Diminishing the Impact of Meteorological Factors on Overhead Electrical Lines

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Abstract - This paper presents some considerations about the methods used in Romania for the reduction of negative effect of the meteo factors upon the overhead electrical lines (OEL).

Some characteristics are reviewed of the meteo specialist cooperation with the power ones concerning the data necessary for OEL design and for short term prognosis, efficient in the prevention of the incidents caused by white frost (rime) and wind. Are also presented the evolution of the meteorological zones for OEL design the general principles founding this evolution concerning wind velocity and accretion thickness and finally the result of this process.

The preventing preheating of OEL conductors to avoid the deposits of rime, also the effective methods of ice melting upon the line conductors with the specific of the Romanian-ones are presented.

These methods are initiated by the warning based on objective signal offered of "white frost detector" which specify the timely moment of beginning the preheating or decide the ice melting.

Afterwards are presented new solution of conductors and poles protections against mechanical overloads done by ice and their main characteristics.

Finally, the authors present some conclusions resulting from their experience in this matter.

I. INTRODUCTION

Romania is a country with excessive continental climate with an important amount of rainfall in winter period at low temperatures (-5… +2 ^{o}C), the rain may produce the great ice deposits on OEL. Associated with the wind velocity, the ice thickness of great density, is fast growing and produces dynamic effects and many damages in Romanian Power System (RPS).

Besides this phenomenon, difficult to predict and with results hard to prevent, who may appear especially in the extra-Carpathian zone, are some zones with frequent rime (white frost) deposits on OEL conductors. These deposits are slow growing, being characteristic for the some good known OEL from zone line western mountains, crossing the Carpathian chain or near the Danube and the Black Sea. All this kind of ice deposits the wind has moderate velocity and the thickness generally easy stabilised. These actions produce only statically efforts on conductor, bent the consoles and poles, reduce lines gabarits and endangers the line stuff. The concern of the romanian power engineering specialists for the diminishing the negative impact of the ice and wind on OEL began before the second world war, when were realised the first 110 kV OEL, upon german design.

Contrary to the german model, Romanian projects contain a combination of horizontal stresses due to the wind velocity upon covered by ice of small density conductors. The scarcity of primary statistical values necessary for an optimal technical-economic design in addition with some particular characteristics of the equipment and reliability quality and of the phenomena mentioned before, has resulted in unfavourable operating indicators of the romanian OEL's (conductors, isolators, poles failures per Km an year).

The methods used for improving these important indicators are presented in [1] [2] [3].

II. IMPROVING THE DESIGN OF OEL

Approximately 25% of the disconnection of the HV- OEL (110-730 kV) are caused by line elements failures. By the other hand, failures and damage analysis represent the main source of information for improving the equipment design and operation. This activity has been systematically developed since 1966 in RPS and lead to the improvement of the design and operational method to prevent the dangerous overloading caused by the icing and wind or their combination.

Design specifications represent the main tool to balance OEL economy and reliability register minimum actual investment and operational expenses over the entire OEL life time.

The climate and meteorological condition in Romania, particularly in the extra-Carpathian zone of the country favour the occurrence of heavy ice deposits associated with high wind speed-the worst loading condition for OEL design. Was difficult to choose the optimum design conditions, done the scarcity of the statistical data on actual distribution of this independent random variables uncorrelated $\overline{v}$ and b. That explains the frequent changes in design specifications for OEL, six editions until 1979.

Now, after a deal between the INMH (National Meteo Service) and OEL Project Institute (ISPE), more realistic and consistent value for wind (v: m/s) and ice thickness (b: mm) were established, based on a statistical processing of the records from meteo stations, evenly distributed over the whole the Romanian territory (130 measuring $\overline{v}$ and 50 measuring b). The main results-unfortunately with some limits (e.g. no correlation between v/b) of data processing lead to establish only two ice-wind zones for the territory- comparatively with 5-5 zones in former specifications (fig. 1).

To optimise the design solutions, a different failure rate (frequency) for distribution D (6…110 kV) and transmission T (220-300 kV) OEL was established (10 years return period for D OEL while 15 for T OEL). Of same importance is the latitude of the designers to choose greater values for b (mm) and $\overline{v}$ (m/s) based on operational experience. These measures in the addition with the use of the project based on “status limita” had a good results. In the last 10 years for the entire country’s territory, the mean failure rate for the OEL’s is 0,056 (1/year) that mean one failure in 17,66 years-similar with those considered in recent specifications.

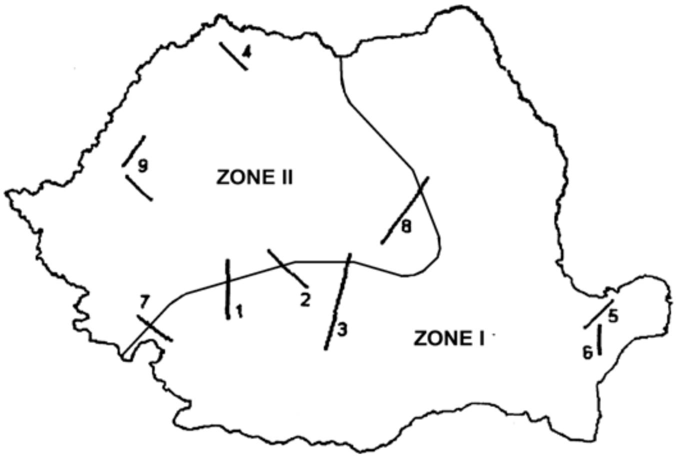


Fig. 1 Meteo zones for Romania and Electric lines with frequent white frost deposits
1. Paroseni-Targu Jiu; 2. Lotru-Sibiu (220 kV); 3. Arefu-Slatina; 4 Baia Mare-Cavnic; 5,6. Lines in Dobrogea area (110 kV); 7. Orsova-Moldova Noua; 8. Brasov-Gutinas (400 kV); 9. LEA 110 kV in Oradea area

The values for $\overline{v}$ and b taken in the last edition of PE 104/94 for OEL design are presented in table 1.

TABLE 1

OEL	Meteo Zone	Wind speed (m/s) Maximum	Wind speed (m/s) Simultaneous with ice	White frost (ice) thickness (b) with γ=0,75kg/dm^3
220-400 kV transport	I	36	22	24
	II	32	17	20
≤ 110 kV Distribution	I	33	19	22
	II	26	14	16

III. CHOOSE OF OEL PATH WAY (ROUTE)

The designers have generally few possibilities to choose the path of the projected lines, been restricted by the administrative and ecological considerations. Despite that, is very important to protect the line against the effects of wind and ice deposits, choosing the line path to avoid or limit those phenomenons. Also, in the case that the favourable meteo path is inaccessible, at the design phase must adopt fortifying solutions for line elements.

From this point of view may be considered the following situations:

- the line way may avoid endangered zone (s) using the field advantages without economic efforts;
- the endangered zones may be avoided lengthening the line path.

The main principle to be followed for diminishing the ice deposits is that to avoid the slopes, empty hills or plateaux perpendicularly on dominants winds with great humidity, coming from the sea (ocean), because on the slope the currents accelerate increasing the danger of the deposits.

In fig. 2 are presented two solutions for concrete situations, in the goal to avoid the dangerous rime deposits.

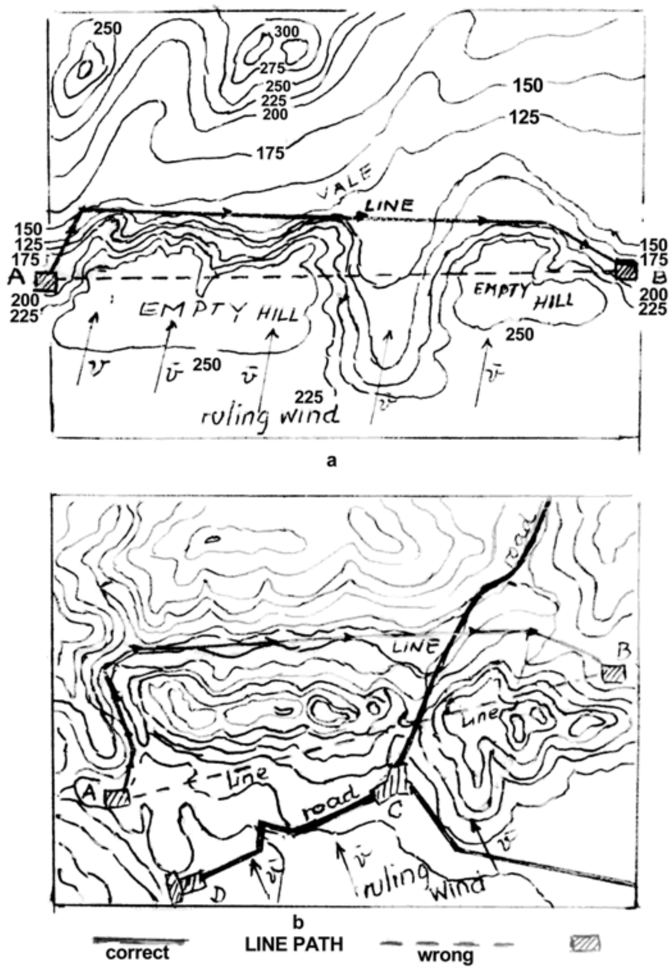


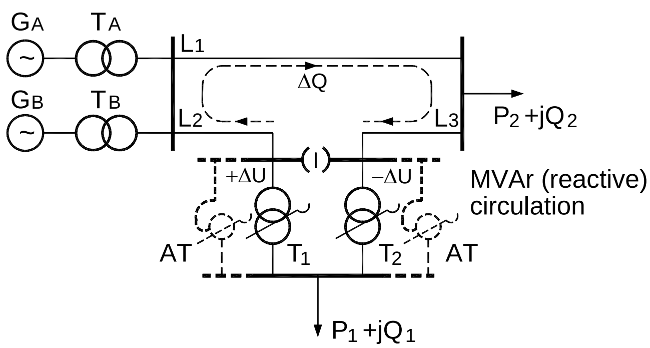
Fig. 2 Change of line path
a) Short lenghteen, b) avoid the danger

IV. PREVENTION OF HAZARDOUS ICE DEPOSITS

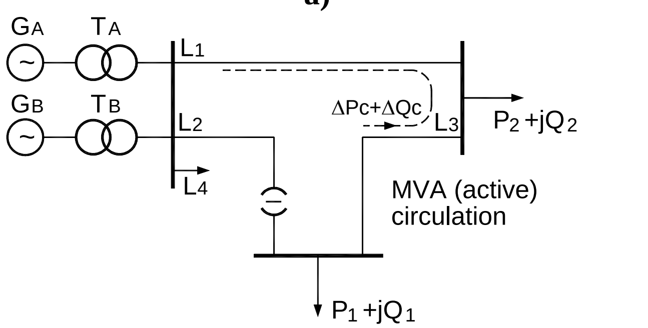
In order to prevent electrocution accidents and avoid the breaking of the conductors caused by great sags resulting from the rime deposits, the preventive heating of the conductors was largely used. The method consists in forcing the reactive and/or active power in the respective line, through the change of loop (loops) parameters containing this line.

That is realised either by modifying the ratio of users transformers adjustment under load or by taking over the loop consumption on one of the user’s supply line to the detriment of the other. The method mainly applies to the double circuit OEL’s of high voltage (220 kV, 110 kV) passing through the Carpathian chain, affected by rime (white frost) coating. Line like Paroseni-Targu Jiu or Sibiu-Lotru are heated for preventing the deposits two-three times from November through March, when the probability of coating is higher as has shown a long field experience (fig. 1).

The proper time to apply the preheating-by using the methods from fig 3 is based on the predictions of National Meteorological Service, now more accurate that in the past time, or by the indications of a sensors described in [2].



a)



b)

Fig. 3 Preheating by forcing reactive (a) and active+reactive circulation (b)

The preheating currents represent less than 50-60% of the usual defrosting (ice melting) which indicates smaller losses and done the possibility for easily realise the operational scheme necessary. The preheating currents for small wind velocity and low temperature for St-Al conductors are presented in fig. 4.

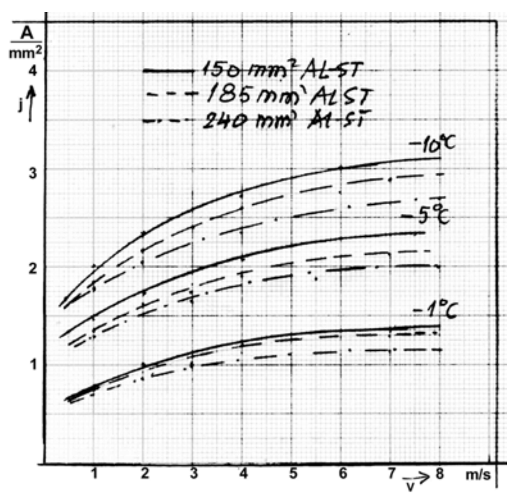


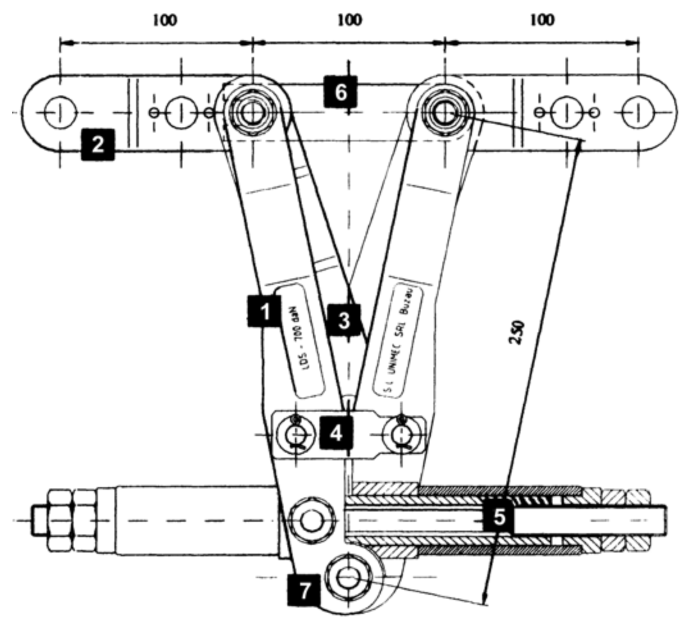
Fig. 4 Preheating current density

For this operation is not necessary to change the adjustment of line protection. The lines with frequent white frost deposits in Romania are shown in fig. 1. If the preheating procedure is not effective, the line is defrosted by the methods described in [2].

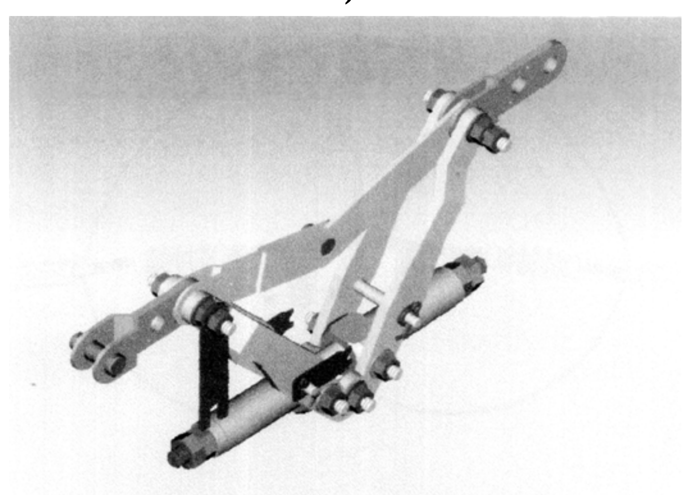
The preferred solution adopted by RPS Dispatch is the short circuit of many series connected lines, to obtain the necessary impedance for optimal melting current, by supply at nominal voltage.

V. Stresses limiter for MV OEL

To protect OEL, if the conductors traction is over a dangerous value, was created a device presented in fig. 5 [4]. It may be used at MV lines with suspension isolators, at each phase on traction poles.



a)



b)

Fig. 5 Stresses limiter for MV OEL
a) General view b) View after work

When the conductor stress exceed the adjusted value are broken the ties 4 and the rod 5 calibrated are submitted at traction, stress without shocks. They may be lengthened, maintaining the traction in the conductor at desired value. The piece 6 shown that the device has worked and must be rearmed, after the change of the rod 5. The piece 3 assures the limit of conductor sag after device work.

The device efficiency was many times demonstrated in practice.

VI. CONCLUSIONS

In Romania, the association of wind and ice have produced many problems in OEL operation. The measures taken in last time in the design and operation activity have diminished the failures of the OEL. An major inconvenient remaining is the nonobservance of the principle of failure containment in order: isolators, conductor, pole, foundation when v and b are exceeded.

The authors consider that no matter the design and de-icing method will be improved the meteo forecasts will be accurate and the type of the endowment equipment could be updated, is necessary to accept that is not economically to intent to assure the complete avoidance of the negative effect of meteofactors on OEL.

The authors must underline that the measures taken to the goal to increase lines reliability versus the influence of meteo factors were similar with some of those recommended of Nicolet Comonision after the ICE STORM from ian. 1998 in Canada: load releasing devices, de-icing and preheating techniques, researches on mechanical stresses, due of wind and ice, and s.o.

VI. REFERENCES

[1] M.L. Goia The study of icing phenomenon on dynamic structures in high altitude mountainous areas. IWALS-2000-Chester

[2] M.L. Goia Overhead line de-icing methods. IWALS-1998-Rejkjavik

[3] M.L.Goia Overhead electric poles protections against mechanical overloads. IWALS-1993-Budapest

[4] M. Voicu Stresses limiter for MV OEL-. S.C. UNIMEC S.R.L.–Prospect-VO