# SOME SOLUTIONS FOR ICING PREVENTION

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**ABSTRACT**

Romanian networks were in the past,annually confronted with numerous incidents due to ice accretion on OHEL conductors .In the last time the desertions (failures) due to ice, have decreased as a result of the climate changes or of other various phenomena (solar cyclicity, el nino, maybe global warming etc.).In spite of this reality,the paper presents some solutions proposed and tested “in situ” of the Romanian specialists and network enterprises to pay attention and sustain the interest to the continious diminish of such desertion in the future.Due to the fact that the transported load on indigen lines has generally decreased,the attention was guided to the design solutions of the new lines and to improve the behaviour of operating ones.

Were used methods like initiation and materialization of “in situ” studies and researches about the real effect of the wind and ice on lines structure and of new types of conductors with diminished ice accretion ,or self deicing capacity,and new solutions for the sensors for ice thicknes,and to the warning signal,direct transmitted by the supervised conductor.Also,have accepted the use of greater meteorological conditions in the new projects,based of operational experience,and were promoted new legislative regulations in new designs.

An important contribution to the adoption and implementation of such open mentioned methods had the Romanian specialists from the Transelectrica - National Transmission Company, ISPE, ICEMENERG- Energy Research and Modernizing Institute,Electrica Company and INMH- National Meteo-Institute. In this paper the authors present some methods applied in the phase of line designs.The work has a pragmatic character, allowing the specialists to initiate discussions and exchange opinions in the frame of IWAIS.

Key words: OEL, ice, climate, design,

## 1. INTRODUCTION

The last years have not brought many changes or news in the field of OEL structure icing in Romania,as was the case of the USA, Canada or Japan. The measures taken in the past have rendered satisfactory enough results, especially because the recent period was a “mild” one from the ‘meteo’ point of view. The main measures applied, based on the experience obtained in the eighteen decade of the past century have been actually positive until the present time. But our concern still remains awake,in spite of the apparent diminishing in the severity of wind and ice influence on the network. Between 1970 and 2010 the evolution of the main indicators of OEL events (failures), especially on conductors and poles, influenced by ice and wind, was monitored. The annual evolution of these indicators, obviously shows that the desertions for conductors coherent with those of poles have the main cause the surpassing of design conditions taken in Romanian prescription The main categories of causes of incidents produced by wind and ice on OHEL are presented in Fig.1.The designed loads cannot be increased upon those economically, such solution leading to non-economically OEL On the other side, the majority of the OEL in operation cannot be easily upgraded,if necessary.This fact justifies the strategy adopted for their design,based on IEC, against the unpleasant effects of icing and wind in the NPS (National Power System)

## 2. DESIGN LOADS

To prevent incidents and diminish the unpleasant effect of the meteorological and climate factors on the NPS components,was acted by meteo-zoning of the country’s territory,choosing more elaborate values for wind velocity and ice thickness, adopting modern methods of OEL structural elements design, as well as the methods of operational activity, had to be improved. This is possible by applying special methods of warning about the ice deposits,using solutions to prevent ice formation and improved methods of ice removal,especially by electrical methods.The initial values of the **basic** parameters for the OEL design, the so-called”computation loads”, namely the wind velocity **v,** ice thick-ness **b**(the circular frost crown-of layer)**,**and its specific weight **g,** and air temperature fluctuation **Δθ** are presented in table 1[1].(*medium temp.at heigh upon 1000m)

**INITIAL VALUES FOR v, b, and g**

**Table 1**

| **METEO ZONE** | **WIND ”v” VELOCITY m/s** | **WIND ”v” VELOCITY m/s WITH ICE** | **WITE FROST THIKNESS ”b” mm** | **SPECIFIC WEIGHT “g” kg/dm$^3$** | **AIR TEMPERATURE FLUCTUATION $^0$C** | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | max. | min. | med. | ice |
| Is | 30 | 15 | 17 | 0,5 | + 40 | - 30 | + 15 | - 5 |
| I | 25 | 15 | 17 | 0,5 | + 40 | - 30 | + 15 | - 5 |
| II | 25 | 10 | 13 | 0,5 | + 40 | - 30 | + 15 (± 10)* | - 5 |

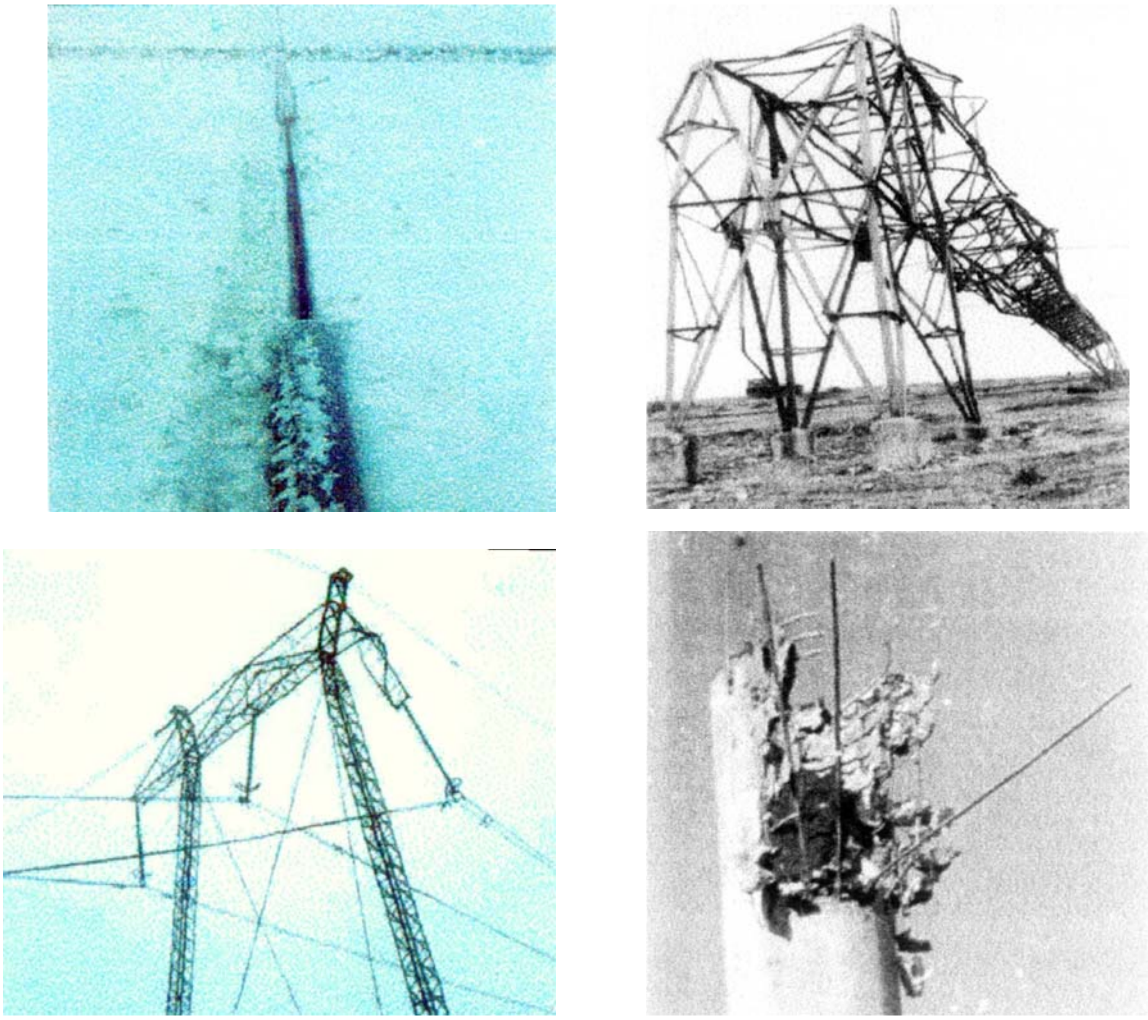


***Fig.1 - Main kind of  failures***

These values have been selected as to be similar to those from the former Soviet Union regulations in the field,having 3 meteo-zones: I, II and III.They have an evolution in time like.is presented in Fig.2,without significant results in the amelioration of lines behaviour indicators .From this cause,an other principle was adopted.Based on the results of INMH, that have analyzed the data from about 150 meteo stations,uniformly distributed over the country's territory in more than These values have been selected as to be similar to those from the former Soviet Union regulations in the field,having 3 meteo-zones: I, II and III.They have an evolution in time like.is presented in Fig.2,without significant results in the amelioration of lines behaviour indicators .From this cause,an other principle was adopted.Based on the results of INMH, that have analyzed the data 35 years, the initial zoning has been finally modified and improved(see fig 3-RPS configuration).

The recorded data, with a normal distribution for **v** and **b,** allow to determine the average dispersion and the values, corresponding to an repetition frequency to1:5;1:10;1:15 and 1:20 years. With the average and dispersion values for different appearance frequency were established the **v** and **b** for OEL designing corresponding to an appearance probability once in 10 years for 110 kV including, and once in 15 years for OEL above 110 kV. Like for wind velocity, for ice thickness greater values are present outside Carpathian chain and on this reason, Romanian territory has been divided only in two meteorological zones, identical for both factors(fig.3). The actual values for **v ,b,** and their combination are presented in tab.2.(*More values upon operating experience and for old lines repair or upgrading).

**ACTUAL VALUES FOR v, b, and g***

**Table 2**

| **METEO ZONE** | $v_{m/s}$ | $v + ice_{m/s}$ | $b_{mm}$ | $g_{kg/dm^3}$ |
|---|---|---|---|---|
| I > 110 kV | 36 | 22 | 24 | 0,75 |
| II > 110 kV | 32 | 19 | 20 | 0,75 |
| I ≤ 110 kV | 33 | 19 | 22 | 0,75 |
| II ≤ 110 kV | 26 | 14 | 16 | 0,75 |

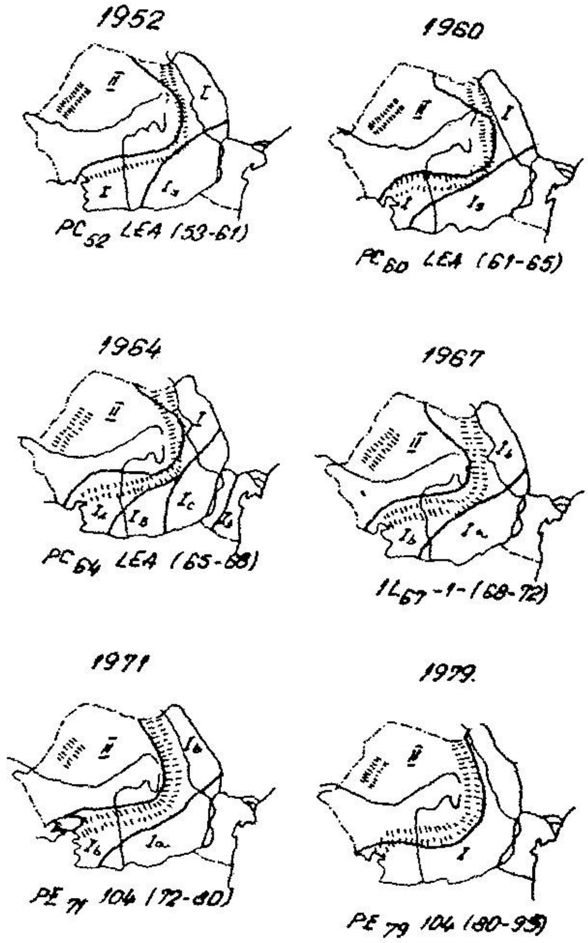



**Fig.2.The evolution of meteorological zoning of country territory**

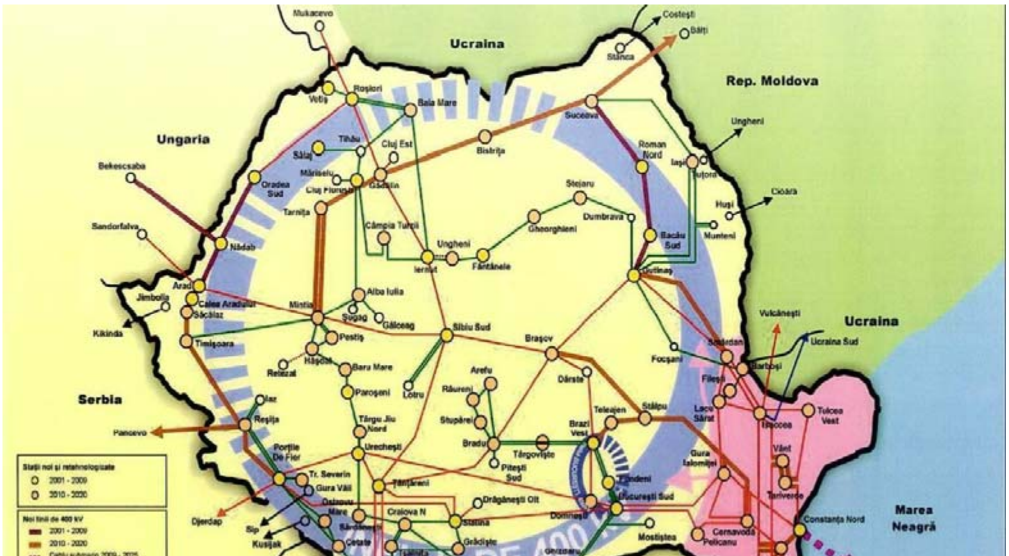



**Fig.3. The configuuration of the Romanian Power System 110-400 kV**

The present meteo zones of Romanian territory are shown in Fig.4

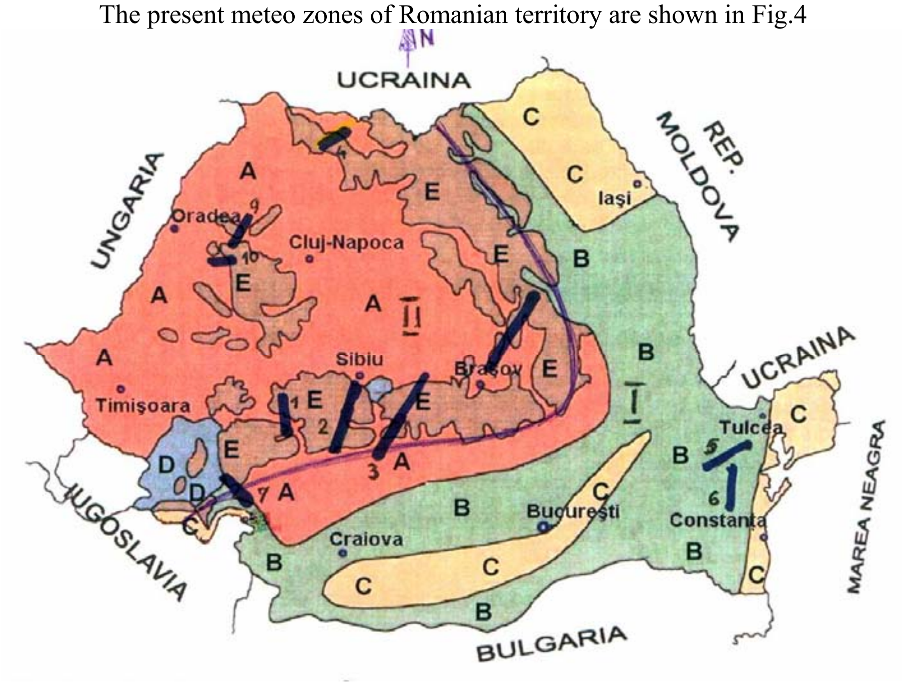



**Fig.4.The main meteorological zones of Romanian territory**
1.Paroseni-Barbatesti.2.Sibiu-Slatina.3 Arefu-Slatina,4Baia-Cavnic.5,6-OEL Tulcea.
7.Orsova-Moldova N.8 Brasov-Gutinas.9,10 OEL-Oradea.

The recent meteorological zones I and II are present inner and outer Carpathian chain.Tne lines which are shown by the numbers 1 to 10 are those who present the most known ice deposits in the winter seasons. They are supervised by different warning systems..The letters E represent mountain zones upon 1000 m.altitude,where the design conditions may be upgradet,upon operational experience in Romanian territory.

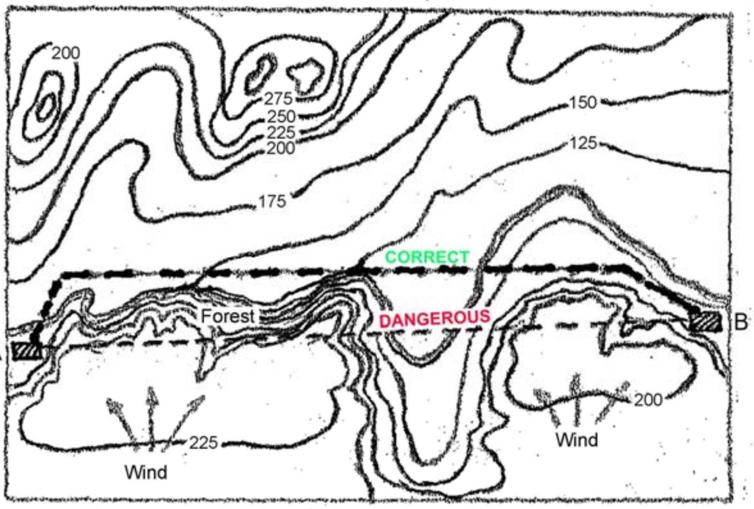
## 3. ICE DEPOSIT PREVENTION

In the phase of line design,is possible to choose lines path in manner to avoiding great deposits on lines conductors.In operational stage,in the line may be the conductor preheat,to mentain his temperature over 2..3 ◦C.The Romanian design specialists who have a great mondial experience ,have used in their work the informations obtained from the local Meteo-systems,from Aeronautical services and from operational experience.The lines of interconnexion with Europeean PS are designed in conformity with IEC-60826,updated.They are designed and supervised the construction of important lines in all continents :Salta-Atacama-Chili,Borneo-Sawarak-South Asia,Emirates eo.who present a great operational reability,confirmed by many years of operation. experience.

### 3.1 Optimal line path

The designers have many possibility to choose the optimal line path by administrative and local constraints.If they have the possibility to choose the line path,is necessary to respect the following important principles,based upon our old experience:
- avoiding the empty hills,perpendicular on dominant wind direction,
- modifiyng a few line path to protect it of the danger due to meteo factors.
- to consolidate only one part of the line to protect the entire conexion between lines end,if the two mentionjed principles are not possible to applied.

In the following pictures,5,6 and 7 are shown those mentioned principles.Upon Romanian opinion,operational experience and the cooperation between the designers and the specialists from Meteorological and Aeronautical Organisations are essential in the phase of lines path settlement.




**Fig, 5. Example for the possibility to avoid the empty hills with strength winds**

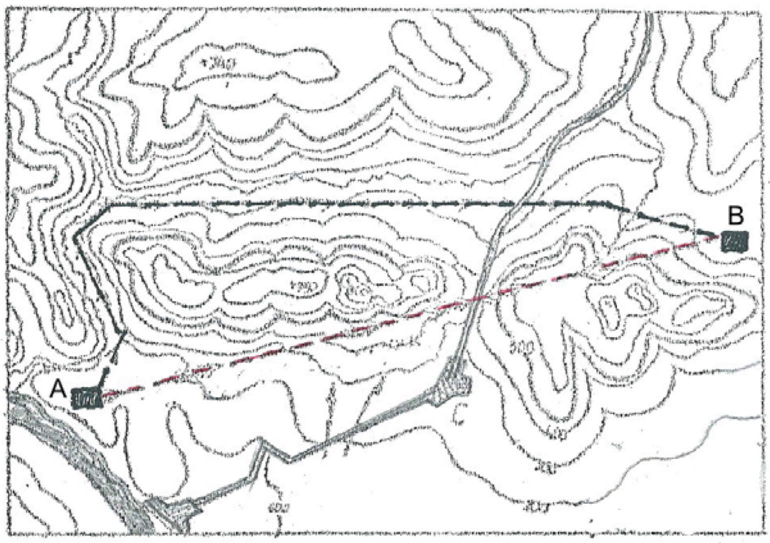



**Fig.6. Avoiding the dangerous zone**

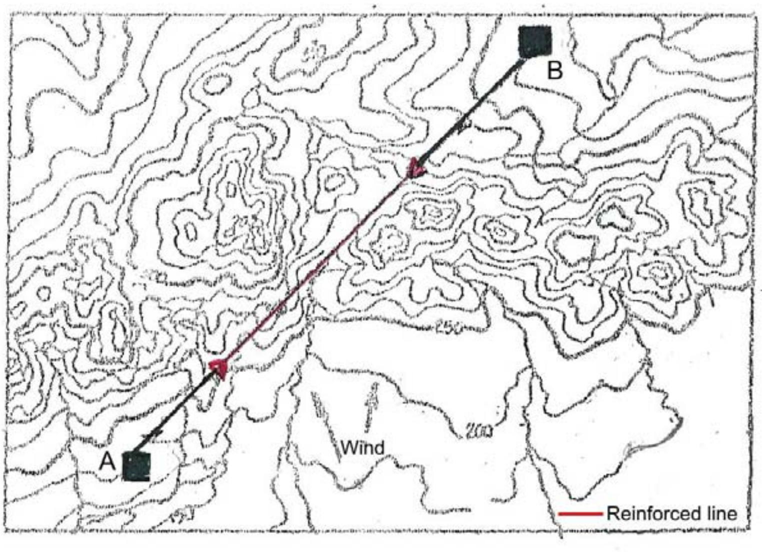



**Fig. 7. Reinforcement of a zone of the line**

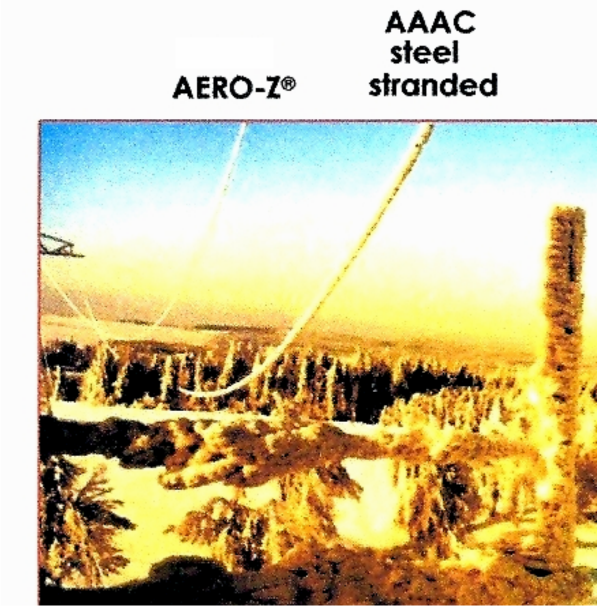



**Fig.8. Ice deposits on Aero-Z and AAC conductors**

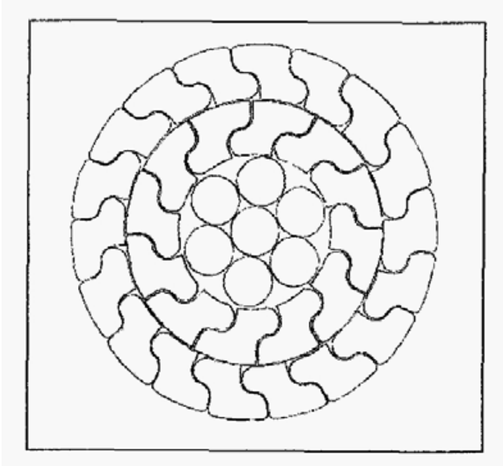


**Fig.9.Conductor special design(Aero-z)**

### **3.2.News kind of conductors.(**fig.8 and 9)

Instead of sistematically considering the construction of new lines,increasing the transit ampacity of existing lines proved to be a particularly interesting possibility,from both the technical and economic perspectives.To achieve this, a new type of compact conductor-called AERO-Z®-was developed. While it still uses,for the outer layer(s), Z-shaped profiled wires instead of conventional round wires, the last layer, virtually smooth, has small helical grooves created between the upper edges of the “Z” wires with carefully chosen lay,depth and width.The large surface of contact between the profiles also gives the AERO-Z® better damping.Several conventional conductors and AERO-Z were subjected to oscillations caused by releasing a weight (25, 50 or 75 kg) suspended in the middle of the span.
The recordings of the stresses at the anchorings of the tower and of the amplitude of the oscillations made it possible to compare the self-damping coefficients of these conductors.Thus, a conductor constituted of 2 layers of Z-wires dampens itself 2 to 3 times faster than a conventional conductor in both bending and twisting oscillations. Moreover, the better damping of the AERO-Z conductor in vertical and twisting self-damping significantly reduces complex galloping problems. Galloping is NOT a forced oscillation, it is a self-excited phenomenon.
The probability of galloping is thus much lower, and if it does occur, its amplitude is substantially smaller.
On-site experiments demonstrated that the AERO-Z conductor also behaves better vis-à-vis snow and frost accretion. The formation of sleeves is rendered more difficult, even impossible. On average, the weight of the sleeve is one-half for the extreme conditions. Furthermore, one should note that sleeves which do form detach more rapidly.Due to the increased rotational stiffness, Aero-Z unload faster than conventional conductors (snow accretion breaks due to its own weight).

### **4.Conclusions..**

"The Romanian experience in the field of designing electric lines is pretty well known worldwide. It is based on the long-time expertise , on monitoring the operational behaviour of OHL’s structural elemens, on the steady improvement of project data basis, as well as on the adequate implementation of CEI 60826. The main concern of the specialists in electric networks is focussed on the improvement of behavior indices, by application of several advanced operation methods meant to mitigate wind and frost influence upon OHLs’

**Literature.**

**1.Farzaneh,M.a.o.Ice deposits on OEL structures.Springer,Canada .2007.**
**2.Goia,L.a.o.Deicing of OEL.Principles,methods,equipments.ICEMENERG.Buc.2001**