Testing the PMS Icemeter at Deadwater Fell

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Abstract— **EA Technology has a severe weather test site at Deadwater Fell on the Scotland/England border in the UK. This site is described in another paper at this workshop. During the 2007/08 winter the PMS Icemeter from the Czech Republic was tested in relation to its ability to monitor meteorological conditions and ice loads on the conductors at the site. The Icemeter picked up all the rime ice loads during the winter and successfully indicated the ice load level. The amount of wet snow during the winter was unfortunately too low to indicate whether the icemeter would pick this up as well.**

The Icemeter provides meteorological data (wind speed, gusts, wind direction, temperature and relative humidity) and the accuracy of this data was consistent with EA Technology instrument recorded data at the site. In operation, data was sent by mobile phone from the UK site to EGU head office in Brno. The current instrument is mains powered but solar/battery powered instruments are in use in the Czech Republic.

As an instrument to provide local weather conditions and ice loads at remote locations, the Icemeter appeared to be reliable and consistent and worth considering for UK network security.

I. Background

The Czech Republic has set up a network of 19 Icemeters to give an early warning of the presence and severity of ice loads on susceptible wood pole and transmission lines. Several units are also installed in Slovenia, Slovakia and Germany. They are manufactured by EGU at Brno, Czech Republic. The Icemeter records the presence and severity of ice as well as basic meteorological parameters. The information is sent automatically by radio link or GSM to the utilities' centre. An Icemeter was installed at the Deadwater Fell Severe Weather test Site in the UK and the output compared with the site meteorological data and monitored ice loads on the conductors at the site for the winter of 2007/8 [1]. The site is described fully in Poster PO.067 [2].

II. The PMS Icemeter – the Instrument

The Icemeter was installed at Deadwater Fell in late November, 2007 (Figure 2.1). The load monitoring device and software are contained in the cylindrical tube with the vertical monitoring rod below. The data is fed into a communications box (Figure 2.2). However, there were communication problems and a new electronic component was sent over to the UK by EGU and installed in December. Since that time the unit has collected and sent data without any problems. The unit was developed from many years of experience of ice monitoring at the Czech test station at Studnice (Figure 2.3). This site has been in operation for around 70 years (since 1980 with 3 towers) and uses both manual and automatic ice monitoring equipment. It also has a tower line section for conductor testing.

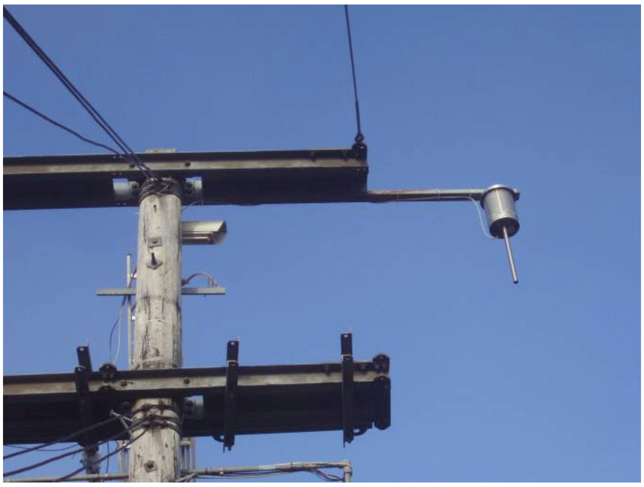

Fig. 2.1. The PMS icemeter installed at the upper crossarm of the southern H-pole on the Deadwater Fell test line.

The unit at Deadwater Fell is powered from a mains supply and this system is used in the Czech Republic when the unit is installed on low voltage lines. On medium voltage lines a small transformer is used. However, on transmission lines the unit is powered by a solar panel as shown in Figure 2.2. The rod on the icemeter is vertical so that it can collect ice accretion from all directions. The vertical weight gives the ice load. Side pressure on the rod is used to monitor wind speed and direction. In all, the unit measures:

1. Ice load in kg/m;
2. Wind speed average;
3. Wind speed maximum;
4. Temperature;
5. Relative Humidity;
6. Wind direction;
7. Solar irradiance (external sensor).

The unit is normally set to monitor every minute but for EA Technology purposes this was reduced to ten minute readings. The standard wind speed data output is a 10 minute average and this was used here although the unit also provides an instantaneous spot wind speed reading at the recording times. The solar irradiance facility was not used.

Fig. 2.2. The solar powered PMS icemeter (Courtesy EGU)

III. Communication

The current system at Deadwater Fell communicates by GPRS link to EGU, Brno in the Czech Republic but the current versions have integrated the PMS into the SCADA system (communication via Protocol IEC 101/104) and all versions now have this implemented. The current system as employed on 400kV networks in the Czech Republic is shown schematically in Figure 3.1.

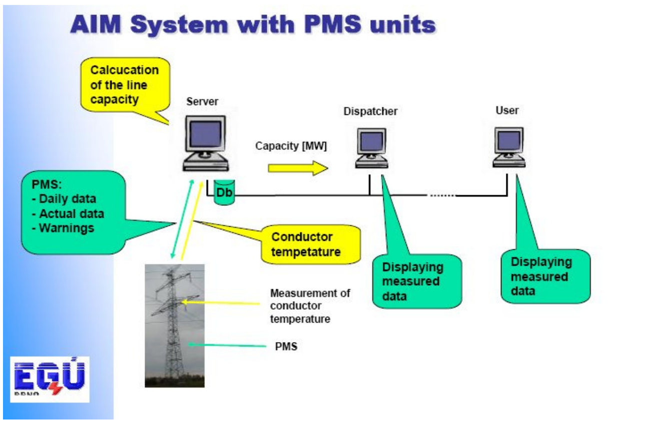

Fig. 3.1. Icemeter (PMS) communication system as employed on 400kV networks (Courtesy EGU)

IV. Performance

A. *Meteorological data*

The data over the January to March period was shown to the STP Module 2 at the April, 2008, meeting. The meteorological data (temperature, wind speed and direction and relative humidity) were compared with data from the Deadwater Fell site instruments. The comparisons are shown in Figures 4.1 to 4.4. In nearly all cases the Icemeter temperature, wind speed and direction and relative humidity were in very close agreement with the Deadwater instruments. The one exception was a significantly erroneous wind speed reading for some days at the end of February (see Figure A2.2). This corrected itself with no intervention from EA Technology or EGU. It did not affect the other readings from the Icemeter.

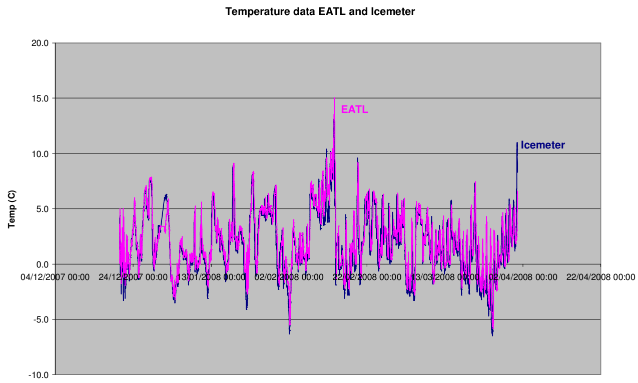

Fig. 4.1 Temperature data from the PMS (Icemeter) and EA Technology (EATL) instruments.

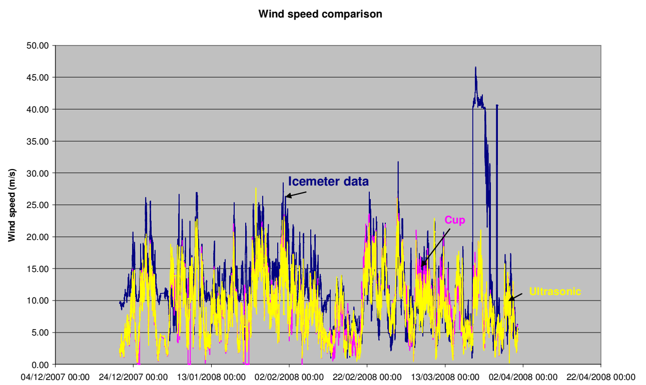

Fig. 4.2 Wind speed comparison of the Icemeter data with the EA Technology cup and ultrasonic anemometers.

As the Icemeter is up at the conductor height (as compared with the EA Technology instruments which are above the hut), it is to be expected that the wind speed measured would be higher due to being less influenced by the ground drag.

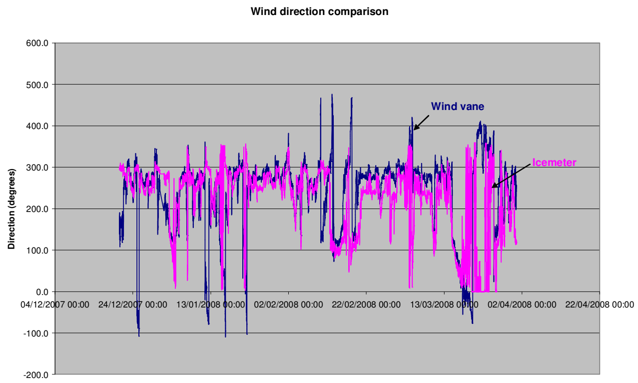

Fig. 4.3 Wind direction comparison of the Icemeter data with the EA Technology cup and ultrasonic anemometers.

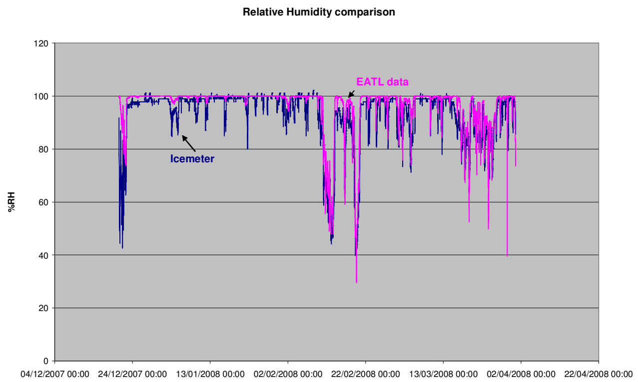

Fig. 4.4 Relative Humidity comparison of the Icemeter data with the EA Technology instrument.

B. *Ice Load Data*

As the Icemeter is a vertical rod, it collects ice accretion from all wind directions. As the Deadwater Fell line is orientated North-South, the conductors will accrete most ice from winds basically with a significant East or West component. In comparing the data from the Icemeter it is therefore expected that all ice loads on the conductors will be picked up by the icemeter. Icing winds blowing directly along the line will be picked up by the sensor but ice will not actually accrete on the conductors with these wind directions. Figure 4.5 shows a comparison of the tensions on a Gap-type conductor and the ice load output from the Icemeter.

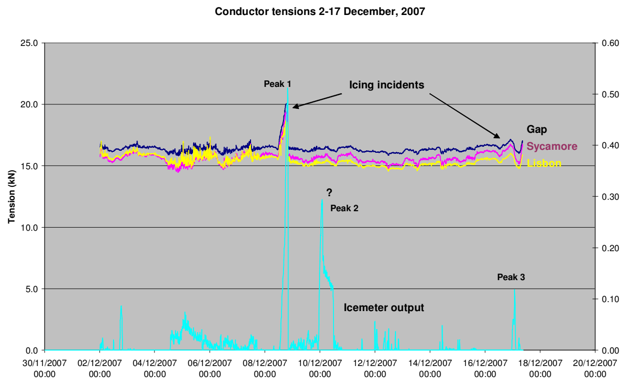

Fig. 4.5 Icemeter iceload output compared with Gap conductor tensions in December, 2007.

The Icemeter picks up three main peaks (although all fairly low accretion levels of 0.5kg/m maximum. The first peak (9 December) is rime ice and agrees precisely with the conductor tension increase. The second peak is wet snow (conditions see Figure 4.6) - but the wind is aligned almost along the span so no accretion was noted on the conductors. The load was noted on the Icemeter as this is non-directional. The third peak is rime ice – a minor load that agrees with the conductor tensions.

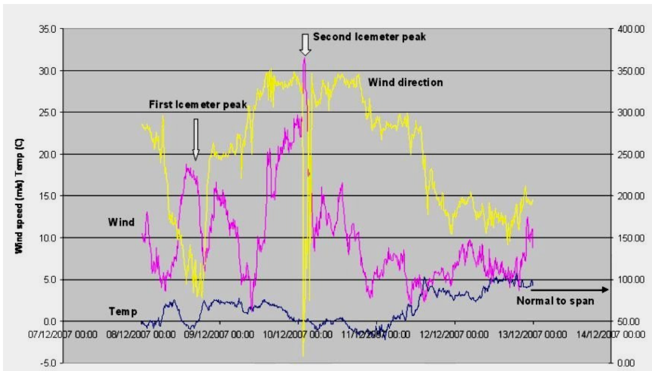

Fig. 4.6 Weather data for Icemeter peaks for December, 2007.

Figure 4.7 shows the Gap tension and icemeter data for January and early February, 2008. Figure 4.8 shows data for February/March. In both these figures there is close correlation between measured ice loads and Icemeter indications both in terms of timing and incident intensity. There appear to be no ‘false positives’ where icing was indicated but conditions were such that it could not have occurred.

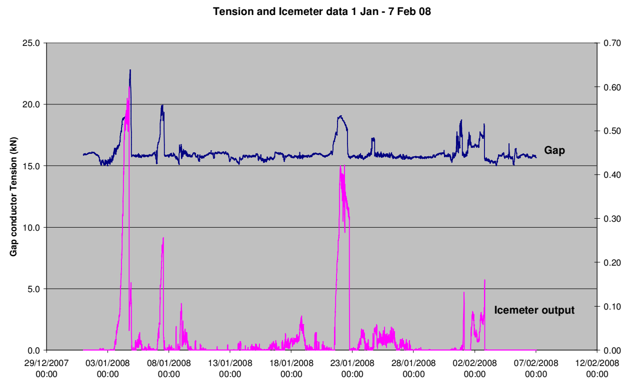

Fig. 4.7 Icemeter iceload output compared with Gap conductor tensions in January, 2008.

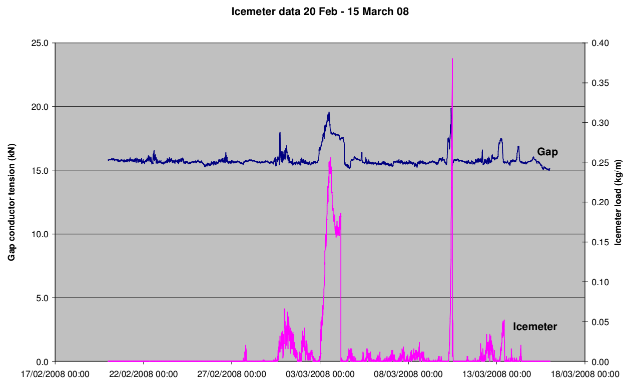

Fig. 4.8 Icemeter iceload output compared with Gap conductor tensions in February and March, 2008.

V. Reliability of PMS Icemeter Data

In summary:

1. Temperature follows EA Technology sensors very closely;
2. Average Wind speed is higher than recorded by EA Technology but this is to be expected as the Icemeter is higher off the ground than the EA Technology ultrasonic and cup anemometers;
3. Icemeter appears to be accurate apart from a significant error from 20 to 24/3/08 when wind speeds suddenly trebled! This is being investigated;
4. Maximum wind speeds are also recorded. Over the winter max is 18% above average;
5. Wind direction is compatible with EA Technology data;
6. Relative Humidity is again compatible with EA Technology data. %RH indicates when the lines are in cloud (rime ice) or subject to precipitation (wet snow if T<1.5C).

VI. Summary

The PMS Icemeter picked up all the rime ice loads during the winter and indicated the ice load level (max recorded load 0.6kg/m in early January). It also provided meteorological data (wind speed, gusts, wind direction, temperature and relative humidity) and this data appeared to be in line with EA Technology instrument recorded data at the site. Data is sent by mobile phone. Although the current instrument is mains powered, solar/battery powered instruments are in use in the Czech Republic;

As an instrument to provide local weather conditions and ice loads at remote locations, the PMS Icemeter appears to be reliable and consistent and is being considered for UK network security. It is also being considered to replace the current Deadwater Fell instruments as it is intended to be maintenance free and could replace all data apart from the precipitation gauge. It could also dispense with the need for a separate logger.

VII. References

Technical Reports:

[1] J. B. Wareing, "Evaluation of the performance of the PMS Czech Icemeter at Deadwater Fell," EA Technology Report 6142, July, 2008.

Papers Presented at Conferences (Unpublished):

[2] J. B. Wareing, " Deadwater Fell Test Site" presented at the 9th IWAIS, Andermatt, Switzerland, 2009. Poster PO. 067.