INTRODUCTION OF ANTI-ICING AND MITIGATION RESEARCHES DONE BY CEATI

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Abstract: The Central China Grid had experienced heavy icing/snowing weather in January 2008. The Grid was damaged seriously and heavy economical loss was resulted in. From then on, the technology of anti-icing and mitigation has become an important subject to the O&M (operation and maintenance) department of power grid. The aim of this paper is to provide some helps for Hubei Grid s anti-icing research through the introduction of anti-icing and mitigation researches having been done by CEATI (Canada Electric Association Technology Institute).

1. INTRODUCTION

January 1998, Canada has experienced unprecedented severe ice storm, causing 900km out of the 3200km line with varying degrees of damage. Many towers in the 116 transmission lines(different voltage levels) collapsed, which caused the power interruption among 40% users of Quebec. 3 of the 5 735kV transformer substations in Montreal Ring interrupted and 5 of the 7 735kV lines interrupted, only 1 high voltage line was remained in Montreal region at that time. Hence, Canada carried out extensive research on anti-icing and mitigation, including the mechanism and model of frozen ice, de-icing / ice melting method and device technology, etc.

2. RESULTS AND DISCUSSION

CEATI is a regional organization carrying out the research of the generation, transmission and distribution of electric power. At present, the anti-icing / anti-ice research has the following main priorities:

(1)Research on severe snow weather and forecasting of ice storm

(2)Research and application of de-icing equipment

(3)Application of line monitoring device

(4)Load shedding equipment of tower

(5)Preventing for cascade down of towers

The observations of the harsh climate, mainly depend on the meteorological department, but the data provided by the weather station with less accuracy can not make a target for the grid to take some measures controlling the severe weather. In order to make a clear purpose for the anti-icing work, ice and wind speed observation station should be established in area with harsh weather, collecting meteorological parameters of the region with harsh climate and developing distribution map of harsh climate areas and even the ice zones and wind zones. Through a certain period of data accumulation and analysis, and ultimately make the short term forecast of the storm and ice storm come true.

3. CONCLUSION

According to the research carried out by the WISWIG Working Group and the demand of anti-icing in our province, the following aspects of the research should be emphasized:

(1)Severe snow (wind) weather research and prediction

(2)Ice monitoring

(3)Related model by computer-aided calculation

(4)Performance of wire should be taken into account while in circuit design

4. REFERENCES

[1] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[2] I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

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***Abstract*—The Central China Grid had experienced heavy icing/snowing weather in January 2008. The Grid was damaged seriously and heavy economical loss was resulted in. From then on, the technology of anti-icing and mitigation has become an important subject to the O&M (operation and maintenance) department of power grid. The aim of this paper is to provide some helps for Hubei Grid s anti-icing research through the introduction of anti-icing and mitigation researches having been done by CEATI (Canada Electric Association Technology Institute).**

Keywords-Canada; anti-icing and mitigation; monitoring; de-icing

I. INTRODUCTION

January 1998, Canada has experienced unprecedented severe ice storm, the radial equivalent ice thickness of some regions reached 75mm, causing 900km out of the 3200km line with varying degrees of damage. As the heavy ice on the wire, many towers of the 116 lines(different voltage levels) collapsed, which caused the power interruption among 40% users of Quebec. 3 of the 5 735kV transformer substations in Montreal Ring interrupted and 5 of the 7 735kV lines interrupted, only 1 high voltage line was remained in Montreal region at that time. Hence, Canada carried out extensive research on anti-icing and mitigation, including the mechanism and model of frozen ice, de-icing / ice melting method and device technology, etc. These results are described in the related literature.

II. 1 RESEARCH BEING CARRIED OUT BY CEATI

CEATI is a regional organization carrying out the research of the generation, transmission and distribution of electric power, whose members come from more than 100 power companies, universities and research institutions in the United States, France, Japan and other countries and regions. One working group of the organization have a research interests including transmission line design, climate and its impact on the overhead lines, crisis management, detection of potential damage to the line after blizzard, disaster prevention measures, de-icing technology. At present, the anti-icing / anti-ice research has the following main priorities.

A. Research on severe snow weather and forecasting of ice storm

One of the projects is " Icing Simulation And Forecast Based On Conventional Climate Model ". Its main contents include: parameters determining of the freezing event, the applicable weather prediction and icing forecast model research, selection and application, simulation of the past ice events and analysis of simulation results. Ice prediction system consists of three parts:

Weather research and forecasting (WRF) system-------- one subsystem of NWP, It can predict the weather within 42,000 square kilometers in the next 24 hours. The data required can be downloaded through the relevant site of the meteorological department.

Ice model-------- the study used a simple freezing rain model (proposed by the Jones in 1996) and Makkonen (1984) rime model. The data needed to enter come from the output of the WRF, including temperature, wind speed and direction, rainfall, rainfall of freezing rain, rain content in the clouds, etc.

Post-processing--------data files and graphics. Freezing points can be given as well as a regional ice chart. The simulation results of the past ice events show that it has a higher accuracy for severe ice events while a lower accuracy for mild freezing (Req < 3mm). The model should be able to predict the weather (depending on the forecast range) in the next 1-2 days.

Another project named “The Design Parameters Update Of Wind And Ice Load Based On Reliability” is undertaken by the Environment Agency of Canada. The study gives the Wind zones and ice zones of Quebec in 50 years, according to decades of weather data and Ice model related ,as figure 1 and figure 2 show, Accurate map of wind zones and ice zones can be used to guide the development of the construction of transmission lines and transmission line design standards

Figure 1. 10min wind speed map (kmh) of Quebec once in 50 years

Figure 2. Ice zones (mm) of Quebec once in 50 years

B. Research and Application of De-icing Equipment

(1) Deicing robot

Hydropower Research Institute, Quebec, Canada developed a robot de-icing (Protura) , figure 3. The main body of the device is a movable rack with power source, a high-speed rotating ice-breaking knife around the overhead wires is installed at the front of the forward direction. Snow and ice on the wire can be cut and broken. It also can be used to clear the ice on the high voltage transmission lines and overhead land line. The vibration characteristics caused by deicing robot is being evaluated to assess whether it would damage lines.

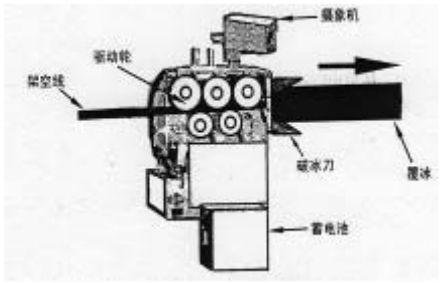

Figure 3. Deicing robot (Protura)

(2) 1.2.2 Vibration de-icing equipment

The device vibrated by using a motor to move an imbalance weight on the wire. The vibration is send to the wire, causing oscillation, which contribute to the de-icing of the line. The output of the motor is adjustable, it can improve the de-icing capability by using several different oscillation frequency. A preliminary test made on A diameter of 1.2 inches, 500 feet span line showed that the line displacement is about 4 to 13 inches and the line acceleration is about 0.5 ~ 14g when the frequency of the de-icing equipment is about 1.5~8.0Hz, within this context, the ice can be fully removed. The hanging ice is the easiest to remove while the tubular ice is most difficult to remove. The disadvantage of the method is: if long-term use, high-amplitude oscillations may damage the line / insulator.

(3) Mechanical de-icing equipment

The device twist the wire or ground wire along the longitudinal axis, then release the elastic mechanical energy accumulated from the distortion suddenly. This moment, the ground or wire diameter decreases or increases respectively, causing interface split between lines and ice in order to achieve de-icing. The advantage of the de-icing system is that it is valid to all types of ice, and it can easily automate on the ground or bare wire. In addition, there is no power operation, the de-icing work does not affect the power supply to users. The system can be powered directly from lines. Also, this method is very low energy consumption, energy consumption per meter line is about 0.05W. In addition, because the deformation of the line does not exceed the shear elastic limit, it will not make their fatigue damage. The main disadvantage is that the device is very complex. It requires a strong motor, reduction gear box, Magnetic coupling with the motor adapter, control module as well as ice detection unit, etc. And some improvements for the ground or the wire are required while being installed, so it is not easy. Finally, the method can not be used to split lead.

(4) DAC

DAC is a kind of mechanical de-icing equipment, it works by using a piston system with a tank to generate shock waves to the cable and thus causing the de-icing. According to the brittleness of the ice, the device use shock wave generated from high frequency stress within the span to crush the ice. Completely on the ground deicing operations and this is its main advantage. The device is simple, easy to carry, and strong and it has good de-icing effect.

C. Application of Line Monitoring Device

The monitoring content of the online monitoring devices used currently in Canada include: current, voltage, wire temperature, wire tension, sag, distance-to-ground net, leakage current, aeolian vibration, etc. However, practical applications of the online monitoring device need further research to enable them to accurately reflect the actual situation of lines and towers.

D. Load Shedding Equipment of Tower

To reduce the load caused by wire broken, insulator string /fitting broken, collapse of the adjacent tower and uneven ice. The shedding device ANCO was developed, figure 4. From the effect analysis of the load shedding equipment by the finite element method, the results show that the device can reduce about half of the load of the tower adjacent.

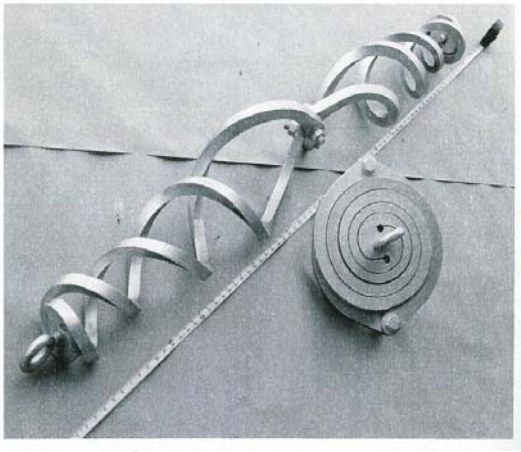

Figure 4. ANCO tower load shedding equipment

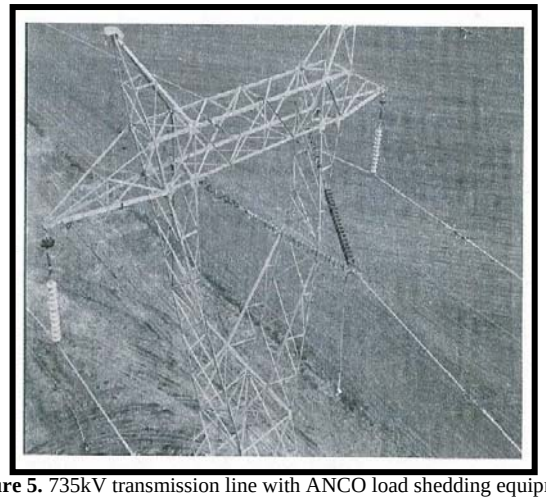

Figure 5. 735kV transmission line with ANCO load shedding equipment

E. Preventing for Cascade Down of Towers

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III. ENLIGHTENMENT OF ANTI-ICING ABOUT OUR PROVINCE

According to the research carried out by the WISWIG Working Group and the demand of anti-icing in our province, the following aspects of the research should be emphasized:

A. Severe Snow (Wind) Weather Research and Prediction

Currently, the observations of the harsh climate, mainly depend on the meteorological department, but the data provided by the weather station with less accuracy can not make a target for the grid to take some measures controlling the severe weather. In order to make a clear purpose for the anti-icing work, ice and wind speed observation station should be established in area with harsh weather, collecting meteorological parameters of the region with harsh climate and developing distribution map of harsh climate areas and even the ice zones and wind zones. Through a certain period of data accumulation and analysis, and ultimately make the short term forecast of the storm and ice storm come true.

B. Ice Monitoring

Make a research on the current situation of the application of the ice monitoring device and select several of them for application research.

C. Related Model by Computer-aided Calculation

Create different lines and tower models, carry out the load calculation (ice condition included) by computer-aided calculation.

D. Performance of Wire Should Be Taken Into Account While In Circuit Design

Such as traction coefficient of the wire research under icing condition, lead fatigue research, wire inherent tensile stress and strain research, etc.

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[1] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

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