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Planning for Upgrading Design of Aung Pin Lae Substation

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***Abstract*— Planning, the future expansion of substation involves determining both capacities and selection of suitable protective equipment. In order to get a realistic picture of the performance of the existing substation along with inherent operational problems, it is essential to have a detailed representation of the substation. This research includes the collection of all relevant data required for the existing Aung Pin Lae substation study and to plan the future and organize the data in a common data pool. This study also involves analyzing the system demand and arriving at voltage regulation, line losses and line efficiency of each outgoing feeder. Reliability evaluation of distribution substation is done to measure the past performance and to predict the future performance in this paper.**

***Keywords*— existing substation, maintenance and replacement of protective equipment, additional new component, expansion substation.**

I. Introduction

The demand on electric power supply in Myanmar as a developing country has changed drastically, both qualitatively and quantitatively.

With increasing development, the dependence on electric power supply has increased considerably. The need for distribution system planning arises mainly as a consequence of high growth rates. In order to meet the growing demand, it is essential to determine a planning strategy with related costs and physical needs.

A critical first step for planning is the determination of the need for future expansion.

A study of the existing substation using analysis programs and studying its operational problems result in suggesting remedial measures with less financial implications. The first and foremost problem of the distribution substation planner face is the collection and organization of the system data.

The trend is towards assessment of existing substations and individual equipment to develop a predicative maintenance and substation life extension program.

This approach implements a planned program for evaluation substation components and making modification, or individual equipment replacements to improve reliability and extend the overall substation life. This paper focuses on upgrading or expansion planning to optimize the replacement and maintenance of Aung Pin Lae substation equipment.

II. Performance Analysis of Existing Aung Pin Lae Substation

In Aung Pin Lae substation, all equipments are protected by reliable protection. Moreover, dielectric oil is used in oil circuit breaker and SF6 circuit breakers are new dielectric media used for arc extinction. There is preliminary protection for substation by using lightning arrester to protect the overhead sub-transmission line fault whatever it may be. And also, the C.T and P.T are essential sensing equipments for measuring and protection. All protective relays are used to detect lines or apparatus and to initiate the operation circuit interrupting devices to isolate the defective equipment. According to the above procedure, existing substation, Aung Pin lae can be checked by hand calculation.

In Aung Pin Lae, Waringone, Nanshae, MTU+Pathein Gyi, 26^{th} street, 35^{th} street at 11kVside and Myo Park at 33 kV side are outgoing loads. Existing substation, Aung Pin Lae, has overall 33MVA distributed to the consumer by outgoing feeders. However, the demand on electric power supply in Mandalay has increased day after day.

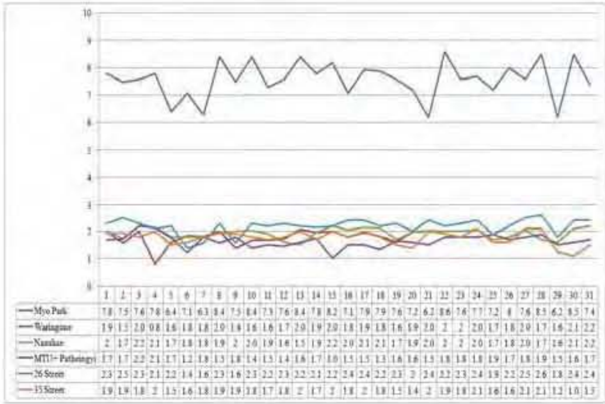


Fig. 1 Monthly Load Utility Curve for Aung Pin Lae

The more increase electricity demand, the more need for a steady power supply with minimum power interruptions and fast fault restoration. It can be seen all side of load demand in a month. According to the following Fig. 1, the total power demand will be increased in coming years. Therefore, it may be predicted to increase the transformer rating due to the increasing electrical demands by checking to the operating history of Aung Pin Lae substation from the daily load demand. In fact, Aung Pin Lae substation should be expanded to uprating as successful expansion substation.

III. Expansion of Aung Pin Lae Substation

Substation expansion is the addition of transmission, sub-transmission or distribution circuits to existing substation. These additional circuits may be required on the primary or secondary sides. In expansion Aung Pin Lae, the incoming side had remained the same such as Sedawgyi and Dagundaing, incoming feeders, however, after establishing Shwe San Yan substation, it could distributed to the Dagundaing substation as incoming feeder.

In fact, Dagundaing substation is likely to distribute more incoming power to Aung Pin Lae. Therefore, if incoming power will be able to increase in Aung Pin Lae, it will distribute the improving power for outgoing side such as Myo park, Waringone, Nanshae, MTU+ Pathein Gyi, 26th street and 35th street as much as these adequate power. Moreover, on the other side, the new outgoing feeder, industrial technological center (ITC), will be apparatus at 33kV side.

In some cases, modifications to the switching scheme may be increased with the installation of an additional capacity (20MVA) is determined according to the operating history of existing Aung Pin Lae substation. In this expansion, adding 20MVA transformer with 132kV line, a 132/33 kV transformer will be distributed by 33 kV distribution structure to an existing substation as shown in Fig. 2.

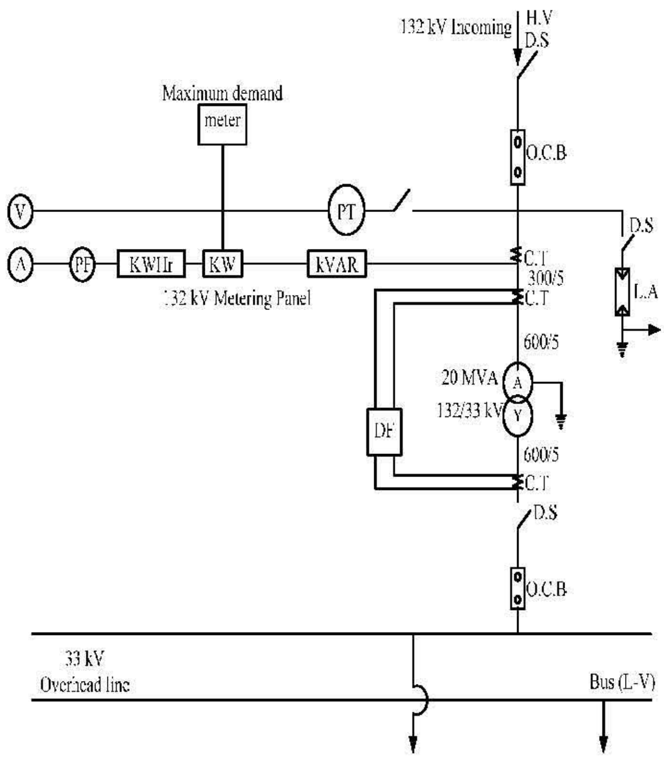


Fig. 1 Measuring System for Additional Transformer

IV. Planning for Outgoing Feeders for Upgrading of Aung Pin Lae Substation

Redesign or modification of the distribution system of the expanded substation is accomplished by summing existing loads and expansion loads. The review of the operating history of Aung Pin Lae substation may reveal that the originally assigned demand factors were overly conservative, and the existing capacity may be adequate for the substation expansion.

The size of conductor is generally a very considerable part of the total cost of overhead line. To reduce the power losses in the line, it is necessary to employ conductor of low resistance and therefore large cross sectional area. But the cost of conductor material will increase and small cross sectional area should be used. So utilities should choose the size of conductor by comparing the cost of loss with the cost of material. Kelvin's law means that, the cost of conductor material equal the cost of loss is the most economical use of conductor material. The selection of the economic size of conductor for uprating substation is shown in Table I.

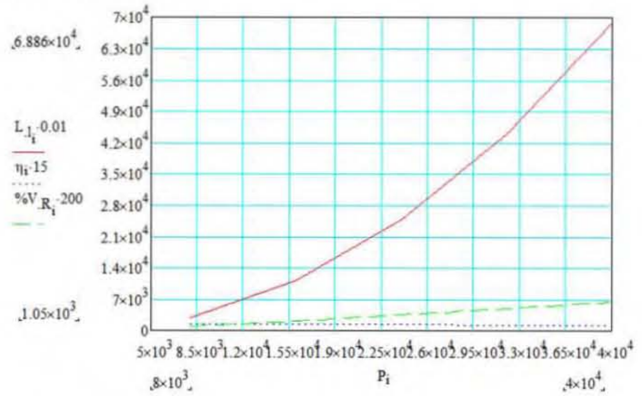
The overhead lines planning and designing are analyzed for uprating substation, especially for consideration of choosing the economic voltage level of the distribution system, choosing the technical optimum size of conductor, calculating the voltage drop on the line, voltage regulation and power losses on the line, evaluating the maximum sag on the line of the span and also develop the programs for above considerations by using MATHCAD software.

TABLE I
Economic Size of Conductor in Upgrading Aung Pin Lae

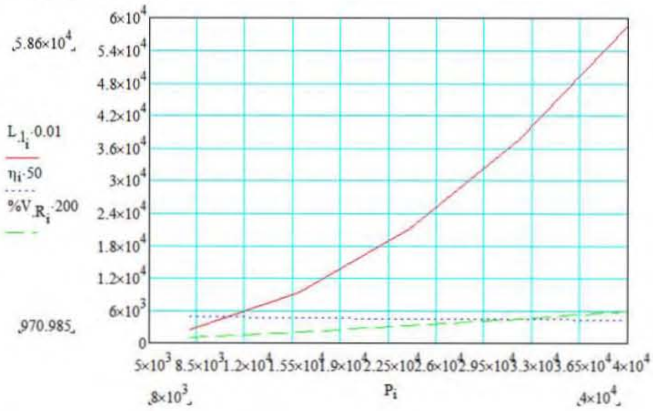
Feeder Name	(kV)	C.S.A (mm^2)	Dist: (mile)	Type	Max: Demand (MW)
myopark	33	200	10	ACSR	10
waringone	33	70	3	ACSR	10
nanshae	11	200	2	ACSR	5
MTU+PTG	33	70	4	ACSR	5
26 street	11	200	3.5	ACSR	5
35 street	33	70	4	ACSR	5
ITC	33	170	0.5	ACSR	5

In substation expansion design, the important element of cable sizing is current carrying capacity. Voltage drop is a secondary factor expects for current transformer circuits, tripping circuits, and long conductor runs. The voltage drop of the longest circuit should be checked because of using the conductor size and the current capacity dictated. The voltage drop in a conductor should not be enough to cause faulty operation of the device being feed by the conductors. In order to distribute improve power economically for expansion; the choice of size of conductor is also important. Both of the calculation results by hand and the calculation results by using MATHCAD software point out to change the conductor size. From the selection of conductor size, the amount of power losses, voltage drop on the line and line efficiency can be acceptable range according to the standard regulation as shown in Fig. 3.

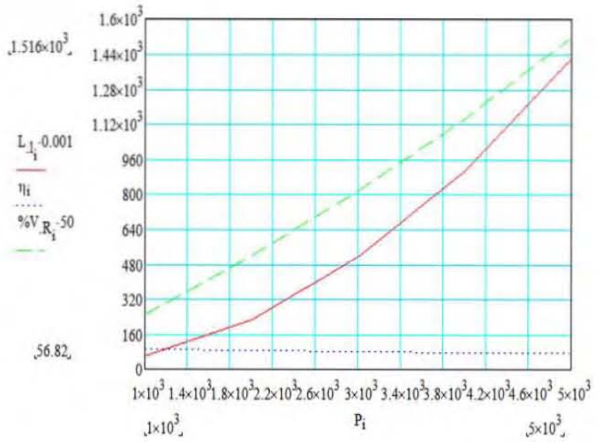
For Myo Park Feeder,
Before 170mm^2,



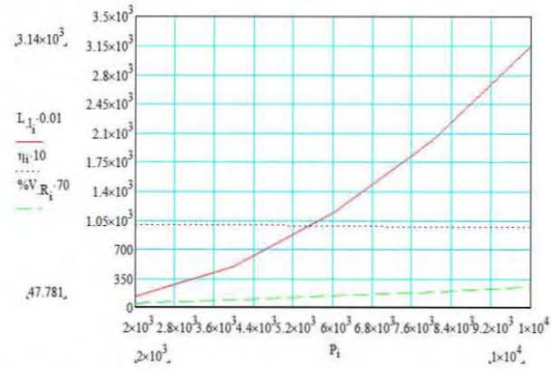
After 200mm^2,



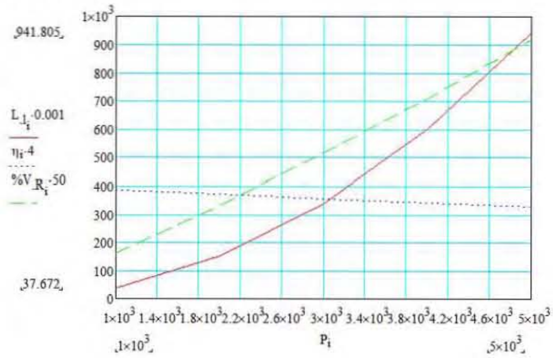
For Waringone Feeder,
Before35mm^2,



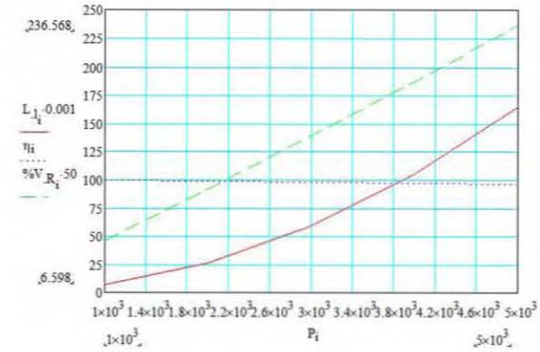
After 70mm^2,



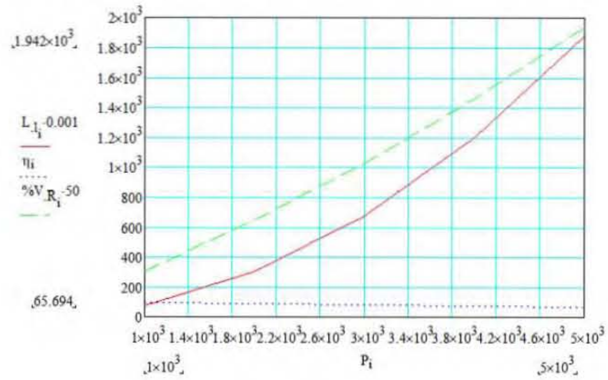
For Nanshae Feeder,
Before 35mm^2,



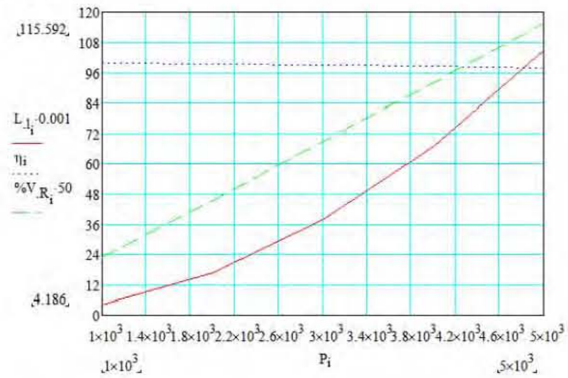
After 200mm^2,



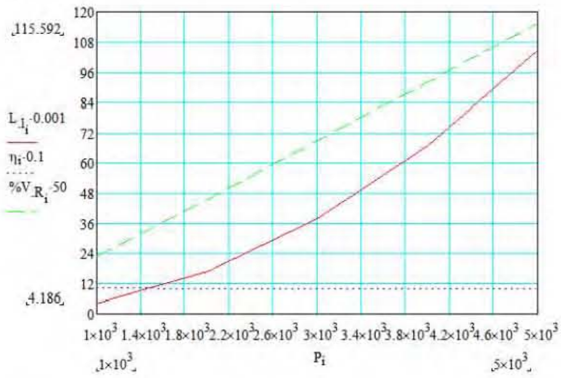
For MTU+Patheingyi Feeder,
Before 35mm^2,



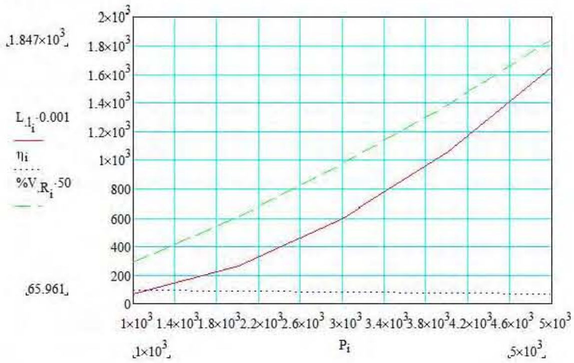
After 70mm^2,



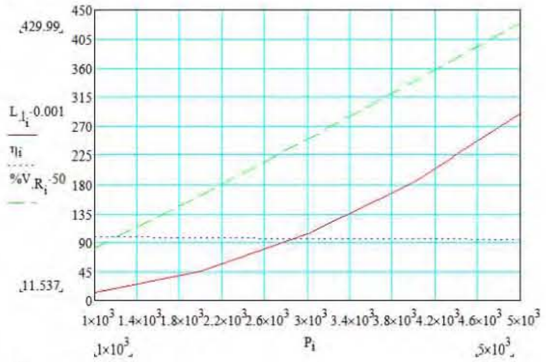
After 70mm^2,



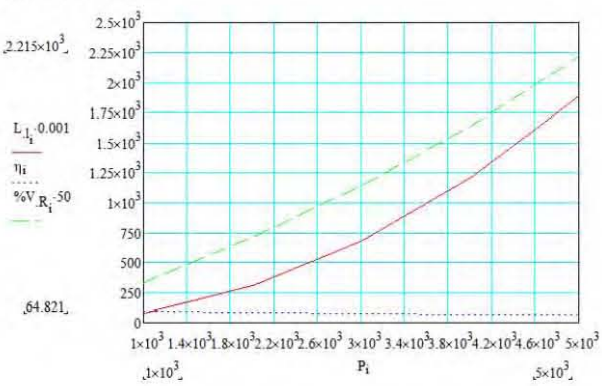
For 26th Street,
Before 35mm^2,



After 200mm^2,



For 35th Street,
Before 35mm^2



ITC Feeder (new),

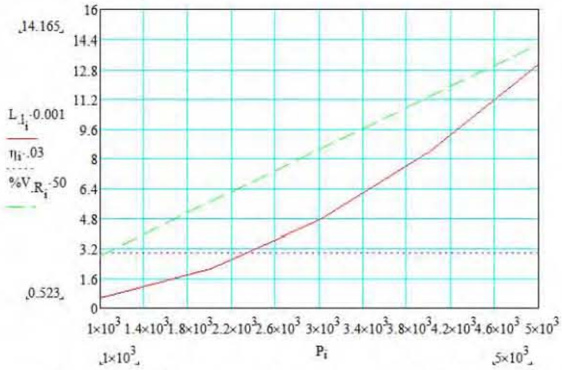


Fig.3 Result Curve for Voltage Regulation, Line Loss and Efficiency Compared with Existing and Expansion at Outgoing Feeder in Aung Pin Lae Substation

With the added capacity and consequent increase of the fault current, these stresses can be determined the voltage regulation, line losses and efficiency of each outgoing feeder if the ACSR conductor is larger. The more sufficient voltage regulation, less line losses and better efficiency because of the larger size conductor can be seen by comparing with Existing and Expansion in Aung Pin Lae Substation. In the graphs, the horizontal axis shows the power demand, P_i (MW) and the vertical axis describes the voltage regulation, V_{Ri} (%), line losses, L_{1i} (W) and line efficiency, η_i (%).

V. CONSIDERATION OF SAG FOR UPGRADING AUNG PIN LAE SUBSTATION

The choice of conductor size is one of the important factor in consideration of the sag between span. Wind loading, ice loading and temperature are also important in sag calculation. In fact, sag calculation can be checked according to the selecting the size of the conductor in uprating, Aung Pin Lae. The following Table II shows the calculation result for sag between existing and uprating by using MATHCAD software.

If the larger size of ACSR conductor of outgoing feeder in existing Aung Pin Lae substation may be used, the sag of the existing tower design should be checked. Thus, the design of the tower height according to the increasing conductor size at existing tower should be considered by taking the sag of conductor from Table II.

TABLE II
RESULT DATA FOR SAG CALCULATION IN UPGRADING AUNG PIN LAE

Feeder Name	**mile**	**C.S.A (mm^2)**	**C.S.A (mm^2)**	**Sag(ft) Exist**	**Sag(ft) Expand**
myopark	10	170	200	0.658	0.704
waringone	3	35	70	0.48	0.504
nanshae	2	35	200	0.48	0.704
MTU+PTG	4	35	70	0.48	0.504
26thstreet	3.5	35	200	0.48	0.704
35th street	4	35	70	0.48	0.504
ITC	0.5	-	70	-	0.504

VI. CONCLUSION

Consideration of a new installation with ample provisions for future expansion may be the best choice, particularly if extensive modifications are required. When equipment uprating is being considered, only the capacity is increased. The voltage level remains the same although they may be reconducted for increased capacity. In these instances, make a through examination to determine the most efficient and economical method to improve the situation.

At the same time, capacity may be increased with the installation of additional transformer. From compared to existing and future condition based on MATHCAD software, size of conductor in each outgoing feeder of existing Aung Pin Lae should not be able to allow because the voltage regulation of larger size conductor is better than the existing conductor size of Aung Pin Lae substation.

In an uprating program, the essential additional to the auxiliary system will probably include new ac circuit for additional transformer in Aung Pin Lae. Therefore, this circuit as critical or essential loads and assign then a 100 percent demand factor can be considered in this paper. In order to solve for redesigning of expanded substation, reliability analysis is being implemented in many maintenance programs to access the probability of failures and prioritize modifications based on safety, economics, obsolescence, and power quality.

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