SC C2 2018 PARIS SESSION

MONITORING SYSTEM OF ICING INTENSITY ON POWER LINES

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Problem posing

Transmission and distribution grids of Russia experienced cases of severe atmospheric icing in winter causing the collapse of transmission towers and the failure of other components.

According to data related to Russia mechanical damage failures of high-voltage overhead lines (OHL) in more than 40 grids over the last 30 years have caused substantial economic losses. Ice accretion was the reason for:

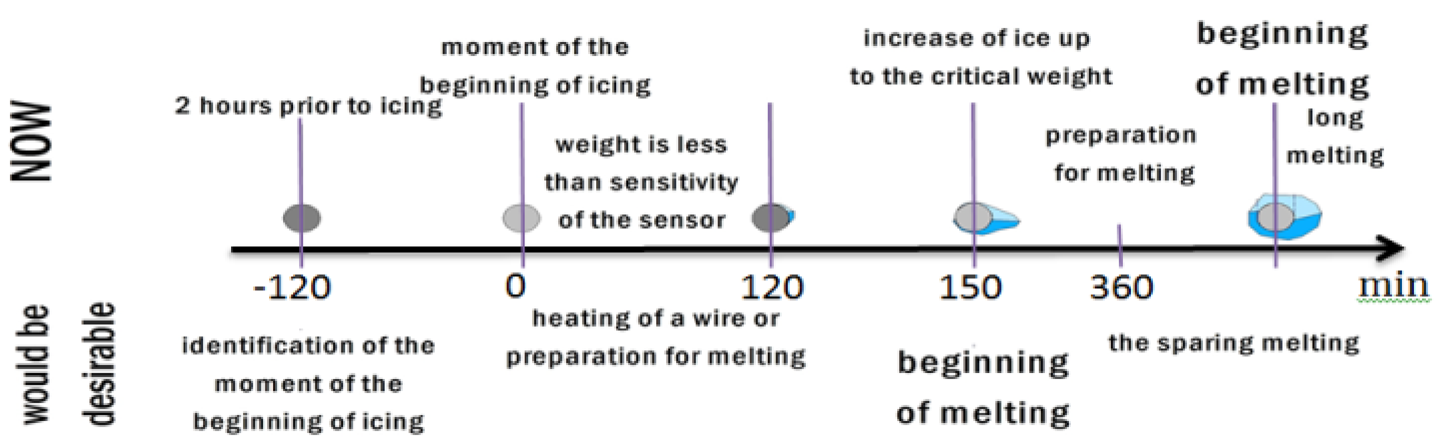
- up to 37% of the total number of failures of ferro-concrete towers for 35 – 110 kV lines,
- up to 12% of the total number of wires breakages on 330 – 750 kV lines,
- up to 42% of breaks of lightning ropes, and up to 8% of breaks and destruction of insulators.

(according to data from ORGRÉS, Russia, Satsuk E.I., 2011).

Benefits of usage the monitoring systems

Data for 100 km of a 110 kV overhead lines in the areas of Russia that are exposed to icing	Traditional monitoring with the staff of service lines assistance; Usage of the ice melting equipment with direct current	Implementation of the monitoring system (CAT, etc.); Usage of the ice melting equipment with direct current
Number of accidents due to ice accretion per one year	≈70 % of the total number (0.0223 per year)	**3.6 times less** (0.0062 in year)
Expenses caused by lines inspection activities	≈2.36 thousand $ in year	**18 times less** (≈125 $ in year)
Electricity consumption due to melting	≈11.8 MWt·hour/year	**2.9 times more** (33.8 MWt·hour/year)
Undersupply of power during melting	≈1.1 MWt·hour/year	**2.9 times more** (3.2 MWt·hour/year)

Key factor - the SPEED of RESPONSE TO ICE INFLUENCE!



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The proposed solution

dispatcher's computer

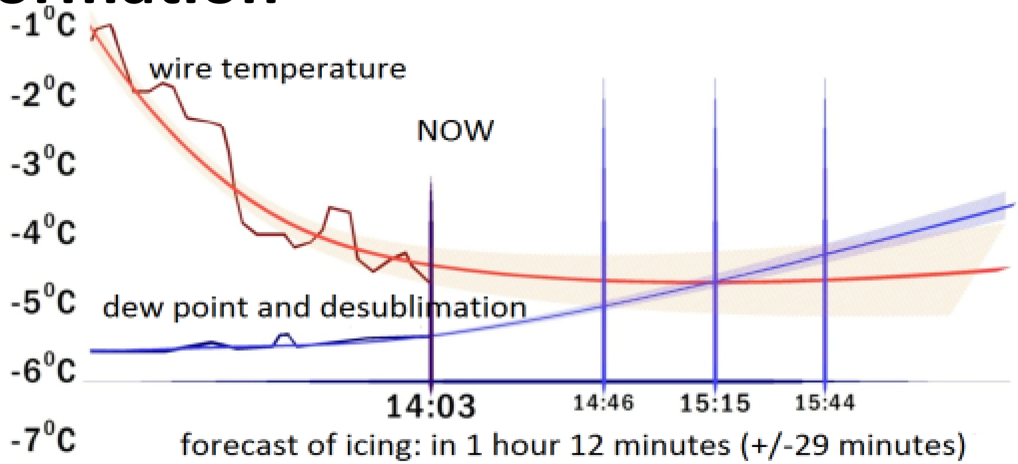
Current system capabilities:

1. Temperature measurement of phase wires and a ground wire;
2. Tension measurement of phase wires and a ground wire;
3. Measurement of air temperature and humidity, wind direction and speed, atmospheric pressure;
4. Detection of the ice formation beginning (the function is implemented in the software as a mode of statistics accumulation (not visualized);
5. Forecasting, saving, visualizing and reporting data.

New solution approach short-term forecasting of ice formation

International Organization for Standardization (ISO) standard for icing of structures:

$$\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 \cdot u_i \cdot lwc \cdot A,$$



where *dM* — accumulated mass per unit length during the time step *dt*, $u_i = \sqrt{u^2 + u_p^2}$— impact speed, u— wind speed, u_p — particles speed, lwc — mass concentration of water in the air, *A* — cross-sectional area of the cylinder perpendicular to the impact speed, α_1— collision efficiency, α_2— sticking efficiency, α_3— accretion efficiency.

Analytical icing models

(based on empirical equations)

- Ackley model
- Lozowski model
- Makkonen model
- Goodwin model
- Jones model etc.

Numerical icing models

(based on finite element analysis)

- Comsol Multiphysics
- Ansys FENSAP-ICE etc.

Project background

1. The practical tests of the sensors that supervise 8 overhead transmission lines in the grid company of the South has been successfully carried out

2. A complete package of intellectual property (operation principles and all non-trivial design solutions) has been received

3. 21 sensors have been installed in the South of Russia so far. It is planning to install 44 more sensors in 2018

4. A cooperation agreement has been adopted/concluded with the Weather forecasting company to develop the lines monitoring system

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Thank you
for your attention!

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