Studnice Test Station (EGÚ Brno)

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***Abstract*— EGÚ Brno has been involved in solving the problems of icing on overhead lines since its establishment. It carries out observation and measuring of icing at test site Studnice. The test site was built at late 70th and is located about 60 km northwest from Brno at 800 m above see level in the Czech-Moravian Highland.**

The data on modelling and icemeter validation from the site is described in another paper for this workshop.

I. Nomenclature

Ice measurement, Overhead lines.

II. Introduction

There are 2 spans (cca 250 m each). The middle tower with measuring platforms (at 10, 20, 30, 40 and 50 m above ground) is used for measuring of icing and monitoring icing conditions.

Studnice test station is one of six test stations through Europe which has been used to test ice sensors and validate icing models under the COST727 programme.

III. Site

Name:	Studnice
Owner/operator	EGÚ Brno, a.s.
Country	Czech Republic
Geographical coordinates (°N, °E):	49° 36' 32" N, 16° 05’ 02” E
Height (m a.s.l.):	800
Weather station numbers LPNN/WMO:	N/A
Distance from nearest airport (or weather station with cloud base measurements)	14 km
Primary interest for test site	Power line icing

A. Orography

The test site was build on the flat ridge of Czech-Moravian Highland with open terrain from east, south and west. Absolute majority of icing events that occur here comes from south-east direction.

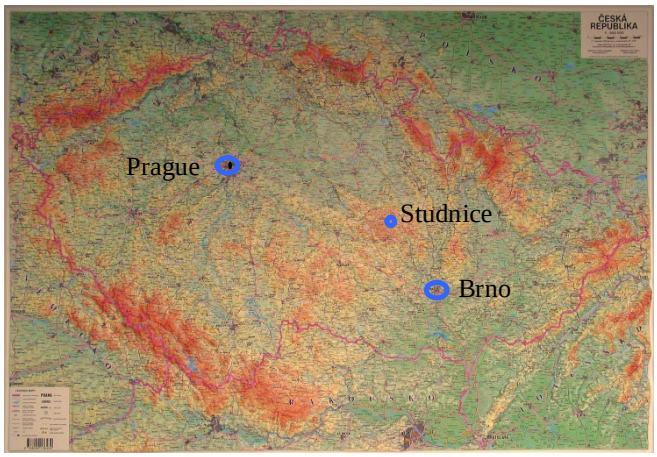


Fig. 1. Map of the Czech Republic

Fig. 2 Map of the site

B. General and specific climatology over the measurement period

Climatological monthly averages (e.g. 10 years averages) and monthly averages experienced during the test are shown in the next table. T is air temperature, RH is relative humidity, V is wind speed, GR is global radiation and N is the number of icing days.

TABLE I
CLIMATOLOGICAL MONTHLY AVERAGES

VALUE	Oct	Nov	Dec	Jan	Feb	March	April
Clim T (°C)							
Test 1 T (°C)	5,2	-1,3	-2,0	-0,1	1,1	0,9	5,7
Test 2 T (°C)	7,2	3,0	-0.8	-4,8	-3,1	1,0	11,5
Clim Tmin (°C)							
Test 1 Tmin (°C)	-2,8	-7,6	-9,3	-8,5	-12,7	-7,1	-3,5
Test 2 Tmin (°C)	0,3	-7,5	-9,4	-12,8	-10,4	-8,0	2,8
Clim Tmax (°C)							
Test 1 Tmax (°C)	15,6	8,1	9,4	7,2	12,5	11,1	16,1
Test 2 Tmax (°C)	17,9	14,5	6,5	2,1	6,3	12,2	19,0
Clim RH (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Test 1 RH (%)	N/A	89,6	88,5	91,3	85,1	84,9	N/A
Test 2 RH (%)	79,1	92,6	94,9	93,5	95,0	92,3	60,2
Clim V (m/s)							
Test 1 V (m/s)	N/A	N/A	3,7	7,2	5,8	6,6	5,4
Test 2 V (m/s)							
Clim GR (W/m^2)							
Test 1 GR (W/m^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Test 2 GR (W/m^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Test 1 N	0	6	11	17	3	0	0
Test 2 N	0	3	9	23	6	0	0

Clim: average for last winter seasons (2000 – 2009)
Test period 1: average at winter season 1.10.2007-30.4.2008
Test period 2: average at winter season 1.10.2008-30.4.2009

C. Available local infrastructure

The middle tower has 5 measuring platforms at 10, 20, 30, 40 and 50 m above ground.

Next to the tower there is another platform with some sensors at the height 5 m above ground.

Fig. 3 Middle tower at the test site Studnice with platforms

IV. SENSORS AND INSTRUMENTS

In next table the manufacture and country, type, some characteristics and maximum heating power (MHP) of sensors operated at test site Studnice are listed.

TABLE II
LIST OF SENSORS AT STUDNICE

Manufacture Country	Type	Principle of operation, Additional information	Picture
EGU Brno, Czech Republic	PMS	• Measuring rod, length 0,5 m, diameter 30 mm, unrotated • The bottom is heated, the body and rod is unheated • Ice load: Measuring range 0…40 (100) kg/m • Also provides air temperature, humidity, wind speed and direction • Wind speed: Measuring range 0…40 m/s • Weight 12 kg	

		• Operating temperature: -30…+70 °C • MHP: 100 W	
EGU Brno, Czech Republic	Meteo	• Measuring rod, length 0,5 m, diameter 30 mm, unrotated • The bottom is heated, the body and rod is unheated • Ice load: Measuring range 0…40 kg/m • Also provides air temperature, wind speed and direction • Wind speed: Measuring range 0…40 m/s • Weight 12 kg • Operating temperature: -30…+70 °C • MHP: 70 W	
EGU Brno, Czech Republic	Vertical rod	• Measuring vertical rod, length 0,5 m, diameter 30 mm, freely rotated • Ice load. Measuring range 0…100 kg/m • The part between body and rod is heated	
EGU Brno, Czech Republic	Horizontal rod	• Measuring horizontal rod, length 1 m, diameter 30 mm, freely rotated • Measuring range 0…40 kg/m • The part between body and rod is heated	

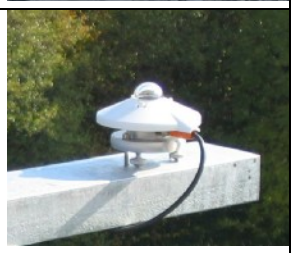
Thies A., Germany	4.3810.	• 2 D Ultrasonic, time of flight • Each arm 15-17 W • Measuring range 0…65m/s • Weight 2.5 kg • Operating temperature: -40…+70 °C • MHP: 70 W	
Pyranometer Kipp & Zonen Netherlands	CMP3	• Range of measurement: 0 to 1400 W/m^2 • Resolution: 1 W/m^2 • Error of the basic state: <1% per year • Accuracy of measurement in the interval (0 – 1000) W/m2: ±2.5% • Temperature drift: in the interval of -10 to +40°C ±5% • Viewing angle: 180°	
Combi-Tech IceMonitor Sweden		• Measuring vertical rod, length 0,5 m, diameter 30 mm, freely rotated • Ice load: Measuring range 0…100 kg/m • The bearing of the rod is heated • Operating temperature: -40…+50 °C	
Goodrich Corporation USA	Model 0871LH1	• Ice detection • Ice state: 0 = No ice 1 = Ice • Power consumption: de-icing 50 W • Operating temperature: -55…+71 °C	

TABLE III
LOCATION OF MEASUREMENT DEVICES AT STUDNICE

Measuring device	**Measurement height (m)**	**Output**	**Since**
Ice load – vertical rods (length of 0.5 m)	5, 10, 20, 30, 40, 50	Analog	1997
Ice load – horizontal rods (length of 1 m)	10, 30	Analog	1997
Temperature	5, 10*, 20, 30, 40, 50	Digital	1997
Meteo	10	Digital	2002
PMS**	10	Digital	2005
Temperature and Humidity	10	Analog	2006
Pyranometer	50	Analog	2007
Ultrasonic anemometer	50	Digital	2007
Combi-Tech IceMonitor	10	Analog	2007-2009
Goodrich Ice detector	10	Analog	2008-2009

)* untill 2006
** only for testing purposes

V. DATA ACQUISITION SYSTEM

Instruments are connected to RS485 line. Instruments are monitored via special software KOS which collects the data from sensors, visualises actual values on screen of the server and store the data into local database (integration time is one minute) on the server. Server can be remotely operated via Internet.

System also includes one camera with extra internal heating and infra red. Picture of some sensors at 10 m platform is taken every 10 minutes (the interval can be set up). The camera is connected to PC Server and pictures are in jpg format downloaded to the server.

In the event of a power failure the test site is equipped with battery back-up system. This allows the system to keep working for up to 12 hours.

VI. MEASUREMENT DATA

Data are stored in binary daily files. Values are recorded every minute, associated with a date and time stamp.

TABLE IV
PARAMETERS

	Unit	*Resolution*	*Recorded*
Ice load	Kg	0.01 kg	1’ average
Temperature	°C	0.1 °C	1’ average
Humidity	%	1 %	1’ average
Wind speed	m/s	0.01 m/s	1’ average
			1’maximum
Wind direction	°	1°	1’ average
			Direction when maximum occurs
Humidity	%	1 %	1’ average
Solar irradiance	W/m^2	1	1’ average

VII. PICTURES OF THE SITE

Fig. 4 View from middle tower towards East

Fig. 5 View from middle tower towards South

Fig. 6 View from middle tower towards West

Fig. 7 View from middle tower towards North

Fig. 8 Video coverage of IceMonitor, Goodrich, PMS and vertical rod

VIII. CONCLUSION

The test site Studnice has been widely used for icing measurements for many decades.

Studnice plays a key role in our research of icing and icing measurements. Various measurements and testing of new sensors and technologies have been carried out there. Results from measurements are applied in power line design and standards for their design [3][4].

IX. REFERENCES

Papers Presented at Conferences (Unpublished):

[1] J. Šabata and L. Zeman, "Icemeter tests at Studnice Station," presented at the 9th IWAIS, Andermatt, Switzerland, 2009. Poster PO. 080

[2] J. B. Wareing and J Sabata, "Testing of the PMS icemeter at Deadwater Fell Test Site" presented at the 9th IWAIS, Andermatt, Switzerland, 2009. Poster PO. 069

Standards:

[3] *ČSN EN 50 423 –19 – 3, Design of overhead lines 1 - 45 kV*

[4] *ČSN EN 50 341 – 19-–3, Design of overhead lines above 45 kV*