Three-phase voltage dips in load nodes of the electrical network of the Santiago de Cuba province measure for its correction

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ABSTRACT

The growing need to supply quality electrical energy to end-users has given rise to various studies and research on the technical parameters that this energy should possess. In addition, many users perceive that many of the problems in the operation of their household appliances are related to the quality of the electrical energy that reaches their homes. One of the fundamental problems affecting the quality of electrical power is the so-called voltage dips, which are nothing more than disturbances of great relevance due to their direct consequences, secondary effects, and frequency of occurrence. In this research, a study is conducted to evaluate the occurrence of three-phase voltage dips in a simplified electrical network in Santiago de Cuba, Cuba. As a result, the Santiago Norte substation presents the most detrimental behavior. In addition, 50% of the simulations performed on the behavior of the Santiago East Substation, which handles a voltage of 13.8 kV, showed that it is the substation where the deepest voltage dips occur. Based on the results obtained, it has been decided to change the transformer tapping of the affected substations to reduce the occurrence of voltage dips and ensure stable operation in the event of three-phase faults in the power system under analysis.

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1. INTRODUCTION

With the advancement, diversification, and proliferation of electronic devices and appliances connected to industrial electrical systems, an increasing number of pieces of equipment are becoming sensitive to voltage dips. These devices include computer equipment, command and control elements, speed control devices, and frequency inverters, all of which play a crucial role in production processes. Therefore, their proper functioning is vital for achieving an efficient and uninterrupted operation [1], [2].

Electric power is a service that must meet specific quality criteria. However, determining the parameters corresponding to the quality criteria for electric power is a complex task. This is so much so that, even though this issue has been formally addressed for several decades, there is no universal consensus on how to quantify the quality of electrical energy [3], [4]. However, within the electricity sector, some theories have become more widespread than others. For example, some theories have been used to describe the quality of electricity service, which is divided into the continuity of supply and the quality of the product. The first is associated with interruptions, and the second is with the voltage waveform [5]–[9].

The growing need to supply users with quality electrical energy has led to extensive research and debate on the technical aspects that should be determined. In addition, users of electrical energy have a growing perception that part of the problems with their electrical appliances' operation has to do with the electrical network to which they are connected [10], [11].

One of the problems that affects the quality of the electrical product is voltage dips, which are also highly relevant disturbances due to their direct consequences, secondary effects, and frequency of appearance [12], [13]. According to Alvarez and Gómez [14], a voltage dip is a transient voltage reduction to magnitudes between 90% and 10% of the nominal value. The equipment disconnected from the electrical service due to these voltage reductions is called sensitive equipment. Today, in power systems, the incidence of voltage dips is high, being considered by some authors as responsible for about 80% of users' claims to electricity companies due to transient disturbances that have led to damage to household appliances. In addition, Alvarez and Gómez [14], it is stated that due to the high sensitivity of electronic equipment with digital clocks, there is an increasing tendency for instantaneous reconnection of the protections that clear the faults, which generally have a response time between 0.3 and 0.5 seconds.

Sometimes, the electrical protections can produce an unwanted trip that isolates elements of the power system, leading to more problems than solutions. This is particularly true in the case of the disconnection of small, dispersed generators connected in parallel with the electrical network, known as distributed generation (DG). According to the definition of the Institute of Electrical and Electronics Engineers (IEEE), which is one of the best known, DG "is the generation of electricity through facilities that are sufficiently small compared to large generation plants, so that they can be connected almost anywhere in an electrical system" [15].

In this sense, it is essential to consider that in the introduction of DG in electrical distribution systems, in addition to the economic benefit, the reliability, security, and quality of supply in the distribution system must be ensured, which must comply with the technical restrictions of the operational criteria. In some DG sites with non-conventional sources as their primary source, which are variable and uncontrolled, such as wind or solar energy, there is no guarantee that the operational criteria will be met [16]–[20].

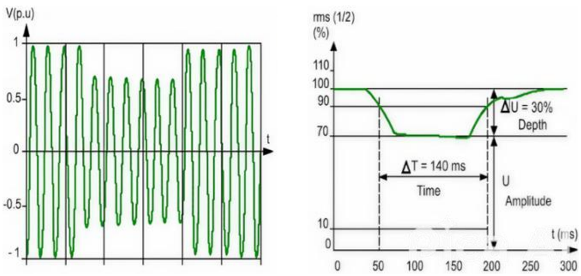
The present investigation presents a study to determine the triphasic voltage gaps in the nine load nodes of the simplified electrical network of Santiago de Cuba, Cuba, and proposes measures to correct these voltage gaps. These analyses are performed with the professional Power System Xplorer (PSX).

2. METHOD

2.1. Conceptualization of voltage dips

Voltage dips are the most frequent disturbances in the electrical network. Generally, several voltage dips per year can be expected at the grid connection point of a typical industrial site. Usually, the voltage of the electrical network oscillates around its nominal value with variations included in a maximum range of ±10% of said value. According to Rauf and Khadkikar [21], Al-Ammar *et al*. [22], a voltage dip is the sudden reduction of the voltage value in one or more phases of the transmission lines, followed by a rapid restoration to its nominal value after some time between half a period of the signal and 1 minute.

According to IEC TR [23], for the voltage reduction to be considered a dip, the value must be between 1% and 90% of its nominal value. A value below 1% is usually a short interruption. Voltage dips are typically characterized by their depth and duration, as shown in Figure 1(a). Depth measures relative voltage reduction and is measured at the deepest point of the dip. In the example of Figure 1(b), the voltage decreases to 70% of its nominal value, considering that the hole has a depth of 30%.



(a) (b)

Figure 1. Characteristic parameters of a voltage dip; (a) depth and duration; (b) example of a 30% voltage dip [13]

The voltage is usually measured by its practical value calculated for each half period, RMS1/2, so the minimum duration for a voltage dip is set at half a period. The duration is when the voltage is less than 90% of the nominal value. In Figure 1(b), the gap lasts 140 ms.

2.2. Origin of voltage dips

Electrical networks connect electrical energy generation with its consumption through conductors that are inductive by their very nature. Any increase in the electric current that circulates through them causes a decrease in the voltage value. Typically, these dips are small enough for the voltage to stay within its standard operating range. Sometimes, however, a large current can cause the voltage to go out of tolerance, causing a voltage dip to appear [24], [25].

According to Tu *et al*. [13], the most frequent causes of voltage dips in electrical networks are short circuits caused by faults in the ground or between two conductors of said networks. These faults represent 70% of the voltage dips and short-term interruptions in power lines. They are mainly due to lightning strikes, contacts caused by animals or tree branches, and meteorological phenomena such as strong winds, heavy rains, or snow. These faults produce voltage drops whose depth decreases depending on the distance from the fault. The actuation of resettable circuit breakers or main fuses prevents them from lasting long-term. Other causes of the appearance of voltage dips are given by the connection of large transformers, which at the time of start-up can absorb a reactive current more significant than ten times their nominal current, and, very rarely, failures of the voltage regulators installed in the transformers of the transmission and distribution networks.

As can be seen, practically all the voltage dips are due to the circulation of large currents through the electrical network, which causes voltage drops in the network's impedance. Although the causes of these currents are very diverse, from the point of view of the electrical network, the effect produced by all of them is the same, and they are characterized by a decrease in voltage whose depth depends on the current magnitude and phase, and on the network impedance. In three-phase networks, voltage dips can be divided into two large categories, symmetrical and asymmetrical, corresponding with the type of fault that originates them [13], Figures 2(a)-(c).

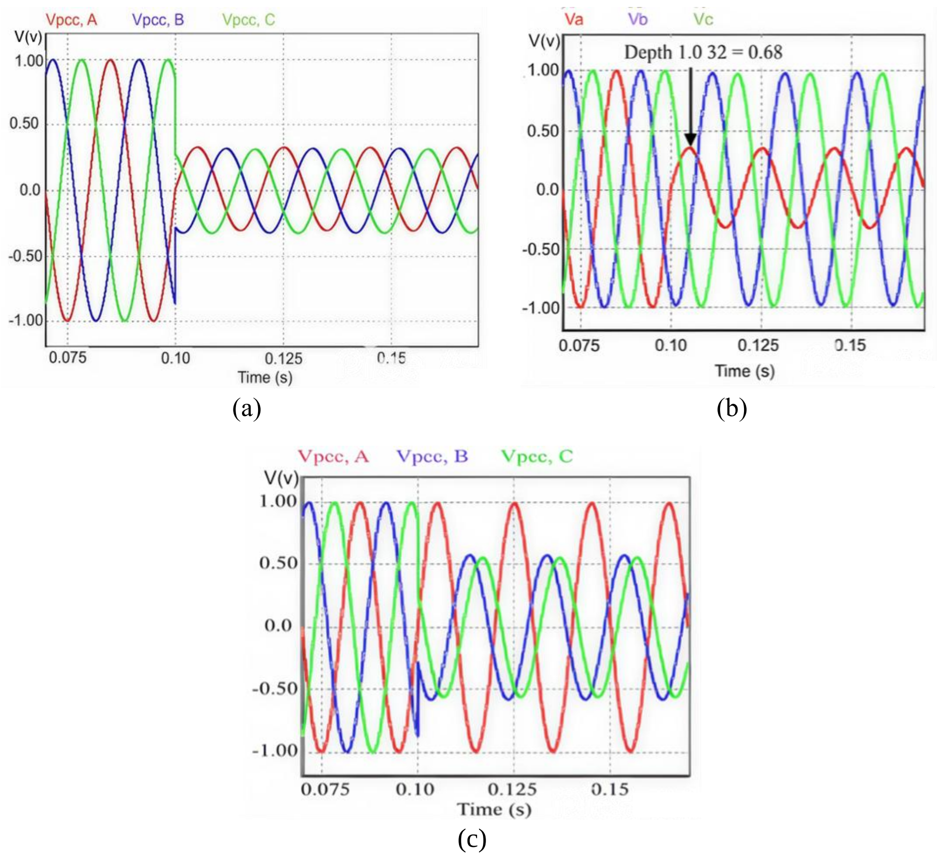


Figure 2. Voltage signal waveforms; (a) waveform of the voltage signal when asymmetric dips occur in three-phase networks, (b) a single-phase asymmetrical dip occurs in phase A, and (c) during a two-phase asymmetrical dip occurs in phases B and C

As shown in Figure 2(a), when symmetrical dips occur in three-phase networks, the voltages of the three phases decrease in the same proportion. Asymmetric dips happen when the voltage drops of the three phases are unequal and unbalanced. The most common asymmetric sags are usually single-phase sags that only affect one phase (Figure 2(b)), and bi-phase voltage sags where two phases are affected (Figure 2(c)).

Most electrical network faults are caused by short circuits between a phase and the ground. A lightning discharge, for example, often produces an overvoltage value sufficient to cause an electric arc between the line and the metal support that supports it. As the towers are connected to the ground for their protection, the ignition causes a short circuit between the line and the ground, called a single-phase ground fault [26]-[28].

Two-phase faults usually consist of short circuits between two phases that can be caused, for example, by an electric arc between two phases of a line when they are brought too close together due to a gust of wind [29], [30]. Finally, symmetrical faults occur when large currents flow through the three phases of a line. These currents can be caused by large load starts or accidents involving the same line's phases [31]-[34].

2.3. Voltage dip parameters

Research by Bagheri and Bollen [35] states that several parameters must be considered when describing what characterizes a voltage dip and what differentiates it from other phenomena that occur in the voltage wave. One of the main parameters that characterizes voltage dips is the difference between the voltage value during the voltage dip and a reference value, commonly the nominal voltage (U_n) or the declared voltage (U_c). The different existing regulations consider that the voltage must fall below 90% of the voltage taken as a reference for it to be hollow. If this is not the case, there would be voltage variations or fluctuations [15], [16].

It is also essential to specify the maximum depth of the dip to establish the border between the voltage dip and the interruption (voltage zero). According to EN 50160:2010 [36], a voltage that drops below 1% of the reference voltage is considered an interruption and, otherwise, a dip. Set the limit to 10% [37].

Another important parameter that characterizes voltage dips is when the voltage falls below 90% of the reference voltage value. In references [23], [36], the lower limit is defined as half a cycle, which is the minimum duration over which the practical value of the voltage can be assessed. According to IEC TR [23], a voltage dip is described as lasting "a few seconds," while in [36], it is specified to last for 1 minute. The difference in dip duration between the two standards is associated with the causes of the dips and the trip times of the protection devices, as noted in reference [38].

It is important to note that most standards categorize voltage dips based on their duration, particularly those lasting less than one second. For instance, standard [36] defines the duration as less than 1 second, while [23] specifies it to be between 100 milliseconds and 1500 milliseconds, and [38] also sets it at 1 second. IEC 61000-4-11:2020 [39], voltage dips are classified according to their duration: instantaneous dips, which last between 0.5 and 30 cycles (approximately 8.3 milliseconds to 0.5 seconds); momentary dips, which occur within a range of 30 cycles to 3 seconds (from 0.5 seconds to 3 seconds), and temporary dips, lasting from 3 seconds up to 1 minute. This classification helps in understanding the different types of voltage dips.

The reference value (U_{ref}) allows voltage drops to be expressed in percentage values to compare different points and voltages [40]. According to EN 50160:2010 [36], applying the following definitions to the reference voltage is possible. The supply voltage is the practical value of the voltage at a given instant at the supply point. The nominal voltage (U_n) is the voltage value that characterizes or identifies a network and references specific operating characteristics.

The declared voltage (U_c) corresponds to the network's nominal voltage (U_n). If, by agreement between the distributor and the customer, the applied supply voltage differs from the rated voltage, this corresponds to the declared supply voltage. The depth of the hole is defined according to (1):

$$\Delta U(\%) = \frac{U_{ref} - U_{min}}{U_{ref}} \times 100 \quad (1)$$

U_{ref} is the reference voltage, U_{min} is the minimum voltage, and ΔU is the depth of the hole.

When significant disturbances occur in an electrical power system (EPS), such as symmetrical and asymmetrical faults in lines and bars, voltage dips occur in the nodes during the transitory process from the fault until it is eliminated [41], [42].

3. RESULTS AND DISCUSSION

The case study developed to evaluate voltage dips analyzes a simplified electrical network of the Santiago de Cuba province that presents high (110 kV and 220 kV) and medium voltage (34.5 kV and

13.8 kV) levels. This network receives electrical energy from the rest of the interconnected national system (INS) through the Cueto link node, the reference node of the analyzed system.

Other generating plants of different natures are also connected to the analyzed electrical network, including Diesel and fuel-il generator sets and photovoltaic plants, constituting the DG of this simplified system [43]-[46]. Table 1 shows the operating data of the load nodes during hours of maximum demand, with an average power factor in the load of 0.91. These nodes will be used to study the possibility of voltage dips and their classification.

Table 1. Data of the nine load nodes of the simplified network of the province of Santiago de Cuba

Electrical substation	Vop (kV)	P (MW)	Q (MVAr)	S (MVA)	PF
1. Stgo industrial	34.8	6	3.73	7.06	0.84
2. Palma	14	8.22	3.48	8.93	0.92
3. Stgo Oeste	13.7	12.14	4.4	12.91	0.93
4. Stgo Norte	13.4	17.39	6.65	18.62	0.93
5. San Luis	34.5	21.71	12.04	24.82	0.87
6. Pavón	14	25.17	11.7	27.76	0.91
7. Stgo Este 13.8	14.3	19.81	7.74	21.27	0.93
8. Stgo Este 34.5	34.5	6.86	2.79	7.04	0.97
9. Contramaestre	33.8	27.06	10.59	29.06	0.93

Various dynamic simulations were conducted to investigate the presence of triphasic gaps in the nine load nodes of the simplified network in Santiago de Cuba. First, a three-phase fault was simulated at the bus of one of the substations or load nodes. The voltage behavior during the transient process in the remaining load nodes was then observed to identify which nodes experienced gaps under tension. This analysis will help in proposing corrective measures for these issues.

The technical standards referred to in [26], [36] consider whether the voltage drop is classified as a voltage dip since they contemplate the occurrence of a voltage dip when the voltage value is between 1 and 90 % of the face value. A value below 1% is considered a short interruption and above 90% is within the normal operating range. Using the professional software PSX, a run of the system's power flow was carried out with all the transformers in the neutral position of the tap changer. Under these operating conditions, the Santiago Industrial and San Luis substations had overvoltages of 1.05 p.u. and 1.04 p.u., respectively. The taps of the transformers were adjusted until they reached values of 1 p.u.

Once the voltages in these substations were adjusted, a three-phase fault was simulated in each of the substations separately, and the voltage deviation in the rest of the substations was observed. The results obtained from the simulation are shown in Table 2.

Table 2. Data of the voltage deviation in the nine load nodes in relation to the three-phase fault in a substation

Sub station	Triphasic fault (Vop/Vgap) (p.u.)								
	1	2	3	4	5	6	7	8	9
1	0	0.83	0.96	0.97	**0.91/0.87**	0.7	0.96	0.96	0.92/0.9
2	0.96	0	0.96	0.96	0.91/0.91	0.69	0.96	0.96	0.92/0.91
3	0.94	0.82	0	0.95	**0.9/0.89**	0.68	0.94	0.94	0.93/0.9
4	**0.92**	**0.8**	**0.92**	**0**	**0.88/0.87**	**0.66**	**0.92**	**0.92**	**0.89/0.88**
5	0.96	0.83	0.96	0.96	0	0.7	0.96	0.96	**0.92/0.89**
6	0.96	0.83	0.96	0.97	0.92/0.9	0	0.96	0.97	0.93/0.92
7	0.94	0.83	0.94	0.95	**0.92/0.85**	0.69	0	0.94	0.91/0.88
8	0.95	0.82	0.95	0.95	0.9/0.91	0.68	0.95	0	0.91/0.92
9	0.95	0.82	0.95	0.95	0.91/0.9	0.7	0.95	0.95	0

Table 2 shows the simulation results of the three-phase fault in each of the substations, observing that voltage dips occurred in the substations of 1-Santiago Industrial, 3-Stgo Oeste, 4-Stgo Norte, 7-Stgo East 13.8 kV, and 8-Stgo East 34.5 kV. There were no voltage dips in the rest of the substations since the voltage decrease in each was above 90%.

The Stgo Norte substation has the most significant dynamic instability due to three-phase faults in each load node, since the most considerable voltage deviations occur, having four scenarios where voltage dips occur. Table 2 shows that voltage dips also happen at all nodes when a three-phase fault is simulated at the Palma substation because there is a decrease of 0.8 p.u.

In this study, the worst scenario is obtained when a three-phase fault occurs in the 13.8 kV bus of the Pavón substation; since voltage dips below 90% of the rated voltage (Vn), the operation of the protection network in the post-fault regime does not exist, since all the protections must trip due to low voltage, as shown in Figure 3. Figure 4(a) shows the voltage dips occurring in the remaining nodes when a three-phase fault is simulated in the San Luis substation. Figure 4(b) shows the voltage dips occurring in the remaining nodes when a three-phase fault is simulated in the Contramaestre substation.

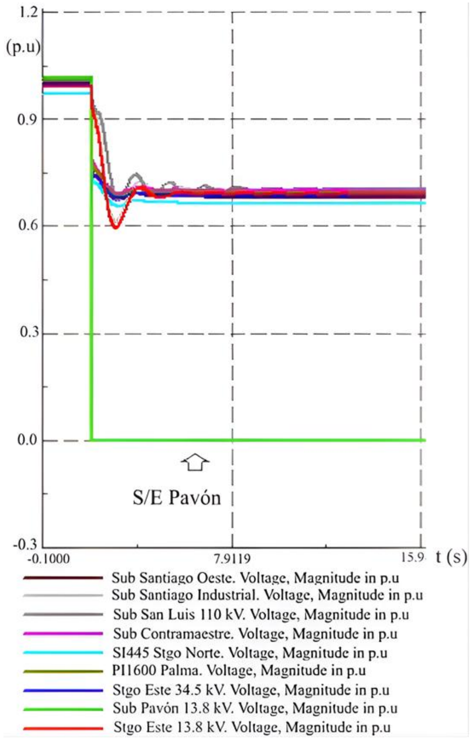


Figure 3. Voltage dips occurred in the nine nodes due to the failure of the Pavón substation

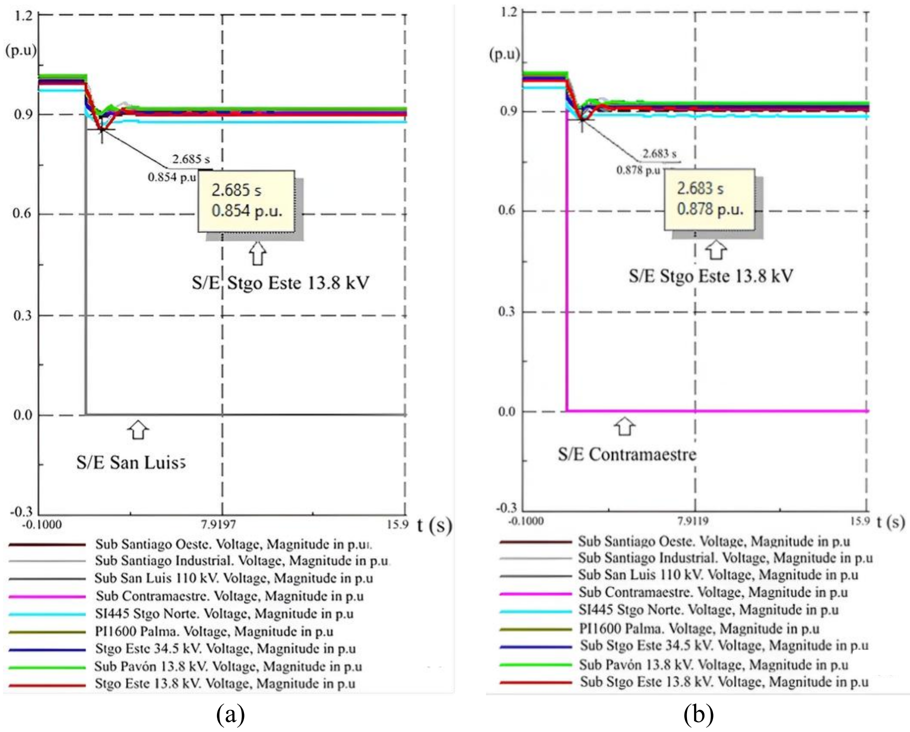


Figure 4. Voltage behavior at the load nodes; (a) in the event of a three-phase fault at the San Luis substation and (b) in the event of a three-phase fault at the Contramaestre substation

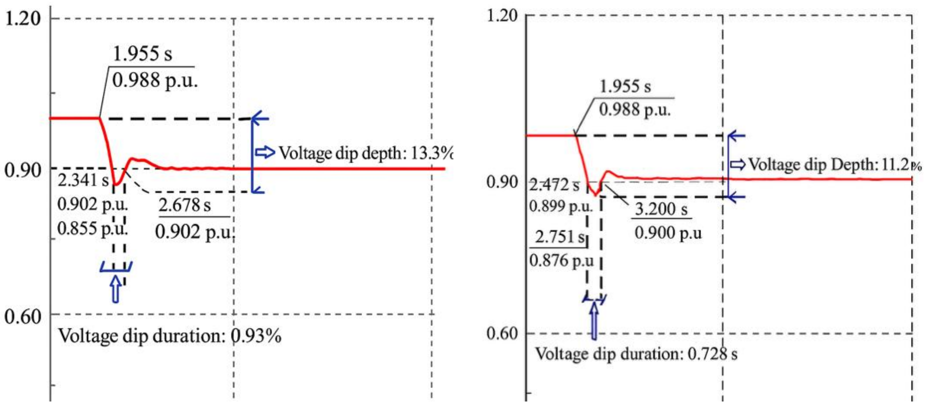
Table 3 shows the data obtained when a three-phase fault is simulated in the San Luis substation, which brings about voltage dips in the 1-Santiago Industrial, 3-Stgo Oeste, 4-Stgo Norte, and 7-Stgo Este substations. The fault simulation causes the voltage at the Santiago Industrial substation to drop to 0.869 p.u. and the system to be restored to 0.91 p.u. At the 3-Stgo Oeste substation, there was a decrease of up to 0.891 p.u., which was converted to 0.9 p.u. In addition, at the 7-Stgo Este 13.8 kV substation, a reduction of up to 0.854 p.u. occurs, restored when it reaches 0.92 p.u. Lastly, we have the 4-Stgo Norte substation, which has the least favorable behavior with a decrease of up to 0.872 p.u. Under these conditions, the system is not restored because the voltage for which it stabilizes is 0.88 p.u. and is below 0.9 p.u., which is required by the standard.

Table 3. Data of the voltage deviation in the load nodes about a three-phase fault in the San Luis and Contramaestre substations

Substation name	Transformer voltage		Triphasic fault (Vop/Vgap) (p.u.)	
	Vop (kV)	Vop (p.u.)	5	9
1. Stgo Industrial	**34.8**	1.01	**0.91/0.869**	0.92/0.903
2. Palma	14	1.01	0.91/0.908	0.92/0.913
3. Stgo Oeste	13.7	0.99	**0.9/0.891**	0.93/0.904
4. Stgo Norte	13.4	**0.97**	**0.88/0.872**	**0.89/0.882**
5. San Luis	**34.5**	1	0	**0.92/0.892**
6. Pavón	14	1.01	0.92/0.902	0.93/0.918
7. Stgo Este 13.8	13.6	0.99	**0.92/0.854**	**0.91/0.878**
8. Stgo Este 34.5	34.5	1	0.9/0.906	0.91/0.918
9. Contramaestre	33.8	0.97	0.91/0.903	0

Table 3 also collects the data obtained when a three-phase fault is simulated in the Contramaestre substation; due to the fault, voltage dips occur in the San Luis, Stgo Este 13.8 kV, and Stgo Norte substations. The simulation of the three-phase fault causes the voltage at the San Luis substation to drop to 0.892 p.u. and the system to be restored to 0.92 p.u. In the Stgo Este 13.8 kV substation, a decrease of up to 0.878 p.u. occurs, restored when it reaches 0.91 p.u. The Stgo Norte substation has the least favorable behavior, with a reduction of up to 0.882 p.u. Under these conditions, the system is not restored because the voltage at which it stabilizes is 0.89 p.u., a value below 0.9 p.u. required by the standard.

In both scenarios, when the three-phase fault is simulated in each of the San Luis and Contramaestre substations, the most significant decrease in voltage occurs at the Stgo Este 13.8 kV substation, recovering later until reaching a favorable post-failure state. Figure 5(a) shows that the depth of the voltage dip at the Stgo Este 13.8 kV Substation in the event of a three-phase fault at the San Luis substation is 13.3% and lasts 0.93 seconds. According to the IEEE 1159 standard, which classifies voltage dips according to their duration, this dip is momentary. Figure 5(b) shows that the depth of the voltage dip at the Stgo Este 13.8 kV substation in the event of a three-phase fault at the Contramestre substation is 11.2% with a duration time of 0.728 seconds, so it is also classified as a momentary gap.



(a) (b)

Figure 5. Voltage drops parameters occurring at the Stgo Este 13.8 kV substation; (a) in the event of a three-phase fault at the San Luis substation and (b) in the event of a three-phase fault at the Contramaestre substation

3.1. Measures to correct voltage dips

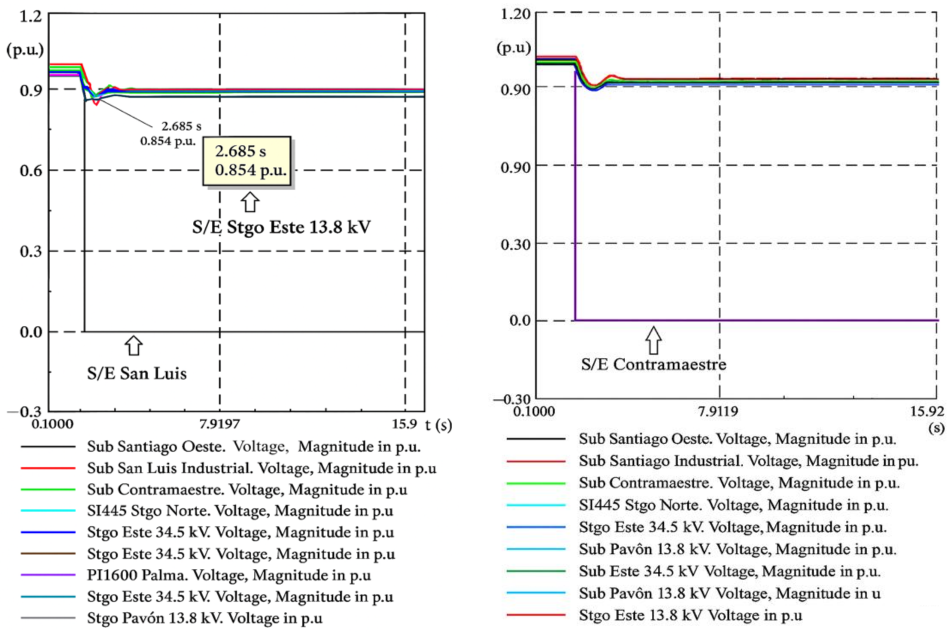
To reduce the occurrence of voltage dips in the event of simulated three-phase faults, the operating voltage level (*Vop*) at the nodes where these phenomena occur is raised. This higher level of operating voltage is achieved by changing the tap position of the transformers in the corresponding substations.

Table 4 shows the values obtained with the tap change in the transformers found in the nodes of the substations of 1-Santiago Industrial, 3-Stgo Oeste, 4-Stgo Norte, 5-San Luis, and 7-Stgo Este 13.8 kV, where it is observed that voltage dips are eliminated. There is only one voltage dip at the Santiago Industrial substation in a three-phase fault at the San Luis substation. Increasing the transformer voltage further is impossible because it exceeds 5% of the NC standard's nominal voltage 365:11 [38].

Table 4. Data of the voltage deviation in the load nodes with tap change of the transformers of five substations in relation to a three-phase fault in the San Luis and Contramaestre substations

Substation	Triphasic fault (Vop/Vgap) (p.u.)								
	1	2	3	4	5	6	7	8	9
1	0	0.83	0.96	0.97	**0.93/0.89**	0.7	0.96	0.96	0.94/0.91
2	0.96	0	0.96	0.96	0.91/0.91	0.69	0.96	0.96	0.92/0.91
3	0.94	0.82	0	0.95	0.92/0.92	0.68	0.94	0.94	0.93/0.9
4	**0.92**	**0.8**	**0.92**	**0**	0.92/0.9	**0.66**	**0.92**	**0.92**	0.93/0.92
5	0.96	0.83	0.96	0.96	0	0.7	0.96	0.96	0.93/0.9
6	0.96	0.83	0.96	0.97	0.92/0.9	0	0.96	0.97	0.93/0.92
7	0.94	0.82	0.94	0.95	0.94/0.9	0.69	0	0.94	0.95/0.92
8	0.95	0.82	0.95	0.95	0.9/0.91	0.68	0.95	0	0.91/0.92
9	0.95	0.82	0.95	0.96	0.91/0.9	0.7	0.95	0.95	0

Figure 6(a) shows the behavior of the voltage values in the nine load nodes of the simplified network of the province of Santiago de Cuba before the simulated three-phase fault in the San Luis substation when the tap change of the transformers was carried out, connected to the load nodes. Figure 6(b) shows the behavior of the voltage values in the nine load nodes of the simplified network of the province of Santiago de Cuba before the simulated three-phase fault in the Contramaestre substation when the tap change of the transformers was carried out, connected to the load nodes. Figure 7 shows the voltage dip at the Santiago Industrial substation. It is classified as instantaneous since its duration was 0.444 seconds, less than the 0.5 seconds required by the IEEE 1159 standard. In addition, the depth of the voltage dip was 13.1%.



(a) (b)

Figure 6. Behavior of the voltage values in the nodes; (a) before the simulated three-phase fault in the San Luis substation and (b) before the simulated three-phase fault in the Contramaestre substation

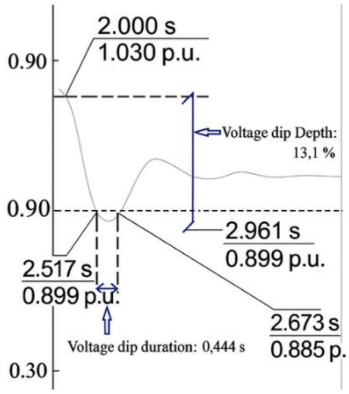


Figure 7. Voltage dip in the Santiago Industrial substation due to the three-phase fault in the San Luis substation

Finally, Table 5 shows the behavior of the voltage values in the nine nodes, simulating the minimum demand regime, and where the transformer taps were varied in five substations. Table 5 shows that the voltages of the nine nodes in the minimum demand regime do not exceed 5% of the nominal voltage of the node, complying with the NC 365:11 standard. Hence, compliance with the measures taken is feasible from the technical point of view and does not entail additional expenses for the system's stable operation under study.

Table 5. Value of the voltage in the load nodes in the minimum demand regime and with a change in the tap of the transformers in five substations

Electrical substation	With transformer tap change	
	Vop (kV)	Vop (p.u.)
1. Stgo Industrial	35.8	1.04
2. Palma	14	1.02
3. Stgo Oeste	14.3	1.04
4. Stgo Norte	14.3	1.04
5. San Luis	35.1	1.02
6. Pavón	14.1	1.02
7. Stgo Este 13.8	14.5	1.05
8. Stgo Este 34.5	34.8	1.01
9. Contramaestre	34.8	1.01

4. CONCLUSION

With the study of a simplified electrical network of the province of Santiago de Cuba, Cuba, for the evaluation of the voltage dips in the event of three-phase faults in the load nodes, it was obtained that the worst scenarios occur when there is a fault in the node of the Pavón substation. In addition, when there is a fault in the node of the Palma substation, all the nodes present voltage dips, and the voltages do not recover to the expected values, so there will be no post-fault operation of the network.

The Stgo Norte substation presents the most damaging behavior, with voltage dips due to three-phase faults in 50% of the simulations. On the other hand, the Stgo Este 13.8 kV substation is where the deepest voltage dips occur and are classified as momentary dips due to simulated three-phase faults at the San Luis and Contramaestre substations. With the analysis of these results, the measure of adjusting the tap settings of the transformers at the affected substations is implemented, thereby eliminating the occurrence of voltage dips and ensuring stable operation in the event of three-phase faults in the analyzed electrical system.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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