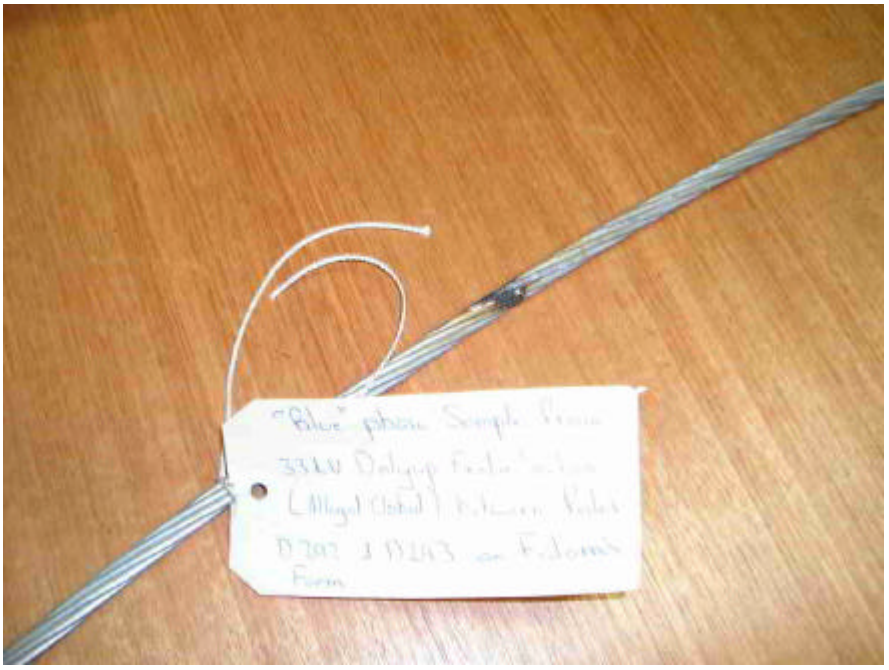
Photograph number 5: Burn mark on the red phase conductor



Photograph number 6: Contact marks on the underslung earth conductor



Photograph number 7: Burn marks on the blue phase conductor



Photograph number 8: Burn marks on the red phase conductor