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MICROWAVE DETECTION OF INAUDIBLE NOISE FROM HIGH-VOLTAGE TRANSMISSION LINES

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ABSTRACT

Landscape features, that affect the route of the line are the most significant part of this research. These features are incorporated into raster-based GIS, and using information gathered from stakeholders, the route with minimum opposition is developed between two substations. Routing with acceptable measured parameters of a line is also affected by the rules and regulations in a particular state. In this work, a brief introduction is given to the main legal requirements involved in this regard. Non-point impacts that are independent of terrain are also given in detail. Potential stakeholders, and their importance are also explained in this work. To carry out the proposed work, we will measure the radio frequency by not using the instrument used to measure the inaudible noise in the conventional way. With this, we will not acquire cost separately and the available resources will also be used, because different types of RF instruments are better than microphones for measuring radio frequency.

Keywords: RF, GIS, JTCL, Inaudible Noise, PLC.

I. INTRODUCTION

Transmission Line Routing Measurement is a complex process which involves local, state and federal agencies. Depending upon the line noise level, approval may be required from several federal and state agencies. Economics dictates that transmission lines transmit power at high voltages. Electric fields around lines are the result of the high voltage gradient on the surface of the conductor. Electric fields are strongest at the surface of the conductor, and lose intensity away from the conductor. Much of the route of a transmission line goes through rural and undeveloped areas, where there are more plants and animals than humans, so exposure of plants and animals to electric fields must be considered. Animals are shielded from electric fields by vegetation, and exposure is greatest when they are passing beneath transmission lines. Various studies have been done on effects of electric fields on animal behavior, melatonin production and immune function, and impacts found were low. Similar results were found in studies on plants. Electric field exposure is an issue of concern in urban areas, but electric fields are shielded by conducting objects like fences, walls and trees. In buildings and houses around 90 to 95% of electric field is shielded. Electric field exposure depends upon the way transmission lines are designed.

Magnetic fields around transmission lines are due to the flow of the current in the line. Unlike electric fields, magnetic fields increase and decrease depending on the electric load on the line. Intensity of the magnetic field is dependent upon the distance from the transmission line. Electrical appliances like ovens or heaters produce magnetic fields of less than 2 mG and in buildings or houses close to transmission lines the major source of magnetic fields is the transmission line. Magnetic field exposure from a line is higher in comparison to the electric field. Magnetic fields are not shielded by trees, fences, or structures, as in the case of electric fields.

Both electric and magnetic fields induce currents, and certain unusual circumstances, like contact of a grounded person with an ungrounded object under a high electric field, can result in nuisance shock or spark discharge. Research on electric and magnetic fields shows no evidence that supports a relation between electric or magnetic fields and adverse health effects like cancer and other diseases.

II. BACKGROUND THEORY

The National Electrical Safety Code requires that for voltages more than 98 kV ac to ground the induced currents not be more than 5 mA. Transmission line designers must design with enough clearances throughout the route of the line so that line can meet the desired requirements. Inductive interference with pipelines must be considered during line design and route selection for a transmission line.

III. ELECTROMAGNETIC INTERFERENCE

Electromagnetic interference is one of the major problems that designers face during the design process. Corona and gap discharges are the main sources of electromagnetic interference. Corona is generally seen in 345 kV and higher voltage transmission lines [2, 6]. Electromagnetic radiation from corona discharges affects AM radios [4], whereas gap discharges affect both television and radio reception. Radio frequency [1] emissions from corona occur between the ranges of 100 kHz to 2 MHz [6], and most communication systems like police, fire, commercial radios and cellular phones operate above 2 MHz. Broadcast AM radio [3], however, operates between 535 and 1604 kHz, and is thus often affected. Signal reflections from power transmission lines may cause ghosting in weak television signals. Electrical discharges between broken and loose hardware like insulators, clamps and brackets are transmitters of frequencies that can cause interference with some radio and television signals. Interference depends upon the strength & quality of the transmitting signal, the distance of the source to the receiver and the quality of the radio or TV system [1].

J. J. LaForest et al. [1] determined the value of the noise current on a spectral-density basis by using an RI meter with an RMS detector. Since this type of instrument is not in widespread use, the total noise current will be evaluated by a standard NEMA- RIV [1] laboratory test on the equipment using the standard Quasi-Peak Instrument. It can also introduce some amount of extra cost [1]. The construction and operation of the transmission line may cause interference with other utilities, including railroad, telecommunications and other electric utilities. States require utilities to notify railroad companies and other utilities about their project in advance. Power transmission lines go through a wide variety of areas and some of them may be in wilderness or areas that have historic importance to the state.

There are two measurement approaches usually adopted for obtaining information about the radio noise (0.010 MHz to 30 MHz) produced by overhead power lines: short-term and long-term surveys [1, 3]. To properly characterize the radio noise performance of overhead power lines from 0.010 MHz to 30 MHz, both short-term and long-term surveys are needed [3]. This method is based on the survey and does not so effective. Yingyi Liu et al. [6] has proposed a speech enhancement method for removing background noises. The method can realize real-time background noise removal by estimating the change of background noises with time if the characteristics of background noises are known. For outdoor detection, because the background noises may contain a variety of sudden interference noises, which are difficult to be predicted, the above method has a poor noise reduction effect. They have also analyzed the statistical correlation between the average logarithmic power spectral density ($PSD_{average}$) of corona [2, 6] current in the 8 kHz - 20 kHz frequency band and the audible noise sound level [5].

IV. PROPOSED METHODOLOGY

In the proposed method the fundamentals of the RF signal techniques are discussed. Two types of methods are used, the short-term method, and the long-term method. The disadvantage of short-term method is that it cannot be used later. Only after some time their measurement changes, due to which these methods cannot be considered more effective. Only those methods, which are long term method can be believed and their measurement can remain constant for a long time. Apart from this, more trust cannot be given to those instruments whose cost is less and accuracy is also less. Equipment's that provide more accurate and true readings are very expensive due to which it is difficult to afford the entire measurement system everywhere and the reading is not as accurate. In such circumstances, a system is required which reduces the cost and also provides more accuracy. For this, either a low-cost option has to be chosen, or else we can use it in this measurement by sharing the measurement system elsewhere.

Jabalpur Transmission Company Limited (JTCL): Jabalpur Transmission Company Limited (JTCL) was incorporated on September 8, 2009. It entered into a transmission service agreement dated December 1, 2010 and a transmission services agreement dated November 12, 2013 with Power Grid Corporation of India Limited. JTCL alleviates transmission capacity bottlenecks and expands the reliability and stability of the power grid in western and northern India by providing open access to transmit power from the independent power projects in eastern India. JTCL operates two EHV overhead transmission lines of 994 circuit km in the states of Chhattisgarh and Madhya Pradesh comprising one 765 kV dual circuit line of 758 ckms from Dharamjaygarh (Chhattisgarh) to Jabalpur (Madhya Pradesh) and one 765 kV single circuit line of 236 ckms from Jabalpur to

Bina in Madhya Pradesh. We believe that the Jabalpur-Dharamjaygarh line of JTCL is India's first 765 KV double circuit line owned by a private company [7]. To carry out the proposed work, we have chosen the Jabalpur-Narsinghpur 765 KV transmission lines, which has the height about 85 to 100 feet [8]. We have chosen 4 locations to implement our work:

- Avantha Power Plant, Jhabua, Ghansour;
- Mohaans, Jabalpur-Nagpur Road;
- New Mandala Road;
- Rampur Chhaapar.

First of all, we will choose 4 locations in Jabalpur. In each location, we will try to measure by the 4G signal being received in the nearby GSM tower, where very modern equipment such as Huawei outdoor units are used for measurement. For this, first we will get the distance [6] between the GSM base station subsystem from the transmission line through GIS software.

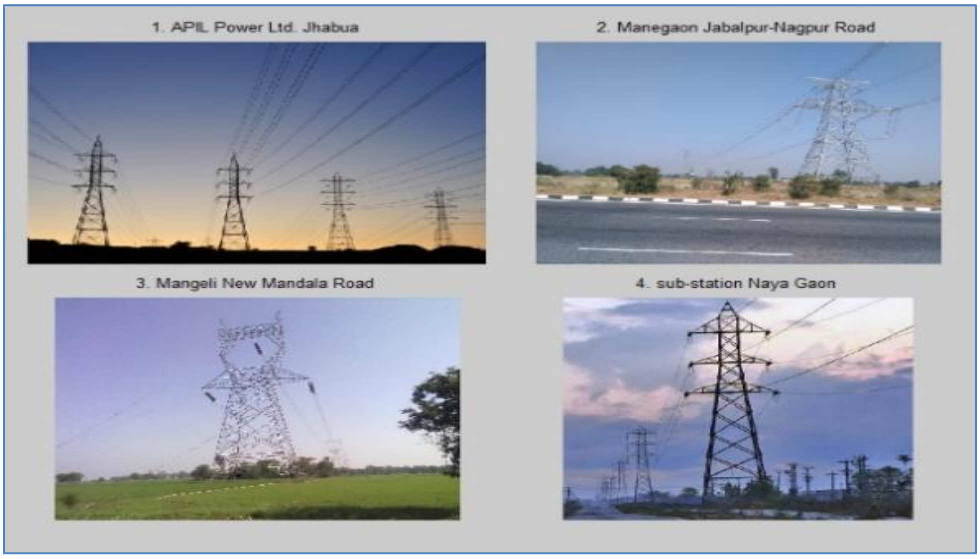

Fig.-1. Four geographical adverse locations chosen in Jabalpur

Measurements will be made during the day and also at night. The 4G signal is usually broadcast on -70 decibel meter. When the receive signal is prominent at the base station, it is the mixed signal (Gross PSD) of the noise of the area, the noise of the transmission line and the power spectral density of the mobile signal. Interference generated in the 4G signal is measured differently by the base station. It is generated by the noise in the interference environment. Hence it is displayed by Noise PSD. No signal is transmitted to the transmission line during load shedding. During this time the environmental noise can be measured by the base station. After load shedding, the transmission line's noise can be obtained by subtracting the total noise and the environmental noise. The same method will be implemented at night, so that the effect of temperature, humidity and air flow on the noise of the transmission line can be determined. It has been made clear through various articles that the environmental condition has the opposite effect on this noise. It is also necessary to analyses some parameters such as the height from the ground of the measuring antenna, and the distance [6] between the towers of the transmission line. Therefore, we have also used these parameters. Finally, all the methods used so far are shown in Jogi Literature, comparing them and the results of the proposed work, so that we know that the proposed method is very important in measuring microwave transmission line noise measurement.

Gonghao Xie et al. analyzed the audible noise of the transmission line. When the height of the conductor to the ground changes, the field strength of each conductor surface changes, and as the height of the conductor changes to the ground, the distance [6] from the audible noise measurement [5] point of the transmission line changes, affecting the distribution of audible noise across the crossing area [4]. The amplitude of the audible noise gradually decreases as the height of the conductor to ground increases.

Transmission Line Noise PSD Measurement through GSM:

1. APIL Power Ltd. Jhabua
Distance: 6000 meters
Measurement at Day time [5]
C_11 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) = NA_NL_C_11 = -99
Noise PSD = NA_NL_11 = -29
during load shedding
Area Noise PSD in dB = NA_11 = -22
after load shedding
Line Noise PSD = NL_11 = -7
Measurement at Night time [5]
C_12 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_12 = -110
Noise PSD = NA_NL_12 = -40
during load shedding
Area Noise PSD in dB = NA_12 = -31
after load shedding
Line Noise PSD = NL_12 = -9

2. Manegaon Jabalpur-Nagpur Road
Distance: 600 meters
Measurement at Day time [5]
C_13 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_13 = -97
Noise PSD = NA_NL_13 = -27
during load shedding
Area Noise PSD in dB = NA_13 = -5
after load shedding
Line Noise PSD = NL_13 = -6
Measurement at Night time [5]
C_14 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_14 = -103
Noise PSD = NA_NL_14 = -33
during load shedding
Area Noise PSD in dB = NA_14 = -28
after load shedding
Line Noise PSD = NL_14 = -5

3. Mangeli New Mandala Road
Distance: 1500 meters
Measurement at Day time [5]
C_15 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_15 = -96
Noise PSD = NA_NL_15 = -26
during load shedding
Area Noise PSD in dB = NA_15 = -21
after load shedding
Line Noise PSD = NL_15 = -5
Measurement at Night time [5]
C_16 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_16 = -103
Noise PSD = NA_NL_16 = -33
during load shedding
Area Noise PSD in dB = NA_16 = -29
after load shedding
Line Noise PSD = NL_16 = -4

4. Sub-station Nayagaon
Distance: 400 meters
Measurement at Day time [5]
C_17 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_17 = -99
Noise PSD = NA_NL_17 = -29
during load shedding
Area Noise PSD in dB = NA_17 = -21
after load shedding
Line Noise PSD = NL_17 = -8

Measurement at Night time [5]
C_18 = -70
Area Noise PSD + Line Noise PSD + Mobile Signal PSD =
Gross PSD (NA+NL+C) =
NA_NL_C_18 = -105
Noise PSD = NA_NL_18 = -35
during load shedding
Area Noise PSD in dB = NA_18 = -28
after load shedding
Line Noise PSD = NL_18 = -7

V. CONCLUSIONS

In the proposed work, we have used the Interference detection model to measure the Inaudible Noise of transmission lines (TL). Some of the data is measured while the remaining data which cannot be available for any of the reasons, is to be assumed and finally analyzed using the mathematical tools of MATLAB. To avoid interference with telecommunications, a line must maintain proper clearances from communication lines. The line owner must give notice in advance to all the telecom utilities along the line.

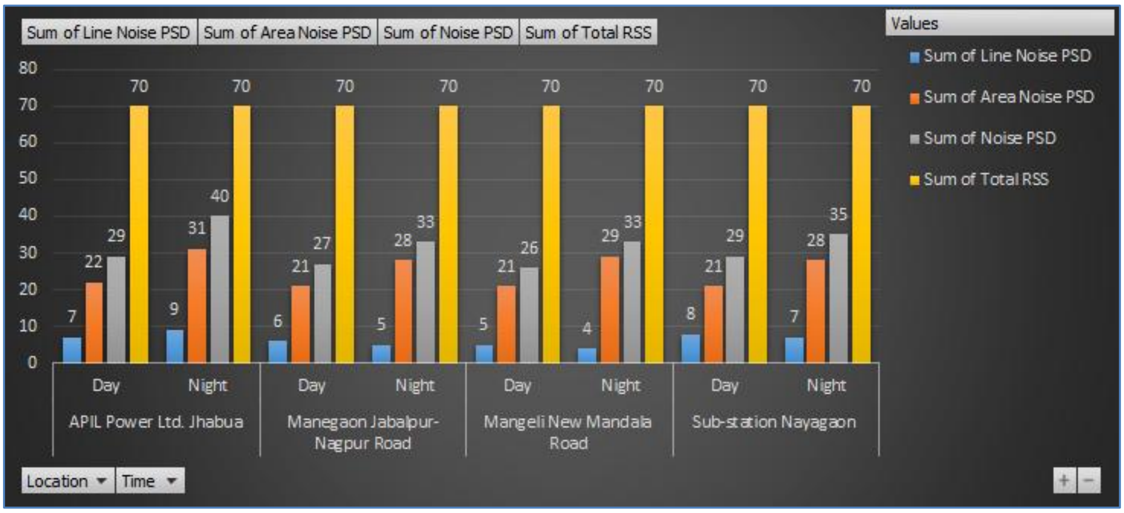

Fig. 2. The Observation Table_1 GUI

Communication signals used by the railroad may be affected by electromagnetic fields produced by the transmission lines and as far as possible this interference should be avoided. A common problem that utilities face is interference with broadcast communication signals and this problem is worse if the receiver or transmitter of the signal is in close proximity to transmission line. Utilities have to make sure that magnetic interference from a line is not going to cause excessive Noise to Radio or TV signals [1]. During the selection of the route, such interference its effects on the communication signal should be considered. For a more consistent detection and analysis, in a future Artificial Intelligence will be applied for automation.

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