Challenges in equipotential zonal protection of Micro grid-level entities.

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***Abstract*:** Negligence led to creating a big wave of problems. Pollution, improper handling of health issues is the signs of it. *"Act now, before it is too late"*. The solution to one problem lies in the proper handling of others. Power quality and proper performance of medical equipment are necessary to face the covid pandemic situation. In this perceptive, the paper presents the challenges involved to maintain protective equipotential zone in micro/ nano grid-level infrastructures, which includes the procedures to implement protective earthing for new and embedded PV plant structures and medical infrastructures. The main challenges such as type of infrastructure based on operations, level of power requirement and fault level and the allowable grid resistance. To study the significance of the challenges involved in providing protective earthing, we simulated the variation in fault current handling using specific source and load. The simulation results incorporated with and without a proper protection level.

***Index Terms*— Equi-potential Zone, IEC60364, IEEE STD 80-2000, Medical facilities, Protective Earthing**

I. Introduction

At present, The world facing so many challenges involving health, pollution, socio-economic variations and power issues. problems sometimes interrelated to each other, improving one aspect in one sector can change the performance of another system. In this perspective, we presented the challenges involved to provide a proper protective system for micro/nano grid-level infrastructures. Infrastructures equipped with renewables or integration of several sources requires to check the protection level required to handle hassle-free operations concerning sensitive equipment used.[1]

In particular medical entities the usage of sensitive equipment led to severe dependency on uninterrupted power supply and quality of power, These issues related to the performance of the protective devices and the drain to which plays important role in draining the unwanted abnormalities at the time of testing and using. Furthermore the analysis of equipotential zone scheme for the instructure is mandate the threatens that occurs in future.

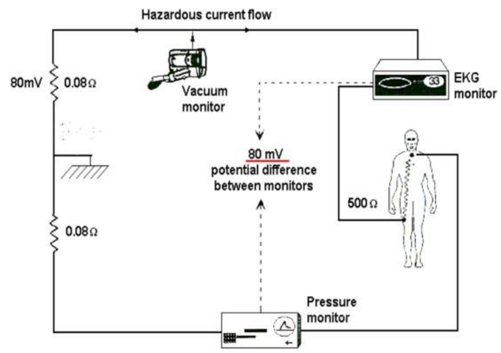

Fig 1: Role of Equipotential zone for sensitive equipment

II. Challenges involved To provide Protective Equi-potential Zone

The world is fighting against Covid-19; in this pandemic situation, health emergency services and uninterrupted power supply plays an important role. Without quality in power and communication signals, We experience mal-operation of sensitive equipment and fire hazards and frequent interruptions.[2] Electrical equipment in emergency services needs proper earthing and equi-potentisation. The earthing system designed based on the type of infrastructure and level of fault currents at the site.[3][4][5][6] The main challenges involved in providing proper protective earthing are 1. Proper grounding of sensitive equipment 2. Type of installation and site specifications 3. Fault level and environmental impacts.

According to the type of infrastructure, There exist two cases

1. Embedded with existed infrastructure
2. New infrastructure

A. Fault Currents

1. Direct contact

A person or animal should be in touch with the live conductor. Usually, this protection provides using high sensitive residual current device. However, this direct contact parameters do not depend on the earthing system design.

2. Indirect Contact

It occurs when the person in contact with an exposed conductive part. These fault currents are severe when their upper limit exceeds. It happens because of insulation failure.
To reduce the effect of direct and indirect contacts, IEC (International elec

1. TN system (Exposed conductive parts to neutral)
2. TT (Earthed neutral)
3. IT (Impedance earthed /unearthed neutral)

B. Embedded with Existing Protective System

In this case, the electrical components should be analysed based on the extraneous conductive parts and bondings data from previous electrical drawings. If the surge protective devices and risk analysis should perform before installations. If the risk is within the limits and building equipped with the required number of surge protecting devices and electric components and IT system, then measure the grid resistance. In order to overcome several issues like faults and EMI. The resistance of the grid should be less than 0.5 ohms. If the resistance of the earthing grid is more than 5 ohm, we should be cautious. If the limit exceeds further, then extra installations of earth pits should be done as per the requirements of the medical infrastructure.

C. *New Existing Protective System*

In this case, the design of the earthing grid decided by the essential survey data related to the area where we are going to install. Measure the earth resistance using wenner method if the grid resistance is not in an allowable limit. Study the effects of dynamic soil characteristics and rainfall data of the proposed infrastructure. Design the model and number of rods or horizontal electrodes/pipes accordingly. If space is limited then go for earth enhancers to reduce the earth resistance

TABLE I
ELECTRIC SHOCK HAZARDOUS LEVEL

50 Hz Current mA (AC)	Direct Current mA	Effects
0.5- 1.5	0-4	perception
1-3	4-15	shock
3-22	15-88	Reflex action
21-40	80-160	Muscular Inhibition
40-100	160-300	Respiratory Block
Above 100	Above 300	Fatal

III. Role of Equi-potential Zone In Micro/Nano Grid Level Infrastructures

A. *Medical Infrastructures*

Reliable and hassle-free operations in hospitals depend on power quality, continuity and energy management. The nuisance created by the power interruptions not only creates gap technically but also led to life-threatening. So, we should focus on these factors to get efficient, safe hospital environment. IEC 60364-7-710 deals with the requirements of electrical systems in class 2 medical environment. These class of medical environment is the risk for the patient, and the protection should be involved with some additional protective measures compare with traditional buildings. [1]

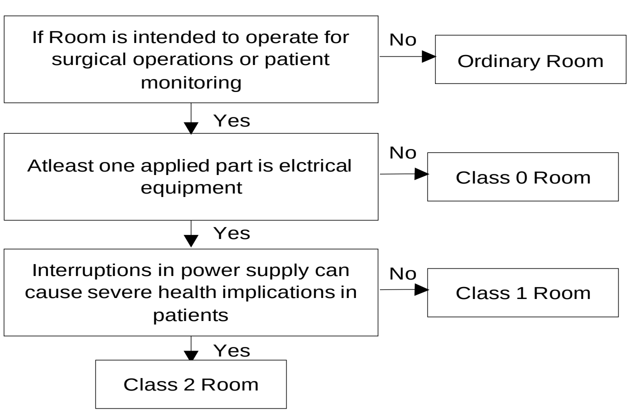

Fig 2: Room identification Flow Diagram

Classification based on applied parts: [IEC 60364-7-710,Definition 710.3.4][8]

1. CF: This equipment comes under class 2 medical room, where we should be more cautious. In such a system the electrical equipment in contact with the person is insulated
2. BF: The electrical equipment not used for direct contact with the person as the degree of safety is lesser than CF devices though the device electrically insulated
3. B: The medical equipment not preferable to direct contact with the person as it is not insulated w.r.t earth and leakage current flows

B. *PV Infrastructures*

Pv system should be embedded with existing power plants, to ensure the safety we can check and access the basic earthing procedure, earth resistance and the frequency-dependent soil characteristics.[9][10] Here we encounter two cases

1) *Already installed area*

Electrical resistance should check whether it is in permissible limit or not if it is ok then, no need of installing new, otherwise we can install new earth pits accordingly.

1. If the earthing system installed, then check whether the installation and safety parameter values are adequate for PV plant
2. Take necessary actions to enhance the performance of earthing system installations, if the quality of the earthing system does not meet the requirements
3. By the proper study of existing earthing scheme and installations, electric drawings of it give information for further research
4. Measure the grid resistance using ammeter method/ fall of potential method.
5. If $R< 5$; it is suitable for PV plants. If $5<R<50$; then we should improve the earth resistance using ground enhance materials. Need extra pit installations

2) *New Installation*

The purpose earthing is to enhance the safety requirements and reduces the danger for equipment and person and malfunction of power electronic equipment. Faults are different, so the earthing should be done accordingly. It provides safety, the fixed reference voltage for equipotentialization, protection to the sensitive equipment and quality communication signals. Factors such as humidity, temperature, type of soil, climatic conditions, and security distance from buried electrical and gas installations. Most of the PV plants designed to embedded with existing power station infrastructure. In some places, earthing practices are lacking so that we should check the safety requirements at the site. Based on the information, we should decide to upgrade it with some new pits or else continue with the same or requirement of the new design.

1. Site specification study and study of extraneous conductive parts and bonding of electrical equipment, types of loads connected
2. Other factors such as humidity levels, frozen earth, ageing of the materials used for installations, oxidation of welded points
3. Select of earth electrode installation method as per safety requirements

IV. Simulation Results and Validation

As mentioned in Section II, It is clear that Proper grounding Results in low EMI and power quality issues in case of sensitive equipment in health, microgrid /nano grid infrastructures. Grid resistance under abnormal conditions plays a significant role. To analyse the system performance with and without Proper grounding performed in MATLAB 2016 b.

TABLE II
SPECIFICATIONS DETAILS

Vrms (Phase to Phase)	500e3
Three-phase short circuit level	100e6
X/R ratio	15
Frequency	50 Hz
Fault resistance	0.001
Snubber resistance	1e6 ohm

A. Simulation Results without proper Grounding

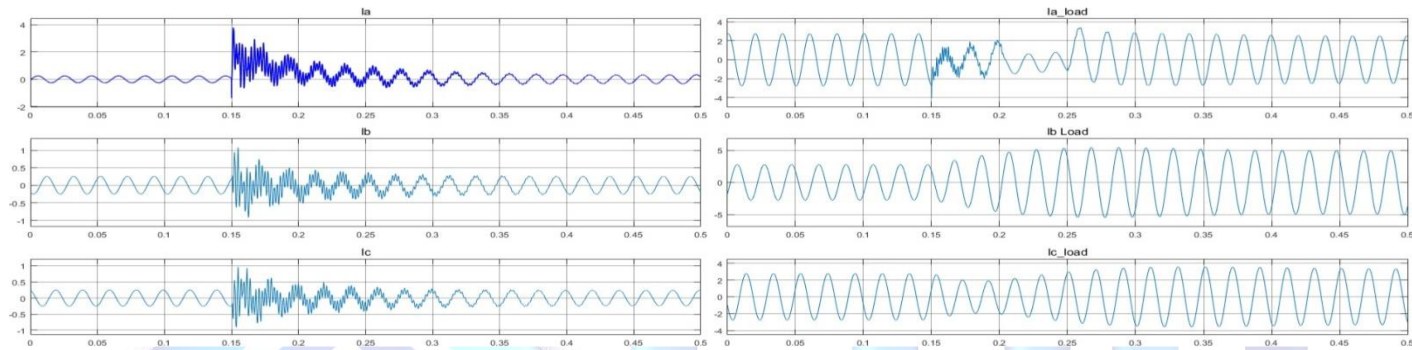

Fig 3: Fault currents (Source side and load Side) Without Proper grounding

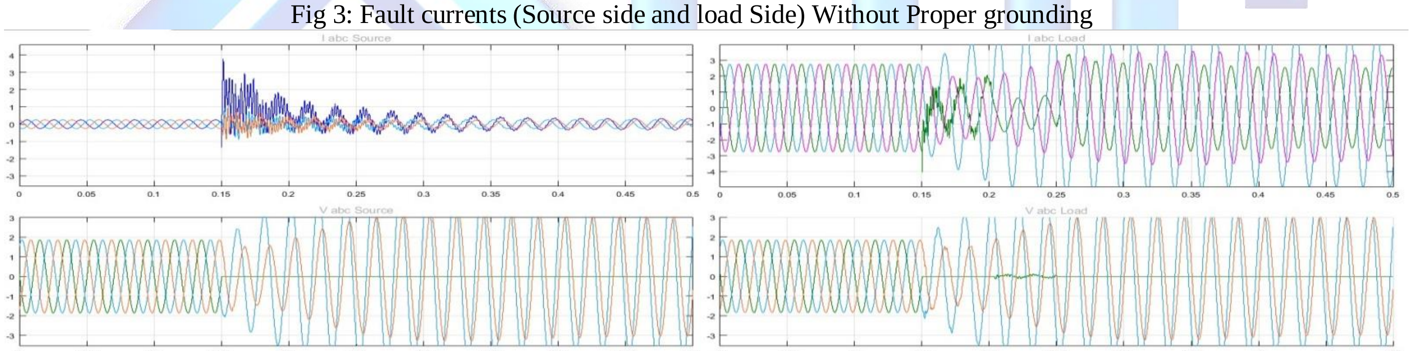

Fig 4: Fault currents and voltages at Source side & load Side improper grounding

B. Simulation Results with Proper Grounding

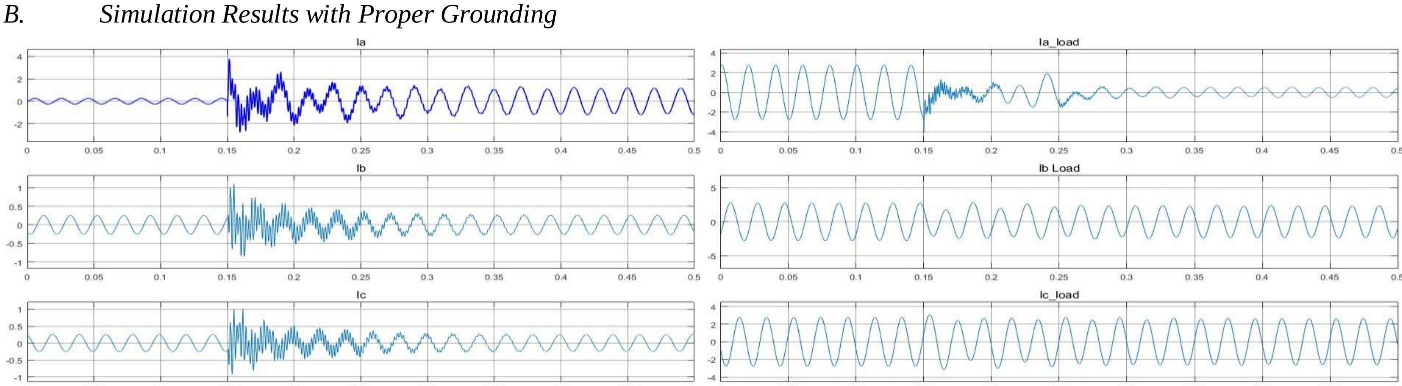

Fig 5: Fault currents and voltages at Source side & load Side With Proper grounding

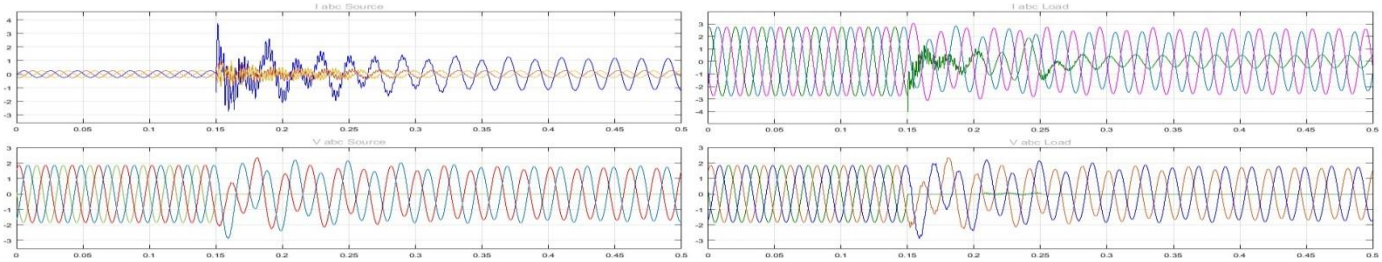

Fig 6: Fault currents and voltages at Source side & load Side With Proper grounding

Table II represents the specifications used for the study to evaluate the dependency of proper grounding in medical and other sensitive equipment used in micro/nano grid level. The variations in line to ground fault with proper grounding at the source side and load side incorporated in Fig 5, 6. Fig 4,5 represents the variations in fault currents at source and load with improper grounding. In Fig 5, the phase to ground fault occurs in phase a the fault current variation under-switching time 0.15 to 2 s is different from the Fig 3 fault current variations. It is clear that reliable operation of the sensitive equipment connected depends on the grid resistance value and proper grounding. Proper grounding and permissible grid resistance allow the user to get rid of the problems associated with protective earthing and overcome the challenges involved in providing equipotential zone.

V. CONCLUSION

The paper presents the challenges involved in providing proper protective earthing system for micro/ nano level structures. The challenges and procedures for proper earthing for medical and PV structures explained in brief. To study the effect of grid resistance, the simulation results with and without proper grounding incorporated here. The simulations performed in Matlab 2016b software. This study presents the role of protecting earthing procedures for embedded and new infrastructures under several abnormalities. The room identification and necessity of equi-potential zone for protective earthing in medical infrastructures explained.

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