# ELECTRIC SHOCK WHILE WORKING ON AN ELECTRIC TRANSMISSION LINE

acciona Energía

**QSE Alert**

Associated Non Compliance Code: EV0000000433

*This document contains information of a public nature and the aim is to share the lessons learned from incidents or situations of risk which may be of interest for workers from the sector in which Acciona Energía operates.*
*This document may be updated in the future as a result of the collection and analysis of better information, advances in the techniques and measures proposed, etc. Therefore, it is import to consult Acciona Energía about the latest version of the Warnings issued.*

## SCOPE

☒ Global ☐ Local. Country:
☒ All Business ☐ Construction ☐ Production
☒ All Technologies ☐ Wind ☐ Hydraulic ☐ Thermoelectric
☐ Photovoltaic ☐ High Voltage
☐ Others. Specify:

## FACTS

### General context in which the accident occurred

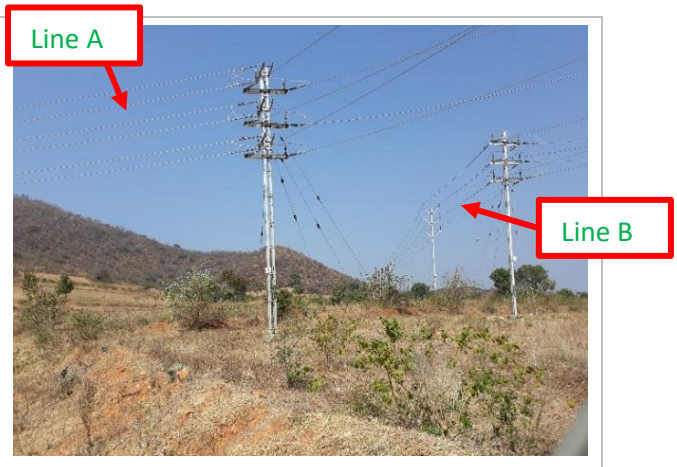
Acciona Energía Wind Farm, January 2019.

Work that was in progress: operators from the high voltage maintenance company were mounting bird spikes guards on the poles of an electric transmission line which connects a wind farm to the evacuation substation. This facility is not integrated in Renewable Control Centre of Acciona Energía.

General information about the electric line where the accident occurred (Line B):

- Rated voltage33 kV
- Double circuit in mountainous terrain
- Approximate height of the poles: 11 m, access via ladder
- Approximate length of line: 12 km
- There are approximately 7 inferior crossings with other lower voltage lines (11 KV) along the path of the line.

Detailed view of the gantry structure of the substation at which four circuits arrive from the wind farm (two double circuit lines).




Detailed view of the two double circuit 33 KV lines (A and B) arriving at the substation from the wind farm. The lines are not parallel.

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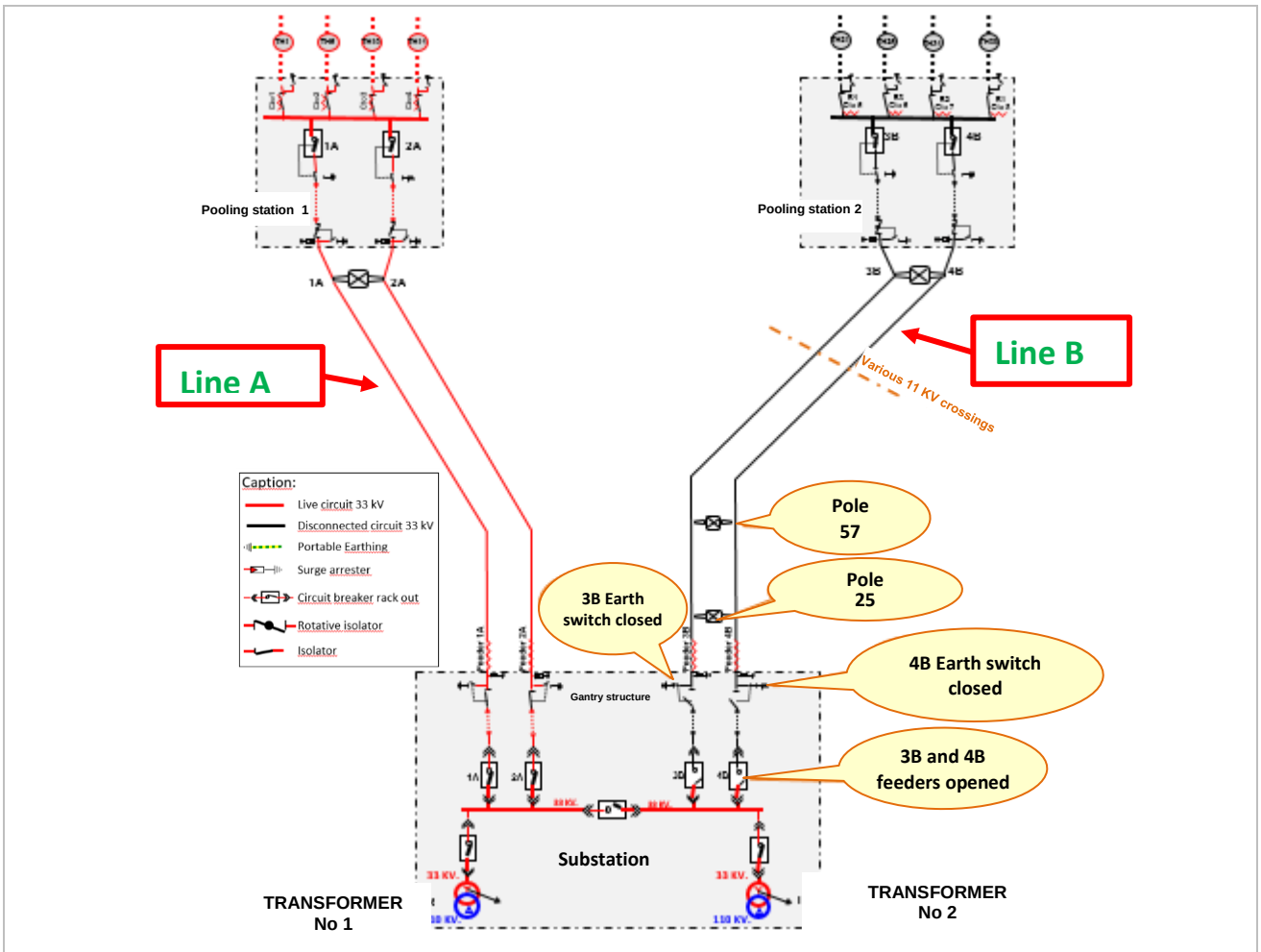
## Description of the accident

Prior to the start of the work, the line (line B) was taken on outage as described below:

- Isolation point at the substation: circuit breaker + isolator 3B and 4B opened and tagged out.
- Isolation point in the wind farm: circuit breaker + isolator 3B and 4B closed, therefore, isolation **not implemented** on the wind farm side.
- Earthing of the line on the substation side: 3B and 4B closed and tagged out.
- Earthing of the line on the wind farm side: 3B and 4B open, therefore earthing not implemented on the wind farm side.

To prevent potential inductions resulting from the crossings, the distribution company was asked to disconnect all the 11 KV lines which crossed the Acciona line. This request was granted.

Early in the morning and after putting line B on "outage", work started. The electric situation of the line was as indicated below:




At the time of the accident, work was taking place on poles 57 and 25 of line B.

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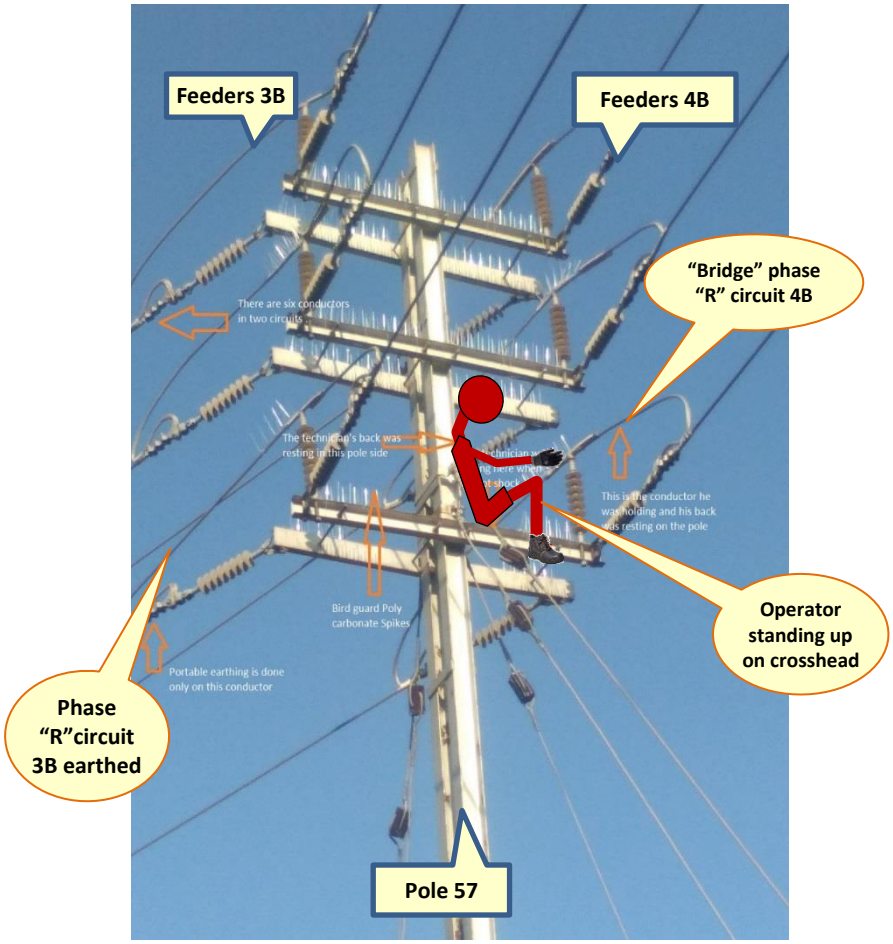
As usual after finishing the morning session work the operators took break for the lunch & after they resumed work for installation of the bird spikes guards, specifically on poles 57 and 25 of line B.

At a particular moment, an operator who was at pole 57 received an electric shock, which seemingly only caused a minor shock and no more serious injuries. He immediately descended from the pole on his own.




Supposed position of the operator at the time of the shock (diagram shown without ladder, harness or safety lines).

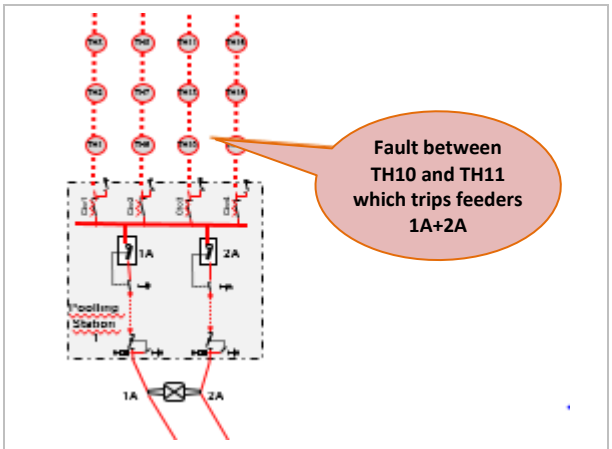
On reaching ground the only injuries found were minor burn spots on different parts of his body (back and left leg) & then he was taken to the hospital for further medical assistance. Following a night in observation, he was discharged from the hospital following day morning, indicating that no further injury had been observed.

It should be noted that the work zone on support pole 57 of the line was not correctly protected with portable earthing, only one portable earth lead had been mounted on one of the phases (phase R, circuit 3B, wind farm side). Moreover, this portable earth cable had a cross-section far lower than that was required for the given short circuit current of the 33kV line conductor.

The victim of the accident was wearing normal work clothes (he was not wearing clothing to protect against arc flash).

## Other information of interest

Shortly before the accident there was an unexpected trip on line A. The wind farm maintenance company (different to the maintenance company mounting the bird spikes guards on line B), following different tests selectively energizing the internal circuits of the wind farm to locate the origin of the fault in the wind farm itself (underground cable in circuit 3).




Fault found in one of the internal circuits of the wind farm that evacuated through line A which was energized normally.

After analyzing the information saved in the protection relays of the substation, it was found that at the same time of the accident occurred, a trip had been recorded due to "function 51 or timed trip" with a current of 998.2 A.

## Causes of the accident

Immediate cause:

The following are listed as the immediate causes of the accident:

- Incomplete outage of the line, without correctly creating the protected area: the wind farm side was not insulated or earthed (line isolator closed and earth switch opened).
- The working area at pole 57 was not correctly protected with portable earthing.

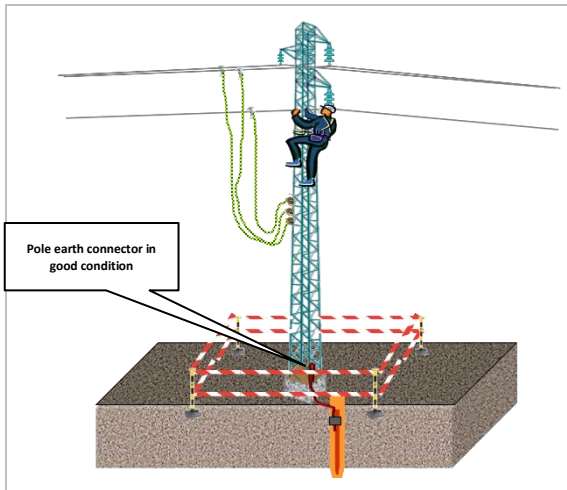
Root cause:

Homopolar return current caused by operations carried out in the wind farm to locate the internal circuit which was causing the fault. The return current reaches the transformer neutral in the substation through the earth mounted on phase R of circuit 3B mounted on support at pole 57.

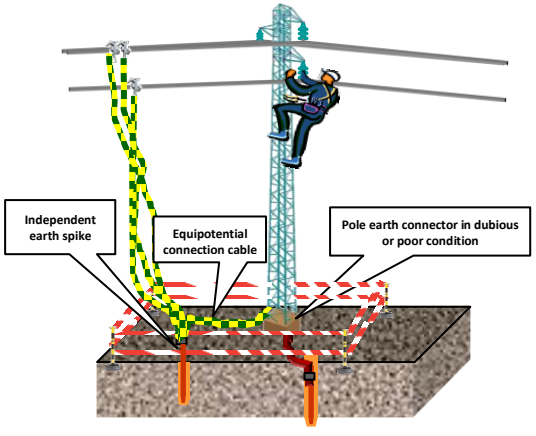
## LESSONS LEARNED

Whether the origin of the discharge was a return current as in this case or it was caused by induction from another line, **the accident would have been prevented if the working area at pole 57 had been correctly protected with portable earthing of adequate cross-section in all the phases**. Therefore, the lessons learned following this accident are mainly aimed at remembering the **vital importance** of the **correct creation** of the **protected area** and **working area** whenever work on high voltage electric lines is to take place:

- In order to work on a high voltage electric line, it is essential to first create the **protected area**. The creation of the **protected area** implies strict compliance of the 5 golden rules for working on electric facilities:
  1. Opening with visible disconnection of all sources of voltage (in this case both ends of the line).
  2. Lock out and tag-out of the switching elements at the isolation points.
  3. Checking for the absence of voltage.
  4. Earthing of the line at the isolation points (at both ends).
  5. Delimitation and marking of the Protected Area.
- After creating the **protected area** on the line, the **working area** must be created. The **working area** on high voltage overhead lines must always comply with the following minimum conditions:
  - Visible portable earthing on all the phases at a point close to the pole on which the operator is working.
  - The portable earthing must provide equipotential, either connected directly to the pole or through earth spikes connected electrically to the pole.
  - The portable earthing used must have an adequate cross-section to withstand the short circuit current. This figure is not standard or fixed according to the rated voltage of the line but depends on the short circuit current of each facility.




Connection of the portable earthing if the earthing of the pole is in good condition.




Connection through an earth spike if the earthing of the pole is not in good condition.