TECHNICAL UNIVERSITY OF NORTH

FACULTY OF ENGINEERING IN APPLIED SCIENCES

"STUDY OF COORDINATION OF PROTECTIONS FOR THE FIVE PRIMARY SUBSTATION FEEDERS SAN VICENTE, NORTHERN REGIONAL ELECTRIC COMPANY (EMELNORTE)".

ENGINEERING IN ELECTRICAL MAINTENANCE

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Resume

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SUMMARY

This work aims to make the study of coordination of protections for four s ubstationfeeders San Vicente, which is intended to reduce the high rates of disconne ction, as well as to mitigate the effects of failu res on the network, whereas in addition the approval of fuses in the derivations. Studies show that short circuit currents have a directly propo rtional relationship with the impedan ce of the electric power system andi n turn decrease depending on the extent of the power supply unit, therefore, failures that occur in very remote areas may be not count ed by the reclosers. Just as theabse nce of a prior study for the coordinati on of protection in the area of influen ce of the substation does not augur the medium term of the pr oblem solution. From this is derived the importance of generalizing the s olution obtained with this work.

Keywords: coordination of protections, substation, fault currents

INTRODUCTION

The substation San Vicente has five positions for feeders of which four ar e operating, the poor coordination of protection helps maintain a high rat e of disconnectionsin the area of infl uence of the substation, thus before a fault current subscribers without el ectric service is high.

The coordination of protections must be taken into consideration when pr otection relays in the header of feed ers, fuses in the leads, fuses in trans formers, and exist reclosers and sec tionalizers on the network.

At the substation San Vicente prese nted problems in the coordination of protections causing unnecessary dis connects in the area of influence.

Through this study of coordination of protections and the implementation by EMELNORTE, is will reduce the f requency of discontinuation due to f aulty in elements of the system, cont ributing to improve the quality of ele ctric service rates.

Distribution systems

Electricity is delivered to users after passing three main stages, generati on, transmission and distribution.

In the stage of distribution the marketer is responsible for bringing power to subscribers through a set of elements that constitute it as structures, networks, protection equipment, distribution transformers etc. (GRAINGER J.J, 1996)

A proper coordination of protection c ontributes to compliance with the regulationsset by ARCONEL.

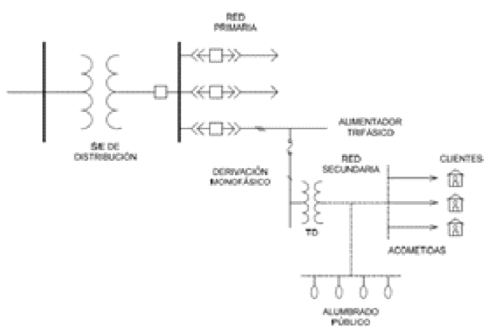


Figure 1*:* *Radial system*

Note: Take LOPEZ, A (2008)

CONCEPTS

Electrical protection

The electrical protection are element s of protection, whose mission is the monitor and protect efficiently the el ements of control and force along el ectrical system before an eventual f ault current, avoided unnecessary s ystem disconnections, thus contribut ing to maintain both the quality and t he continuity of electric service

.**The electrical protection require ments.**

Reliability: You must act provided that a failure, mak ing the action required under abnor mal conditions, over a period of time . Is directly linked with the safety, si mplicity, and robustness of the prote ctive equipment.

Selectivity: When a system is a fail ure, you must operate closer to the same protection, without affecting the supply of electri c energy in other areas of the distrib utionsystem, ensuring the continuity of the service where the network is i n a normal regime.

Sensitivity: You should detect and respond without a ny fault condition problem is maximu m or minimum power, and according to a range determined for theoperati on, in the case of the relays is based on minimum settings the same.

Speed: Is characteristic is a function of the magnitude of the failure and t he coordination with other protection s. In the relays this feature prevents system out of sync, as well as damage protection elements and maneuver.

METHODS AND RESULTS

In the area of influence of the Sub st ation "San Vicente" presents a high rate of disconnections (see table 1), due to short circuits, overloads, lightning mostly by the extension of the three feeder, which affects the continuity of the s ervice's subscribers and the prestige of the company Distributor.

TABLA1: Indices de desconexiones

ALIMENTADOR	COD.	FMIK	LIMITE FMIk	TTIK	LIMITE TTIk
0401 (San Vicente Alimentador 1)	401	6,50	5	7,87	10
0402 (San Vicente Alimentador 2)	402	13,32	5	13,08	10
0403 (San Vicente Alimentador 3)	403	13,13	5	11,06	10
0404 (San Vicente Alimentador 4)	404	14,29	5	15,47	10

Fuente: Tomado de EMELNORTE SA.

In the table shown as limits the frequ ency of interruption (FMIK) and time of interruption (TTIK) are surpassed in all feeders.

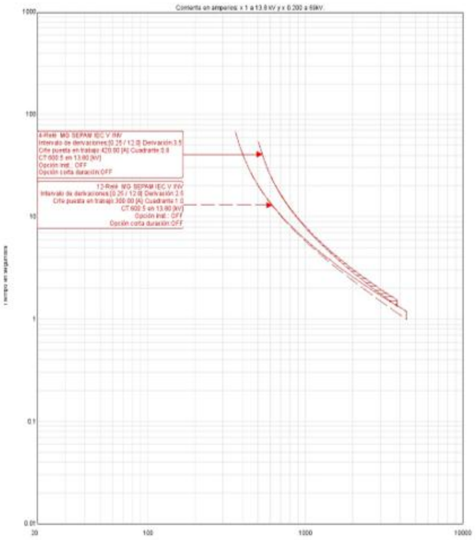
Then describe the procedure of coor dination of protections in the feeder t hree dueto their length and complexi ty, for remaining feeders the process is the same with the own of the sam e considerations.

Adjustment of relays.

Is important mention that them settin gs both of the relay general as of the m relays in them feeders is establish ed through a study prior from EMEL NORTE S.A, such relays are of dela y mark Schneider type SEPAM, the adjustment of the DIAL is located lo w standard IEC is not greater to 1.

TABLA 2: Ajustes para la configuración de los relés generales 51 y 51N

Protección	Voltaje(Kv)	RTC Protección	Línea	Tap	Dial	Corriente de cortocircuito máxima
GENERAL	13,8	600/5	Fase	3,5	0,8	3820
			Neutro	3	1	4380



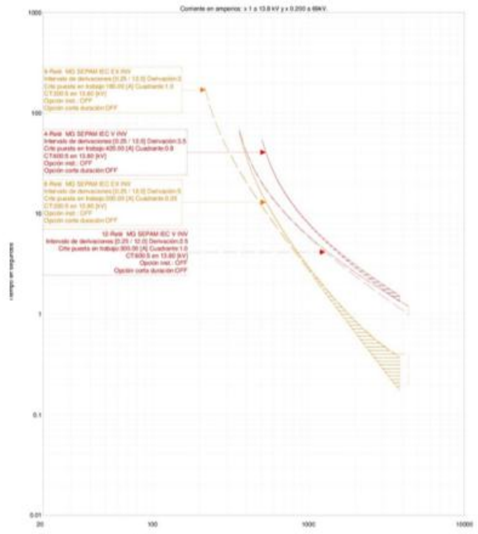
GRÁFICA 2: Curvas de los relés generales

Protection relays settings 51 and 51N

Feeders relays used extremely inverse curves, these curves must not interbreed withthe curves of General relays, so that there is coordination between them.

TABLA 3: Ajustes de los relés 51 y 51N en el alimentador 3

Voltaje(Kv)	RTC Protección	Línea	Tap	Dial	Corriente de cortocircuito máxima
13,8	300/5	Fase	5	0,8	3820
		Neutro	3	1	4380



GRÁFICA 3: Curva de los relés del alimentador 3

Due to the expansion of the three feeder, the relays of the same curves are the permissible limit of distance with respect to the curves of General relays, in order to increase the margin of coordination with fuses both reclosers.

Coordination of protections.

Prior to the process of coordination were entered to the CYMDIST program the equivalent impedance of substation (see table 8) and the demand for feeder, the following data were obtained:

• Currents of short circuit in transformers, reclosers and bursts of derivations.

• Load flows with which was the approach for the analysis of ICF (cold load current).

TABLA 4: Impedancias equivalentes de la Subestación San

Z	R	X
Z0	0	1,472
Z1	0,274	2,371
Z2	0,273	2,366

Tomada de EMELNORTE

TABLA 5: Demandas del alimentador 3

Ia (A)	Ib (A)	Ic (A)
126,9324	155,677	158,13
	Fp	
99,0256	98,4855	97,638
Vab (p.u)	Vbc (p.u)	Vca (p.
0,931169	0,932265	0,9470

Subsequently identified the possible ramifications of primary, secondary, tertiary and Quaternary, taking into a ccount the sensitivity of the relays a nd reclosers in moredistant areas.

Coordination between relays, reclos ers.

To carry out the coordination of reclosers has taken into account the following con siderations:

• The curves of the reconnectors mu st not interfere with the curves of the relays upstream.

• Since the present work has been d one under IEC standards the dial set ting limit is0.05 to 1.00.

• Setting should be able to register t he currents of short circuit, in the more remoteareas corr esponding to its area of protection.

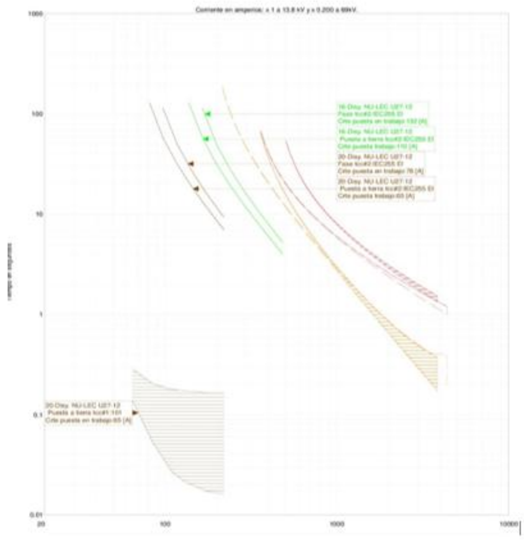
• Quick curve in the last Recloser must only be activated, with the aim that the reconnectors upstream act as switches

• Quick curve in the last Recloser sh ould be given the opportunity to be transit ory and avoid failures that the fuses downstream Act.

• The curves of the fuses in the last Recloser, preferably should not ente r into the area of protection of the qu ick curve.

TABLA 6: Ajustes en los reconectadores del alimentador tres

Nº de reconecta dor	Voltaje (Kv)	Corriente fase	Corriente tierra	Curva rápida activada	Corriente de cortocircuito máxima (A)	Dial
R1	13,8	132	110	NO	485	Fase:0,8
						Tierra:0,9
R2	13,8	78	65	SI	220	Fase:0,8
						Tierra:0,9

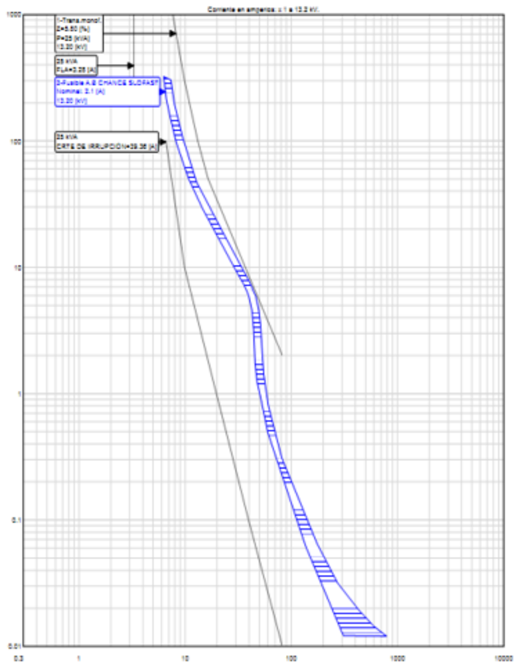


GRÁFICA 4: Coordinación entre reconectadores y relés

Selection of fuses in transformers

Distribution transformers shall be protected with fuses SF, since thi s fuse curves fit better between mag netization curve as of damage to the transformer, in turn complywith the homologation of fuses.

If the curves of the fuse are under th e curve of magnetization of the trans former, fuse will blow against transie nt faults, at the same time if they exceed the damage curve transformer, fuse will not protect the transformer to a fault and it will burn in thesame way took into account comply with ICF<IF.



GRÁFICA 5: Coordinación de un fusible SF con el transformador

Coordination between the fuse type T and SF.

According to the current of short circuit and the SF fuse in the transformer, fuse type T, same will be located at the start of the derivations is selected. Consider that thecurves of the fuse type T must be about SF fuse curves.

Coordination between fuses type T.

They should be located in cascade according to their ability is major to minor. We maintain the criterion of mentioned overlaying previously, so that if two fuses are of same value there is coordination.
Fuse type T are responsible for protecting the derivations as they are primary secondary tertiary or Quaternary, have been placed in the boot of the same, it should beemphasized that the backbone must be free of fuses as well as the entire circuit must be homologated.

Analysis for the selection of fuse type T was performed taking into account the currents of short circuit in the derivations and transformers located in the same, since such currents increase in relation to the proximity of the power supply unit.

First analysis

The first analysis was carried out until the first Recloser, primary bypass, was considered the highest short-circuit current at startup with greater proximity to the same substation which is 2941A, therefore selected fuse 80 T.

The choice of the fuse for secondary derivations, took into account a short circuit current of 2754A which was detected using the CYMDIST program in a transformer of10KVA, single phase fused a SF 1.0 that running is the most elevated considering the parameter of greater proximity to the substation, therefore, selected fuse 40T, since coordinates with the SF 1.0 up to 2765A and with the 80T to 3700A.

Tertiary referrals are followed the same procedure as described above providing a short circuit current of 1237A in a 10kVA protected with a fuse transformer 0.7 SF was selected a 20T fuse since coordinates with fuse 0.7 to 1270A SF, and in turn coordinates with the fuse up to 2000A 40T.

For one ICF more real was a load flow data provided in table N0 9 at the start of thederivations with greater load, this value multiply by four, leads where there were nocurrents, proceeded to apply the following formula: ICF= 4 x ∑ IN

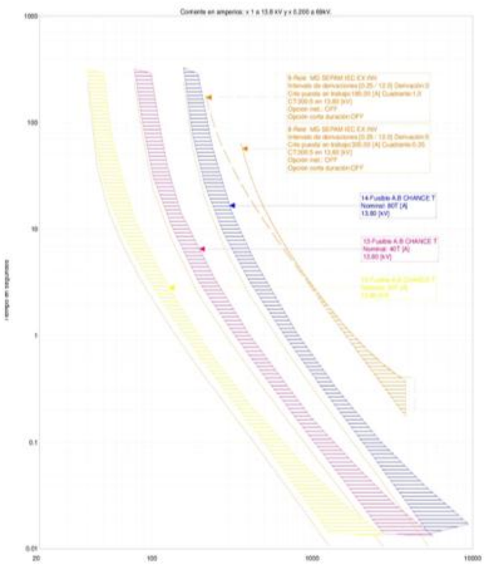
Where:

ICF= Cold charging current

∑IN=Sum of current ratings of transformers in the derivation.

TABLA 7: Fusibles propuestos

Derivación	Corriente de cortocircuito (A)	ICF(A)	IF(A)	Fusible seleccionado	ICF<IF
Primaria	2941	110	158.2	80T	SI
Secundaria	2754	21,2	78.2	40T	SI
Terciaria	1237	2,4	39,9	20T	SI


GRÁFICA 6: Coordinación de fusibles 80.40 y 20T

Second analysis

Starts from the first Recloser to last Recloser, once the adjustments (see table N08),proceeded to carry out the coordination under the same slow curve, perform the same process described in the first analysis where the short circuit currents, must be considered as well as the respective coordination between fuses.

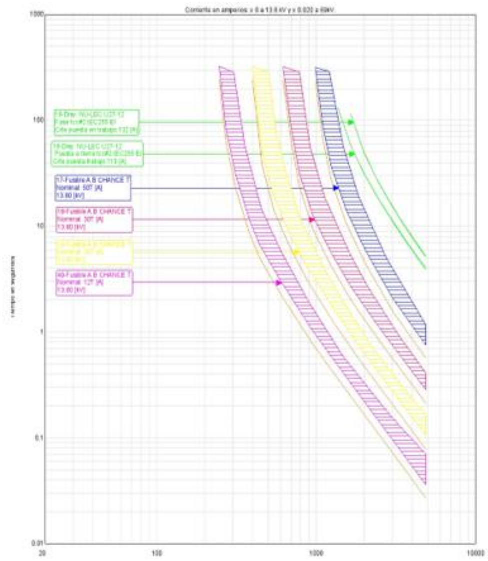
TABLA 8: Ajustes para el primer reconectador

Nº de reconectadores	Tipo	Voltaje(Kv)	Corriente fase	Corriente tierra	Curva rápida activada	Corriente de cortocircuito máxima (A)	Dial
R1	Electrónico	13,8	132	110	NO	485	Fase:0,8
							Tierra:0,9

As mentioned above the feeder is too extensive and taking into account the sensitivity of the Recloser arises the possibility of having Quaternary derivations with the purpose of increasing selectivity.

TABLA 9: Fusibles propuestos

Derivación	Corriente de cortocircuito (A)	ICF	IF	Fusible seleccionado	ICF<IF
Primaria	323	14,8	125.4	65T	SI
Secundaria	295	11,2	78.2	40T	SI
Terciaria	121	2,89	49.7	25T	SI
Cuaternaria	120	2,89	4,4	12T	SI


GRÁFICA 7: Coordinación de fusibles 65.40,25 y 12T

Third analysis

It corresponds to the last

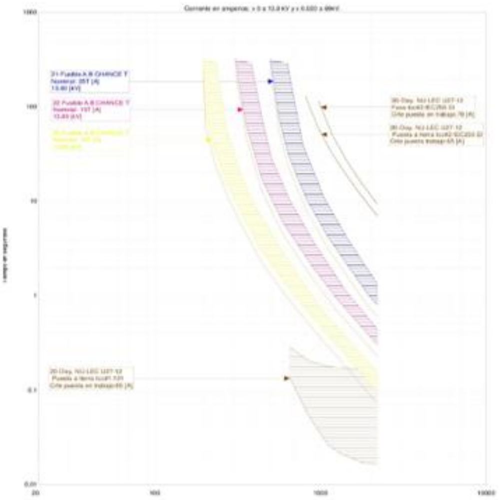
Recloser far more retired feeder, for the analysis and selection of fuses remain the same parameters and criteria previously mentioned.

TABLA 10: Ajustes del segundo reconectador

Nº de reconectadores	Tipo	Voltaje(Kv)	Corriente fase	Corriente tierra	Curva rápida activada	Corriente de cortocircuito máxima (A)	Dial
R2	Electrónico	13,8	78	65	SI	220	Fase:0,8
							Tierra:0,9

TABLA 11: Fusibles propuestos

Derivación	Corriente de cortocircuito (A)	ICF(A)	IF(A)	Fusible seleccionado	ICF<IF
Primaria	152	11,2	49.7	25T	SI
Secundaria	149	7,6	30.48	15T	SI
Terciaria	146	0,8	19.63	10T	SI



GRÁFICA 8: Coordinación de fusibles 25.15 y 10T

Conclusions and recommendations

Conclusions

• Short circuit currents have a directly proportional relationship with the impedanceof the electric power system and in turn decrease depending on the extent of the feeder.

• Coordination of the relays in the substation curves are adjusted according to a previous study that establishes coordination of the subtransmission system until bar 69 kV of the points of connection with the national transmission system by which these are a reference to coordinate protection of substation feeders teams San Vicente.

• When in a trunk is more than one Recloser, only must be activated fast last Recloser curve waters beneath the substation, for Recloser upstream operate as a circuit breaker at the time that occurs between these two reclosers failure because otherwise there would be undue operations between these two teams and otherwise comply with the criteria of coordination.

• There`s no problem of coordination in place conventional transformers or auto protected, since the latter have a protection magneto thermal fault internal and External fault an NH fuse and its secondary side, SF fuse is located in the primary.

• A fuse melting depends on both the duration and the magnitude of the fault current flowing through it.

• Fuse SF curve, is that best fits between damage and magnetization curve in distribution transformers, which guarantees greater protection against fault currents.

• Approval of fuses decreases the response time by staff of maintenance, to eventual failure.

Recommendations

• Prior to performing the load flow in CYMDIST take into account units in which these values are.

• 2AWG wire supports a current maximum 180A, with this current are carried out sensitivity settings in the reclosers, however, we must consider that currents decreaseas they move away from the substation and that, to reduce this current dependingon the short-circuit current, we can increase the sensitivity of the reconnectors in more remote areas.

Bibliography

1 ENRIQUEZ HARPER, Gilberto (2006) protection of electrical systems, edit. Limusa,Bogotá, Colombia.

2 TORRES BREFFE, Orlys E. (Tutor). Diploma work. Instituto Superior Minero metallurgical, 2001.

3 TORRES BREFFE, Orlys Ernesto, (2007) development of tools for the creation, modeling and verification of electrical protections, edit. Edum, Santiago de Cuba, Cuba.p 41

4 TORRES BREFFE, Orlys Ernesto, (2012) transient processes, methods of symmetrical components for the analysis of asymmetric faults, Material 2, Cenase, Ecuador. P 21