Operational Experience with Automated Icing Monitoring System

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***Abstract*—With respect to the development and wide application of dispatching systems demand for building automated icing monitoring system and its implementation into dispatching system was raised. In this paper 6-year operational experience with automated icing monitoring and warning system is described. New version of device „Meteo" is also be described. This new type (called „PMS") can be supplemented with some extra sensors, such as pyranometer etc. PMSs' are being put into operation on transmission voltage lines on the territory of the Czech Republic at present. A few examples of placement on those lines will be shown.**

I. Nomenclature

Icing, Overhead lines, Automated icing monitoring system.

II. Introduction

Icing as a natural phenomenon influences the operational reliability of overhead lines significantly. Its monitoring usually requires the presence of attending personnel or building up ice-measuring stands. Our contribution demonstrates a way of observing and measuring the icing which is based on a continuous measurement performed by the network of automated monitoring equipments. This enables to obtain both current data and the whole sets of data for a subsequent analysis, prediction and statistical evaluation of the impacts of icing and wind on overhead lines.

III. Concept of automated monitoring system

EGÚ Brno in cooperation with distribution companies has been involved in solving the problems of icing of overhead lines since its establishment. The experience obtained during the years of icing measurement and monitoring has been exploited for designing a measuring device which, in connection with communication means, enables to build up an automated system for a continuous measurement of ice mass, wind velocity and direction and temperature without the requirement for the presence of personnel.

The automated icing monitoring system must provide the necessary real time data on the meteorological situation for a long term period, but especially in winter periods.

The concept assumes to build up a network of monitoring equipments by which the measurement will be performed and the data on air temperature, ice mass and wind velocity and direction processed.

Any means such as radio networks, GPRS, optoelectronic cables etc. may be used for data transmission and for communication between the centre and individual monitoring equipments.

The operation itself of the automated icing monitoring system is realized in two regimes:

A. Standard regime

The monitoring equipment measures the current quantities, processes the measured values and downloads them into the local database. By the command of the server from the centre or on demand of the dispatcher the newly measured data are transmitted and downloaded into the central database.

B. Warning regime

Each monitoring equipment may send a warning message into the centre when the set up values have been exceeded or when another abnormal event arised.

The warning messages may indicate:

- exceeding the set up ice mass,
- exceeding the set up steepness of ice growing,
- exceeding the value of wind velocity,
- outage of supply and its restoration,
- foreign intervention into the monitoring equipment.

IV. Project "meteo"

EGÚ Brno started this project in 1999 when the first prototype was tested on the territory of distribution company VCE. One year later a project of building up automated icing monitoring network on the territory of distribution company JME was approved. In the initial stage location in the given area was prepared with regard to set up criteria (size of ice deposits according to icing mesoareas, appropriateness of the ambient relief, accessibility, costs etc.).

In autumn 2001 12 Meteo devices was installed in the region supplied by JME. The radio data network has been chosen for transmitting the data from individual monitoring equipments. The data asked for by the central dispatch office and alarms sent by monitoring equipments are transmitted by the radio network via retransmission points into the data concentrator of individual areas.

In February 2003 another Meteo device was installed on the territory of distribution company VCE (location Novy Hradek). Data from both devices are sent to central dispatch office via radio network.

Fig. 1. Monitoring equipment installed on the building of substation Novy Hradek

The equipment consists of three parts:

- measuring device METEO with vertical measuring rod
- radiostation with antenna and back-up supply
- constructional part (the poles of already built-up lines may also be used).

The measuring device METEO is made of stainless steel and it has no moving parts requiring frequent maintenance. It consists of a body with sensors for the measurement of temperature, ice mass and the velocity and direction of wind, and of a measuring rod fixed vertically downwards.

The body of the measuring device also includes the electronic part for processing the measured data and for communicating with superior SW or with the system.

The disposition of the automated monitoring equipment on a separate pole can be seen in Fig. 1.

The automated monitoring equipments have been mostly installed on the overhead mv and lv lines.

V. PROJECT "PMS"

The project to improve Meteo device itself and also extent its use was started at the beginning 2006. The meteorological monitoring station (PMS) is based on the concept of Meteo device, new features have been supplemented.

A. Description

PMS is a compact equipment for monitoring and processing meteorological data, with the main object of monitoring the main climatic quantities affecting the reliability of operation of overhead electric networks.

The following quantities are monitored by the PMS station:

- temperature
- ice mass
- wind speed and direction (on the measuring rod or by the external ultrasonic anemometer)
- relative humidity
- irradiance (option).

The measured data are evaluated, archived and supplied to a superior system. The PMS station is able to send warning messages when the set parameters of quantities being monitored have been exceeded.

The PMS station consists of three basic parts:

- Box of the central unit and of the source part including the accumulator
- Support arm with sensors of climatic quantities
- Solar panels for supplying the station (option).

Fig. 2. Communication box for PMS

It is possible to communicate with the PMS either remotely

via GPRS or by means of Ethernet using the PC connected at the place of installation.

The constructional parts are made either of stainless steel or of steel protected against corrosion by zinc coating.

The PMS station is equipped with a control system protecting against unauthorized getting into the box of the control unit.

The PMS may be supplied in three ways:

- from LV network
- from MV network across a voltage transformer
- from solar panels.

B. PMS installation on transmission lines

Last year a project of installing PMS on transmission lines was initiated. Transmission lines are operated by CEPS, which is operator of Czech national grid. In autumn 2006 3 PMS were installed in the region of north Moravia on transmission lines 400 kV and 220 kV. Another two PMS were put in operation in spring 2007 in the region of north and west Bohemia.

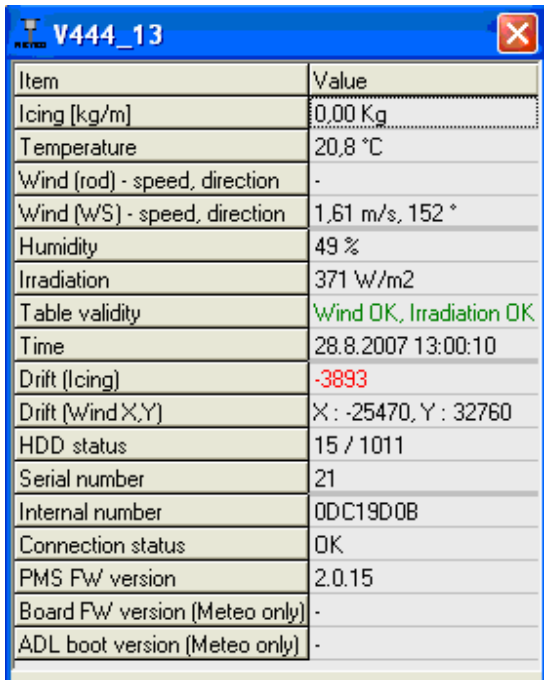
To power each PMS solution with solar panels was chosen. Solars panels were situated at the top of each tower.

Examples of installation can be seen on pictures 3 and 4. On picture 3 support arm with sensors is shown, on picture 4 set of three solar panels to power the PMS can be ssen.

Fig. 3. PMS at line 400 kV (location Nosovice)

Fig. 4. Solar panels at the top of the tower on line 400 kV (location Nosovice)

On figure 5 a window with actual data is shown. On this form measured quantities (icing, temperature etc.) and also other information are displayed.



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Item	Value
Icing [kg/m]	0,00 Kg
Temperature	20,8 °C
Wind (rod) - speed, direction	-
Wind (WS) - speed, direction	1,61 m/s, 152 °
Humidity	49 %
Irradiation	371 W/m2
Table validity	Wind OK, Irradiation OK
Time	28.8.2007 13:00:10
Drift (Icing)	-3893
Drift (Wind X,Y)	X : -25470, Y : 32760
HDD status	15 / 1011
Serial number	21
Internal number	0DC19D0B
Connection status	OK
PMS FW version	2.0.15
Board FW version (Meteo only)	-
ADL boot version (Meteo only)	-

Fig. 5. Window with actual data from PMS

C. Determination of transmission lines capacity

Besides monitoring and processing meteorological data PMS are about to be implemented into a system which will be used for calculation of transmission capacity of some transmission lines. PMS are used as a source of actual meteorological data. The first phase of the whole system (transmission data from different system and collecting in the centre) is being tested at present.

D. Installation of PMS in Slovenia

Another project of installation PMS was started this year. PMS will be placed on the line 400 kV in Slovenia. Equipment will be connected to the Ethernet network, communication with centre will be via optic cable. PMS will be powered from solar panels.

VI. CONCLUSION

We assume that cooperation with distribution companies will enable us to expand the utilization of the automated equipments for icing monitoring onto the territory of the Czech Republic which can be affected by icing.

Main use of PMS is in the following spheres:

- Information for making operative decisions
- Obtaining data for statistical evaluation
- Verification of ice prediction.

We see subsequent importance of measured data and their statistical evaluation at:

- Determination of loading conditions on overhead lines (not only)
- Dimensioning of towers and overhead lines
- Possible saving of investment costs.

By dislocating PMS in areas which are important from the point of view of icing we can obtain sufficient information both for the operative control of distribution networks and for a subsequent statistical evaluation of icing when designing overhead lines.

VII. REFERENCES

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