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Extremely Low Frequency Electric and Magnetic Field Investigation of 132 KV Transmission Lines and Substations in Oman

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Abstract: - This study focuses on examining the longitudinal and lateral impacts of electric and magnetic fields generated by 132 kV transmission lines in the Sultanate of Oman. The longitudinal and lateral measurements of the electric and magnetic field profiles of 132 kV power lines are being conducted at three specific places within the Sultanate of Oman, namely Al Buraimi, Khaboora, and Rustaq. The analysis of electric and magnetic fields emitted by transmission lines involves the utilisation of an EHP-50F E&H field analyzer sensor unit and an environmental metre. The on-site measurements of the 132kV transmission line are being compared to the International Commission for the Protection against Non-ionizing Radiation (ICNIRP) standard for electromagnetic field exposure in both public areas and workplaces. The measurements were conducted at 132kV transmission lines or to a distance of the insignificant field at the high-voltage substation. The components included power transformers, current transformers (CT), potential transformers (PT), circuit breakers, reactors, earth switches, transport couplers, lightning arrestors, and others. This study conducted in Oman represents the primary investigation of multiple elements related to the Oman Electricity Transmission Company (OETC) and its technical standards, which are based on optimal practices. The Sultanate of Oman has established an objective for the year 2030 to construct a state-of-the-art smart transmission grid with the purpose of efficiently transmitting and distributing power in a manner that is both secure and cost-effective. This article presents a systematic approach to the implementation of a smart transmission grid.

Keywords*: Electromagnetic field; Human exposure; Measurements; OETC.*

1. Introduction

Oman well known as the Sultanate of Oman, is a nation located in Southwest Asia. It runs through the entrance to the Persian Gulf on the Arabian Peninsula's southern coast, with a current population of 5,470,512. Oman Electricity Transmission Company SAOG (OETC) is essential to the Oman Electricity Sector as it owns and operates both the main transmission network and as transmission network in Dhofar, through which electricity is transmitted from generating stations to distribution load centers in all governorates of the Sultanate. The 400kV system serves as the backbone, the 220kV system as transmission, and the 132kV system as a sub-transmission for this strategy. Transmission voltages in the main electrical grid are typically 132 kilovolts or higher [1]. This paper consists of the measurement of the electric and magnetic fields in three different regions of Oman: Al Buraimi, Khaboora, and Rustaq. Longitudinal and lateral profiles are presented and compared to ICNIRP restrictions for the main network of 132 kV substations and transmission lines connecting Al-Buraimi substations to Al-Buraimi city, Al-Khaboora (KIS) to Saham line, and Rustaq substation to Rustaq city in the Sultanate of Oman.

Myriad authors have conducted research on this topic and presented their findings and associated hazards. There have been several epidemiological studies aimed at establishing a link between magnetic and electric field exposure and health problems in humans in many parts of the world. Here are some authors from around the world who conducted extensive research on transmission lines and debated the contentious issue of adverse health effects on humans and the environment. Indian researchers in 2014 measured the Electric and magnetic field strengths along 400 kV power transmission lines using a MAGNUM 310 and a Spherical Digital Electric Field Meter [3]. Bosnia and Herzegovina (B&H) researchers calculated the electric field distribution of high-voltage transmission lines in 2014 using the approach of equivalent charges at random locations near transmission lines. [4]. The California Power Line Study, which was completed in 2015, is a case-control study that looked at the relationship between residing near transmission lines and the incidence of pediatric leukemia [5]. In 2016, Bosnia and Herzegovina researchers used two fully linked feed-forward neural networks to detect magnetic induction and electric field strength near high-voltage overhead transmission lines [6]. A new technique for reducing the effects of magnetic fields near power lines has been developed, introduced, completely modeled, and subjected to parametric

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analysis by Italian researchers. [7]. In 2018, Indian researchers did a study on the Effect of Electromagnetic Radiations Caused by High Voltage Transmission Lines on Humans [8] Electric and magnetic field measurements were utilized in a 2019 study to examine the operation of the Turkeys power system's transmission lines and substations [9]. The researchers Korea in 2020 used an EMDEX II field analyzer to measure the quantitative values of ELF-MFs in five classrooms across four schools during digital learning class hours in order to control ELF-MF exposure in schools and the effects of ELF-MF exposure during school hours on children's health environments in schools [10]. In 2020, researchers in Lithuania used superposition and reflection mathematical analytical methods to assess a 400 kV double-circuit overhead transmission line [11]. 230 kV tower double circuit topologies were the subject of a theoretical analysis and mathematical model used by Iraqi researchers in 2020 to examine electromagnetic fields in high-voltage transmission lines [12]. Algerian researchers in 2022 provided a thorough analysis of the extremely low-frequency magnetic fields created near high-voltage overhead power transmission lines that make up the Algerian national energy power transmission infrastructure [13]. Iranian researchers studied and evaluated the impact of extremely low-frequency electromagnetic fields (ELF-EMF) on the blood parameters and liver enzymes of high-voltage power plant employees in 2023 [14]. In addition, the IEEE C95.1-2019 standard states that there is insufficient evidence to conclude that exposures below the IEEE C95.1-2019 level are detrimental over time [15]. Researchers are still investigating many angles of this debate in an effort to improve environmental quality and public health. Their study suggests there are symptoms of a health issue, which encouraged them to start looking for a solution. Our research, the first of its kind in Oman, measured electric and magnetic fields in both the longitudinal and lateral directions near 132kV transmissionlines using the cutting-edge EHP-50F field analysis sensor and Environmental meter. The EHP-50F sensor analyzer that is used in our study is a probe that captures and examines low-frequency electric and magnetic fields. Operating between 1 Hz and 400 kHz, it offers a high-dynamic-range, high-frequency technical solution for field investigation. It contains an effective integrated spectrum analyzer and can measure simultaneously in three dimensions (X, Y, and Z). A computer should be utilized with the EHP-50F for capturing and analyzing the online data collected from the sensor at the transmission line. Additionally, a disconnected mode of operation permits continuous data collection for up to 36 hours. The results of our research will have far-reaching consequences for the electricity sectors, and they are in line with the goals of Oman 2030's vision for a world-class smart transmission grid. This infrastructure will allow for the safe, dependable, secure, and cost-effective transportation and dispatch of electricity. Specifically, the following aims were formulated for this study.

1. To investigate longitudinal and lateral electric and magnetic fields close to the 132 kV transmission lines and peripheral distance of substations equipmentusing an EHP-50F field analysis sensor and Environmental meter.

2. To compare the EHP TS software's outpof substationsut against the ICNIRP Standard.

3. To suggest corrective measures for the electricity sector to steer clear of in the near future.

4. To propose a health sector for monitoring the health symptoms of the general public and the occupational workforce.

It is of the utmost importance to understand the historical context and current operational framework of 132 kV Transmission lines in the Sultanate of Oman to comprehend the manifestation and presence of electromagnetic fields, and to effectively achieve the intended objectives.

A. Electromagnetic fields

When two or more electrically charged particles interact, a physical phenomenon known as an electromagnetic field is created. The behavior of charged items in the area around a point changes as a result of the electromagnetic field. Electromagnetic interactions span the entirety of space and time. It's typically thought of as the first electromagnetic field since it combines electric and magnetic fields. Charges in motion create a magnetic field, whereas charges at rest form an electric field. Electromagnetic fields are a synergy of electric and magnetic fields of force that are invisible to the naked eye. Both natural events and human activity, particularly the usage of energy, contribute to their production. Since light travels at the speed of light, the electromagnetic field may be thought of as a type of radiation. A waveform is the mode of transmission for an electromagnetic field. To begin with, moving electric charges produce electric and magnetic fields, which then clash. Therefore, since electric charges are subject to pressures from both electric and magnetic fields, electric charge travels across space.

The majority of electricity transported through power lines is alternating current (AC). Alternating current (AC) oscillates 50 or 60 times per second, which corresponds to a frequency of 50 and 60 Hz. As their frequency is below 300 Hz, these electromagnetic fields are classified as Extremely Low Frequency (ELF) fields. Typically, an electromagnetic field is associated with the generation, transmission, and distribution of 50 or 60 Hz frequency supply. Power generation, transmission, and distribution, both conventional and unconventional, generate low- frequency electromagnetic fields. Transmission lines that generate electricity are typically located in remote locations, far from population centers, and are significant sources of extremely low-frequency fields. Transmission lines are the conductors used to transmit electricity over vast distances from the power stations to the load centers. The electric field is measured in volts per meter (V/m). The tesla (T) is the universally accepted measurement of magnetic field strength.

When the transmission line operates at high voltages, it generates a strong electric field around the conductors, but the magnetic field develops when the transmission line carries a heavy load (current), exposing the general public and occupational personnel. Exposures in the general publicand at work might differ. The International Commission for the Protection against Non-Ionizing Radiation (ICNIRP) 2010 has established range limits for electrical fields in the general public of up to 5 kV/m and in the workplace of up to 10 kV/m.[2]. Table I displays the recommended openness reference values for the general public in the vicinity of transmission lines and occupational employees.

TABLE 1**.** ICNIRP Limits Occupational and General public

Exposure Characteristics	**Electricfield kV/m(rms)**	**Magnetic flux density in μT (rms)**
Occupational	10	1000
General public	5	200

B.Oman Electricity Standard for 132 kV Lines

The specification covers the complete supply, erection, and commissioning of 132 kV double circuit transmission line on Lattice Steel towers with twin conductor 400 sq. mm all aluminum alloy conductor and shield conductor of aluminum clad steel. The three phases of each circuit must be suspended in a vertical formation, with a single overrunning earth wire. The parameters and ratings of the 132 kV line must be established for a normal electrical load transmission of 300 MVA through each circuit at 132 kV nominal voltage in Oman's climate. Maximum (summer) and minimum (winter) system demand extremes are used to evaluate the performance of the OETC transmission system when it is most strongly strained or least loaded [16].

A. Equipment utilized

The equipment used to measure the electric and magnetic field is EHP-50F. It is a LF analyzer sensor with Electric field(E) and magnetic field(H) sensors for each of the three spatial aspects. It has the ability to measure extremely accurate and dynamic non-directional estimates of electric and magnetic fields. The EHP-50F can actively measure long-distance parameters up to 24 hours in independently. It also stores the outcomes in the actual device as in Figure 1 and Figure 2.

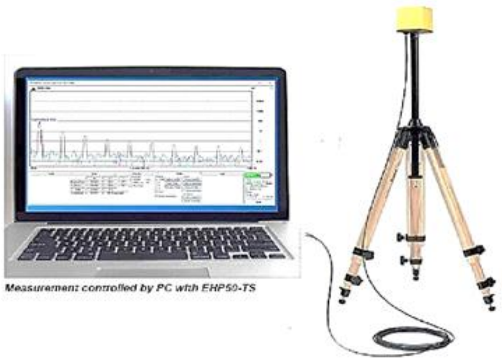

Figure 1. EHP-50F E&H Field Analyser sensor unit 1Hz-400 kHz, Standalone /PC Us

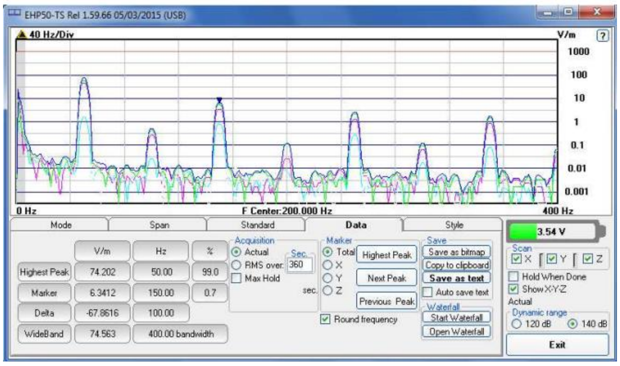

Figure 2. EHP-50F Data

Figure 3. EHP-50F sensor

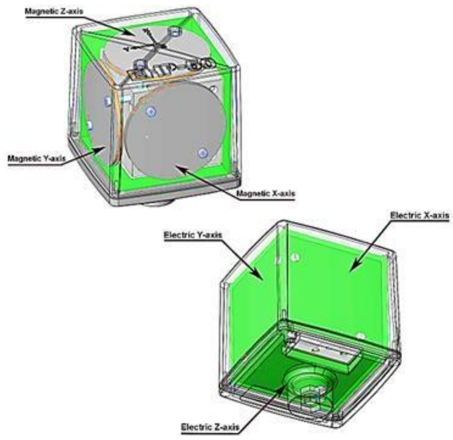

Figure 4. EHP-50F axes

The EHP-50F sensor is housed in a small cubic case. The bottom side panel includes an optical fiber connector, extension rod screw, battery charger connector, ON/OFF button, and Status LED as in Figure 3. The EHP-50F sensor's strong FFT analysis offers coverage over a large frequency range, including some subranges from 1 Hz to 400 kHz. Higher frequency ranges use a more expansive objective and a slower resolution transfer speed, which results in a quicker estimation execution for lower frequency ranges[17]. Measurement of the electric or magnetic field range takes place continuously along each of the three dimensions (X- Y-Z) and additionally provides the wide band with a motivation for the recorded frequency range concurrently as shown in Figure 4.

Figure 5. Environmental meter

The relative humidity, temperature altitude of air, wind pressure, wind speed, etc. recorded by using an environmental meter during the measurement of ELF-EMF as in Figure 5.

2. Methods

Electric and magnetic field strengths were recorded at intervals along a span, with the measurements taken in a direction normal to the line and at a height of 1 meter above the ground. From the maximum sag point of the span under the line to a lateral distance of up to 50 m from each of the double circuit transmission lines or to a distance of the insignificant field, lateral profile measurements were taken at regular intervals. The profiles were also measured at regular intervals throughout the double-circuit line and electric and magnetic fieldintensities were measured along the line at a height of 1 m to get a longitudinal profile that runs parallel to the ground. Beginning at the point of greatest sag and continuing in both directions for a distance equivalent to one span, longitudinal profile measurements were taken [17].

At the high-voltage substation, power transformers, CT, PT, circuit breakers, reactors, earth switches, transport couplers, lightning arrestors, and others were measured around their perimeter at 1 meter above ground level and 1 meter away [17]

B. Measurements of three different sites in Oman

Electric and magnetic field profiles have been recorded longitudinally and laterally in the Sultanate of Oman's three regional areas, Al Buraimi, Khaboora, and Rustaq, whichare close to 132 kV power lines.

LINE 1: AL BURAIMI SUBSTATION TO AL BURAIMI INDUSTRIAL ESTATE.

Electric and magnetic field strength measurements were taken in both lateral and longitudinal profiles, and the results are displayed in Table 2.

Table 2. Displays information on Line 1

Circuit	**Voltage(kV)**		**Load (MW)**	
	Lowest	*Highest*	*Lowest*	*Highest*
1	132.9	133.6	6.5	7
2	132.5	134	6.5	7

The towers utilized for measuring were situated precisely 2 km away from the Al Buraimi substation and toward the Industrial Estate. Between towers numbers 1 and 2, the ground was plain and covered in fine sand. At the time of measurement, temperature and the relative humidity were respectively 24.7^0 C and 60.3%. The location of the Line 1 tower, the line profile, and its single conductor two circuits are shown in Figure 6.

Figure 6. 132 kV Single conductor double circuit of Line 1

LINE 2: KHABOORA DEEL ABDULSALAM STATION (DAS) TO KHABOORA INTERCONNECTED SYSTEM.

Electric and magnetic field strength measurements were taken at both lateral and longitudinal profiles, and theresults are displayed in Table 3.

Table 3. Displays information on Line 2

Circuit	**voltage(kV)**		**Load (MW)**	
	Lowest	*Highest*	*Lowest*	*Highest*
1	132.9	133.6	7	8.5
2	132.5	133.8	6.5	8

The measuring towers were located exactly 11 kilometers from the Deel Abdul Salam substation and 3 kilometers from the Khaboora interconnected substation. The towers have the numbers 52 and 53, and the ground was uneven and covered with rocks. At the time of measurement, the temperature and relative humidity were, respectively, 31.7^0 C and 47.4%. Figure 7 displays the location of the Line 2 tower, along with the line's profile and twin conductor, double-circuit configuration as in figure 7

Figure 7. 132 kV Double conductor two circuits of Line 2

Line 3: Rustaq 132 kV substation to Rustaq city.

Electric and magnetic field strength measurements were taken in both lateral and longitudinal profiles, and the results are displayed in Table 4.

TABLE 4. Displays information on Line 3

Circuit		Voltage(kV)	Load (MW)	
Highest	Lowest		Lowest	Highest
1	133	133.8	13.2	13.6
2 .	133.5	134	12.5	13.34

The substation and Rustaq city were both exactly 7 and 5 kilometers away from the measuring towers, respectively. The land was unlevel and covered in pebbles, and the towers bear the numbers 15 and 16. The temperature and relative humidity were 33^0 C deg and 46.2%, respectively, at the time of measurement. The location of the Line 3 tower, the lines profile, and its twin conductor, double circuit design are all shown in Figure 8.

Figure 8. 132 kV Double conductor two circuits of Line 3

3. Results

The longitudinal and lateral profiles of Line 1 (Al Buraimi), Line 2 (Khaboora), and Line 3's (Rustaq) electric and magnetic fields are depicted in Figures 9, 10, 11, and 12 respectively. Three color-coded lines with field distribution graphs are provided to expedite the identification of regions within transmission lines that generate the strongest electricand magnetic fields.

Figure 9 depicts the 132 kV electric field strength values for Line 1(Al Buraimi), Line 2 (Khaboora), and Line 3's (Rustaq). The longitudinal electric field characteristics of lines 1 and 2 are well within ICNIRP standards. The longitudinal profiles of line 3's electric field, on the other hand, have exceeded 6.3531 kV/m, above the 5 kV/m limit. This is because Line 3 (Rustaq) has a greater maximum voltage of 134 kV, a higher maximum load of 13.6 MW, and a higher maximum temperature than for Line 1(Al Buraimi), Line 2 (Khaboora). Line 3 (Rustaq) can carry a maximum load of 13.6 MW, which is about twice as much as for Line 1(Al Buraimi), and Line 2 (Khaboora). Furthermore, the ground between the two measurement towers is clearly uneven and a little rockier

Figure 10 depicts the magnetic field strength levels at 132kV for Line 1 (Al Buraimi), Line 2 (Khaboora), and Line 3 (Rustaq). The longitudinal profile of the magnetic field of lines 1, 2, and 3 is all within the ICNIRP's restrictions. The greatest magnetic field value does not surpass 100 µT since all three lines are loaded to about 50% of their rated capacity.

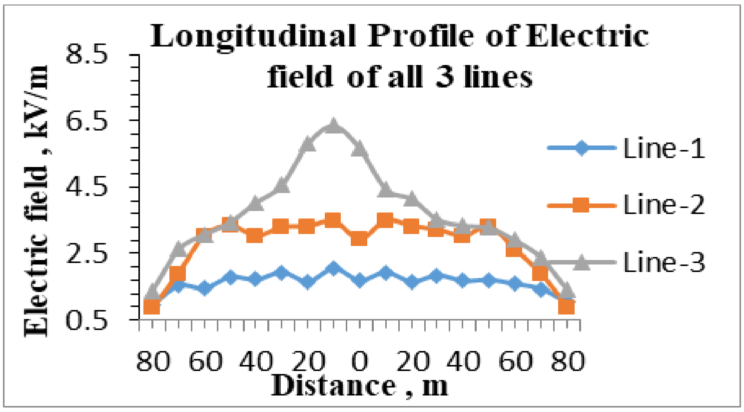

Figure 9. Longitudinal profile of the electric field of all 3 lines

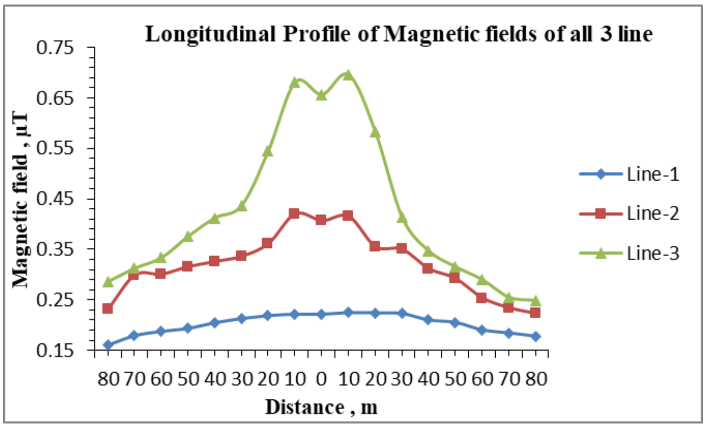

Figure 10. Longitudinal profile of the Magnetic field of all 3 lines

Figure 11 depicts the electric field intensity values for Line 1(Al Buraimi), Line 2 (Khaboora), and Line 3's (Rustaq) at 132 kV. Line 1(Al Buraimi) and Line 2 (Khaboora), have lateral electric field patterns that are substantially within the ICNIRP limitations. Because the lateral measurement starts at the highest sag point of the conductor between the towers, the lateral profile of Line 3's (Rustaq) electric field exceeds the 5 kV/m limit by 5.9325 Kv/m. This is due to the fact that Line 3 (Rustaq) maximum voltage is 134 volts, its maximum carrying load is 13.6 megawatts, and it has a higher temperature than Line 1(Al Buraimi) and Line 2 (Khaboora).

Figure 12 depicts the magnetic field strengths at 132 kV along Line 1(Al Buraimi), Line 2 (Khaboora), and Line 3's (Rustaq) for all three lines. These strengths are in agreement with the strengths measured along the lines. This proves that the magnetic field profiles along Line 1 (Al Buraimi), Line 2 (Khaboora), and Line 3's (Rustaq) are safe according to ICNIRP guidelines.

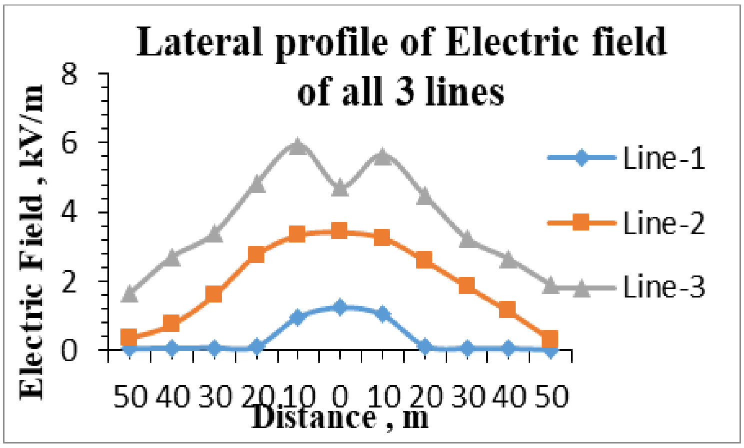

Figure 11. Lateral profile of the electric field of all 3 lines

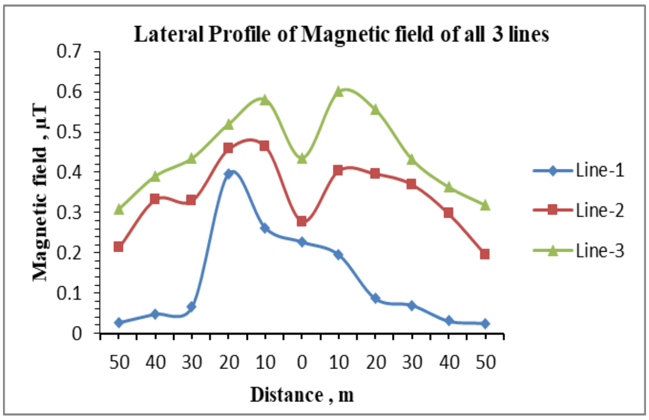

Figure 12. Lateral profile of the Magnetic field of all 3 lines

The measurement results suggest that the public exposure limit to the electric field at the 132 kV transmission line in Rustaq (Line 3) has significantly exceeded the ICNIRP standards, potentially exposing humans and the environment to adverse effects. The longitudinal and lateral observed values of electric fields in Line 3 near 132 kV lines with twin conductor bundles exceed the ICNIRP general public exposure standard thresholds. The highest magnetic field value does not exceed 100 µT since all three lines are loaded to about 50% of their rated capacity, keeping it below the ICNIRP standard limits.

Rustaq 132 kV Substation

The results of the Rustaq 132kV/33kV Substation measurements are shown in the Single Line Diagram (SLD) and Table 5. Data pertaining to temperature and humidity were collected, revealing a temperature reading of 33 degrees Celsius and a relative humidity of 46.2%. The active power and reactive power of transformer 1 are measured to be 114.11 MW and 4.736 MVAR, respectively. Furthermore, the Circuit Breaker, Current Transformer, Transformer Bushings, and Busbar components comply with the ICNIRP regulatory limitations. The rationale for operating the substation transformer at 70% of its rated value, while maintaining normal levels of temperature and humidity, is as follows

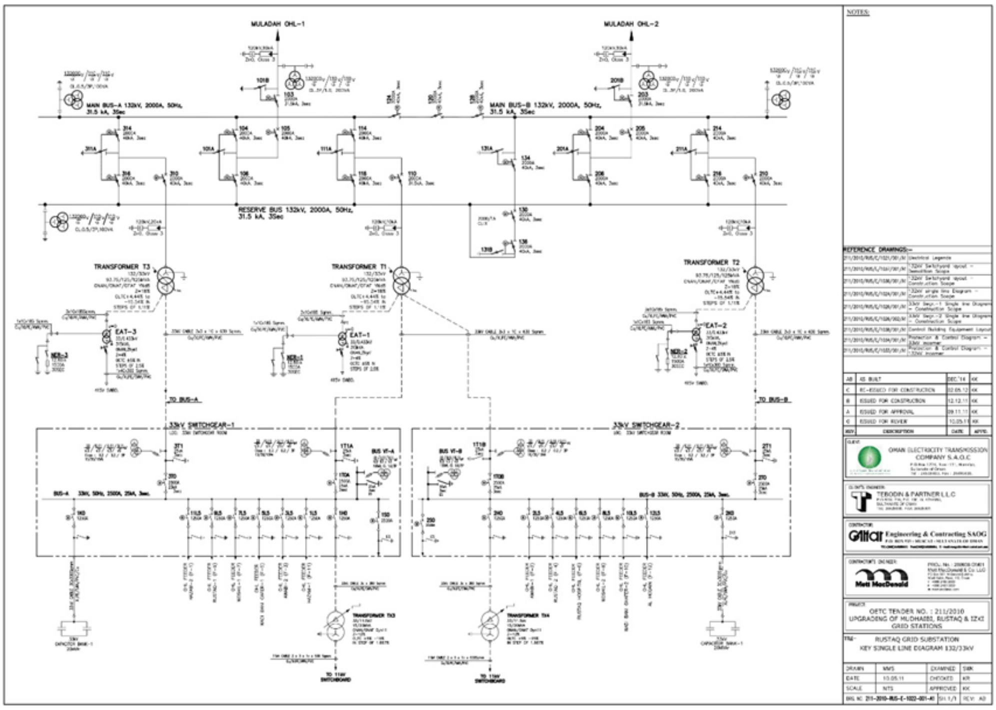

Figure 12. Rustaq single line diagram

Table 5. Electromagnetic fields around the periphery of the equipment

Sl.No	Equipment Name	ID number of the equipment	Electric field strength,kV/m	Magnetic field strength,µT

			R-phase	R-phase
1	125MVA,132/33 kV power transformer 1(outdoor)			
	HV side		0.1169	2.3166
	LV side		0.1386	2.7314
2	Circuit Breaker		5.611	1.5123
3	Current Transformer	ABB,1HSE 8816479	7.8751	0.4811
4	Surge Arrestor		1.4907	0.3123
5	Bushings		5.5079	1.8841
6	Bus - Bars		7.5041	0.3098
7	Capacitive Voltage Transformer (CVT)	ABB 8723514	2.9412	0.7226
8	Earthing Switch		4.0108	0.5842

Al Buraimi 132 kV Substation

The measurements obtained from the Al Buraimi 132kV/33kV Substation are included in both the Single Line Diagram (SLD) and Table 6. The data including temperature and humidity were gathered, unveiling a recorded temperature of 27.5 degrees Celsius and a relative humidity of 41.7%. The measured values for the active power and reactive power of transformer 2 are 53 megawatts (MW) and 2.836 megavolt-ampere reactive (MVAR), respectively. In addition, it should be noted that the Circuit Breaker, Current Transformer, Transformer Bushings, and Busbar components are in accordance with the regulatory constraints set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The justification for operating the substation transformer at 50% of its rated value, while ensuring that temperature and humidity levels remain within normal ranges

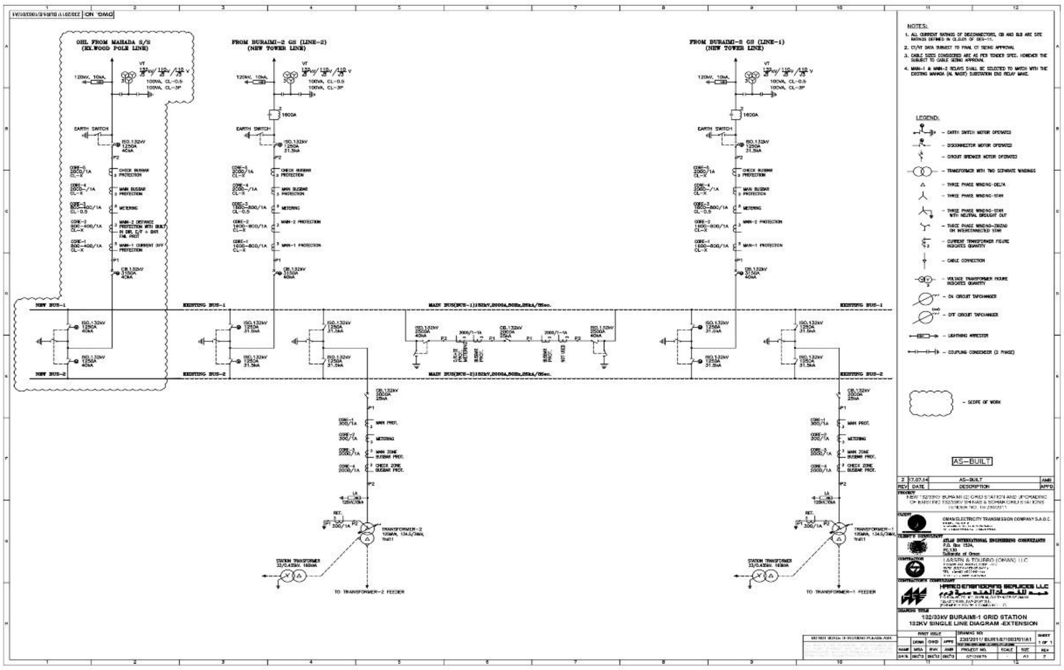

Figure 13. Al Buraimi single line diagram

Table 6. Electromagnetic fields around the periphery of the equipment

Sl.No	Equipment Name	ID number of the equipment	Electric field strength,kV/m R-phase	Magnetic field strength,μT R-phase

1	125MVA,132/33 kV power transformer 2(outdoor) HV side LV side		 0.0116 0.3384	 4.7935 1.535
2	170kV ,Circuit Breaker	LTB 170D1/Bombay 8503137, ABB	6.6578	0.4648
3	145 kV , Current Transformer	1HSC 8802098, ABB	3.6923	0.8878
4	Surge Arrestor	LB 910007 - A, ABB	7.6997	1.4477
5	Bushings		6.143	2.342
6	Bus - Bars		7.5627	0.7062
7	Capacitive Voltage Transformer - CVT	HE 539570, ABB	4.0611	0.8002
8	Earthing Switch		4.0107	0.6854

Khaboora 132 kV Substation

The measurements derived from the Khaboora 132kV/33kV Substation are shown in both the Single Line Diagram (SLD) and Table 7. The data encompassing temperature and humidity were collected, revealing a recorded temperature of 38.6 degrees Celsius and a relative humidity of 35.8%. The active power and reactive power of transformer 1 have been measured to be 54 megawatts (MW) and 4.232 megavolt-amperes reactive (MVAR), respectively. Furthermore, it is important to acknowledge that the Circuit Breaker, Current Transformer, Transformer Bushings, and Busbar components adhere to the regulatory limitations established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The rationale behind operating the substation transformer at 60% of its rated value, while still maintaining temperature and humidity levels within acceptableparameters.

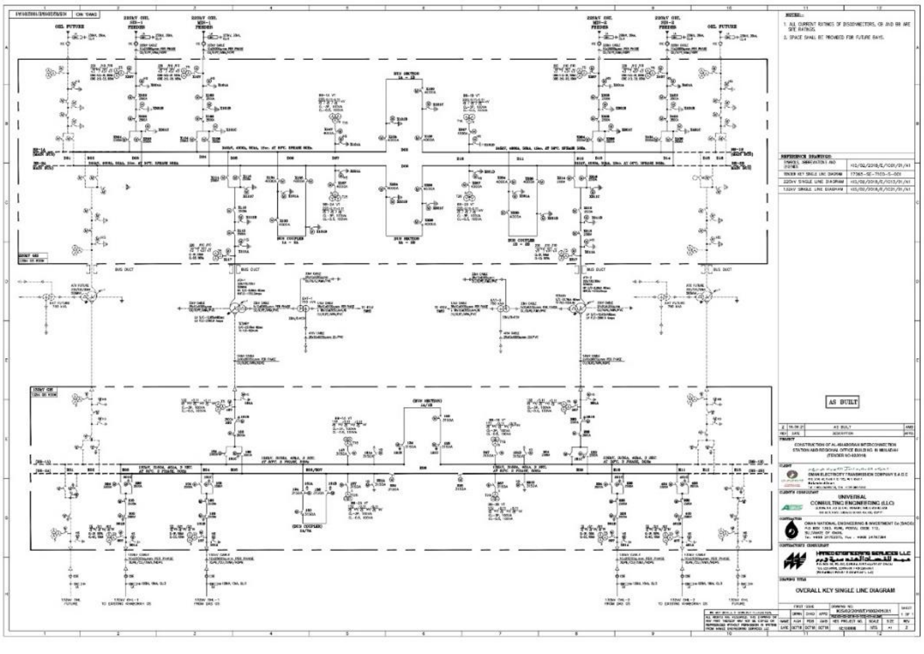

Figure 14. Khaboora single-line diagram

Table 7. Electromagnetic fields around the periphery of the equipment

Sl.No	Equipment Name	ID number of the equipment	Electric field strength,kV/m R-phase	Magnetic field strength,µT R-phase

1	125MVA,132/33 kV power transformer 2(outdoor)			
	HV side		0.00564	5.3735
	LV side		0.26734	3.5864
2	170kV ,Circuit Breaker		7.1673	3.5436
3	145 kV , Current Transformer		6.7914	3.4632
4	Surge Arrestor		7.8531	4.6957
5	Bushings		6.4262	5.6326
6	Bus - Bars		7.5627	4.7943
7	Capacitive Voltage Transformer - CVT		5.4537	3.9684
8	Earthing Switch		5.8356	3.4671

4. Discussions

According to a 2012 study by an Omani researcher, the electric and magnetic fields produced by transmission lines in the Oman power grid are well within the safe exposure levels set by the International Commission for Non-Ionizing Radiation Protection (ICNIRP). The researcher, however, anticipated that future increases in electricity consumption will lead to higher levels of electromagnetic fields in Oman. Therefore, updated risk assessments are required to prevent further radiation exposure [18]. Recent studies have shown that an increase in load over the past decade will cause the Rustaq region (line 3) to rise in elevation by the year 2023. The increase in the allowable electric field strength at the 132 kV transmission line, as determined by our investigation, is due to the fact that In the densely populated area of Rustaq, conductor clearance from the ground has been somewhat lowered due to sagging between the towers brought on by the high temperature and high operating voltage of 132 kV transmission lines (134 kV).

5. Conclusion

Our research indicates that by 2023 the Rustaq area (line 3) will have risen in elevation because of a load increase over the preceding decade. Due to sagging between the towers caused by the high temperature and high operating voltage of 132 kV transmission lines (134 kV), the allowable electric field strength at the 132 kV transmission line has increased in the densely populated area of Rustaq (96335 people). The Rustaq neighborhood (Line 3) is not directly under the 132 kV line conductor, thus locals have nothing to worry about. Taking lateral profile measurements at 30 m on either side of the conductor from midspan will have an impact on the ROW. Potential victims include Rustaq residents and local businesses. According to the results of our survey, residents of the Rustaq area find it challenging to carry out daily activities due to symptoms including severe headaches, extreme tiredness, and dizziness. There is scant evidence that people living in these areas are in danger, and the medical establishment does not consider electromagnetic field exposure to be a cause of sickness. However, a survey on risk assessment is necessary to indicate the strength of the evidence related to exposure and impact, and it must be recorded by the Ministry of Health (MOH), which is primarily responsible for the provision of medical treatment to the people of Oman. The risk assessment will give an idea of how much of an impact on health can be expected from different exposure levels and patterns if a correlation is found. Estimates of both the percentage of the population exposed and the effects of that exposure are necessary to determine whether or not these electromagnetic fields pose harm to human health and the environment.

Based on the findings of this study, several conclusions have been drawn regarding the prevention of sagging, a phenomenon that can exacerbate the strength of electromagnetic fields and represents a possible issue in the Rustaq region.

- Restringing the conductor is essential to keep it at the right height.
- The average sag of the conductors should not be more than 4% different from the norms.
- Furthermore, the sag difference between any two line conductors within the same span cannot be greater than 50mm.
- Spacing between phase and earth must be maintained at 1.57m
- Spacing between sub conductor should be 250 mm.
- The design of the phase in the tower should be a vertical configuration.
- Cross section of the conductor preferably 479 sqm

The three substation regions of the Sultanate of Oman are considered to be in compliance with the requirements defined by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Consequently, it is apparent that none of them are burdened beyond capacity. The efficiency of air conditioners may fluctuate during the summer season, particularly when they are used for extended durations, in order to optimise their performance.The specific goals have been effectively accomplished, and the research has moreover delineated the preventative measures that the power sector need to embrace, alongside a timeframe for the deployment of a smart transmission system by 2030.

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