CHAPTER 1

INTRODUCTION

Today's complex societies are so dependent upon a continuous supply of electric power that an interruption may have important social and economic consequences, depending upon its extent and duration. The maintenance of maximum service reliability has always been the primary concern of the electric utility industry. To attain this end, power systems are designed and operated so that for any predicted system condition there will always be adequate generating and transmission capacities to meet load requirements in any system area. For the most part, this design and operating procedure has been highly successful in producing a high degree of service continuity, even under emergency conditions. However, regardless of how great the planned margins in system design and operation, there have been and probably always will be some unpredictable combination of operating conditions, faults, forced outages, or other disturbances which cause system split-ups and/or a deficiency in generating capacity for existing area loading.

In any given system or interconnected system, the loss of a major source of generation or the loss of an interconnection carrying incoming power can produce the condition. The basic cause of most of these disturbances usually results from a short circuit. The short circuit either directly causes instability because of the shock to the system or, because of inadequate or slow relaying, indirectly causes instability by prolonging the reduction of the power transmission capability. Hydroelectric generating sources are usually located at some appreciable distance from the load areas they serve. Their long transmission lines on the same right-of-way are more vulnerable to multiple outages and thus may leave some load areas severly deficient in generation. When this occurs on a modern power system, it generally indicates that a highly improbable event has occured. Therefore, it is essential that the generation deficiency be quickly recognized and the necessary steps taken to minimize the impact of such incident and prevent the disturbance from cascading into a total system collapse. The massive outage in the Northeast of U.S.A. on the night of November 9-10, 1965 was a good example of the kinds.[1]

Loss of generation in an electrical power system will normally be accompanied by a decrease in system frequency, since the prime movers and their associated generators begin to slow down as they attempt to carry the excessive load. The frequency will not suddenly deviate a fixed amount from the nominal but rather will decay, on the average, exponentially at a rate determined by the size of the deficiency, and by the inertia and self regulation of the generation and load. The variation of system frequency during such disturbance is not a smooth rate of decay but rather is oscillatory in nature because of

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[1]Gordon D. Friedlander, "The Northeast Power Failure," <u>IEEE Spectrum</u>, February, 1966, pp. 54 - 73.

the interaction of the interconnected generators. Moreover, the rate of decay and the period of oscillation may differ appreciably across the system.[2] The higher the ratio of load to remaining generation, the faster the system frequency will drop. As the system frequency decreases, the torque of the remaining system generation will tend to increase, the load torque will tend to decrease and the overall effect will be a reduction in the rate of frequency decay.

Assuming no governor action, the damping effect produced by changes in generator and load torques will eventually cause the system frequency to settle-out at some value below normal. If governor action is considered and if the remaining generators have some pick up capability, the rate of the frequency decay will be reduced further and the frequency will settle out at some higher value than case of no governor action. In either case the system would be left at some reduced frequency which may cause a further decrease in generating capacity before any remedial action could be taken. The immediate problem is to attain a balance between generation and load before the decaying system frequency caused by the overload affects the performance of the remaining generation and power plant auxiliaries.

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[2] J. Berdy, "Load Shedding--Application Guide, " General Electric Company, Trans. 1968, p. 2; and C. Concordia, "Panel on Load Shedding and Bail-Out frequencies, " EEI System Planning Committee, Feb. 13 - 14, 1969, p.2.

This balance can be achieved by increasing generation or by automatic load shedding on low frequency.

In general, increasing generation can not be accomplished quickly enough to prevent a major decrease in system frequency, or in the extreme, there may not be sufficient available generating capacity to pick up the additional load. On the other hand, automatic load shedding on low frequency, provides a quick and effective means for attaining a generation load balance and for restoring system frequency to normal.

The application of underfrequency relays throughout the load area, preset to drop increments of load at specific levels of low frequency, provides a simple and direct method for alleviating system overloads and for minimizing the magnitude and duration of any service interruption. Since system overloads are generally caused by a major disturbance of unknown cause and system collapse may be imminent, load shedding should be performed quickly and automatically.

1.1 The EGAT Power System

The system of Electricity Generating Authority of Thailand (EGAT), shown in Figures 1.1 and 1.2,has been geographically grouped into four regions. They are called the Central or Region I, the Northeastern or Region II, the Southern or Region III and the Northern or Region IV. Region I covers the area of 21 changwats in the central part of Thailand. Region II begins at Nakhon Ratchasima and covers 16 changwats in the Northeast. Region III starts from Ranong and covers 15 changwats in the South. Region IV starts from Nakhon Sawan and covers 15 changwats in the Northern part of the country.

Region I, Region II and Region IV are tied together as an interconnected system while Region III is operated seperately. Region I and Region IV are tied together by four 230 KV transmission lines while Region II is tied with Region I by an 115 KV, double circuit, 477 MCM all aluminum transmission line. This tie-line starts from Angthong (AT) substation to Nakhon Ratchasima-1 (NR-1) substation. It has a distance of 194.64 Km with the maximum capacity of 128 MVA or about 100 MW at a power factor of 0.85.

There are four hydro power generating stations in Region II :

1) Ubol Ratana (UR) power station. It contains three units of 8,300 KW each giving a total capacity of 24,900 KW.

2) Nam Pung (NP) power station. It has two generating units of 3,000 KW each.

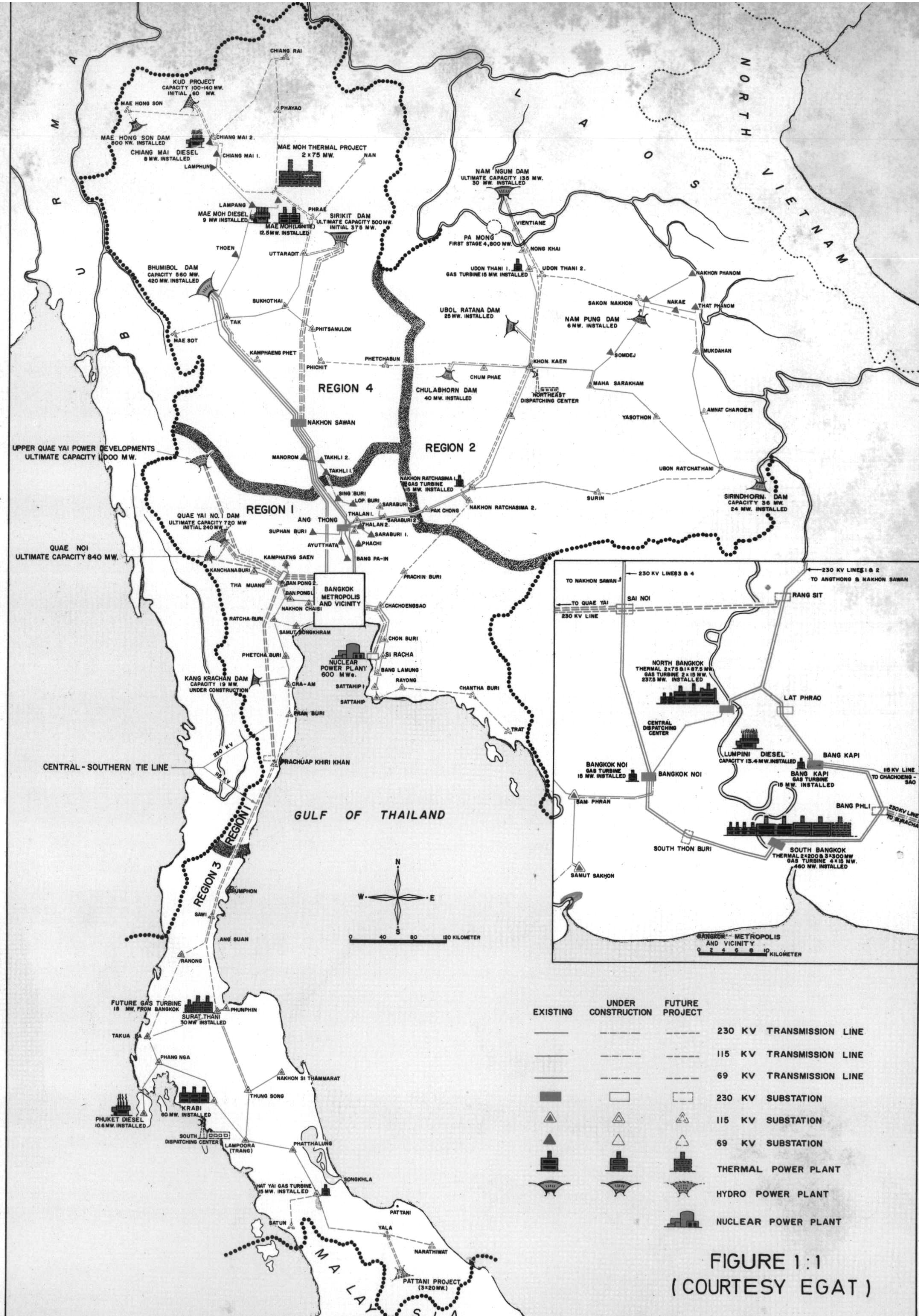

FIGURE 1:1
(COURTESY EGAT)

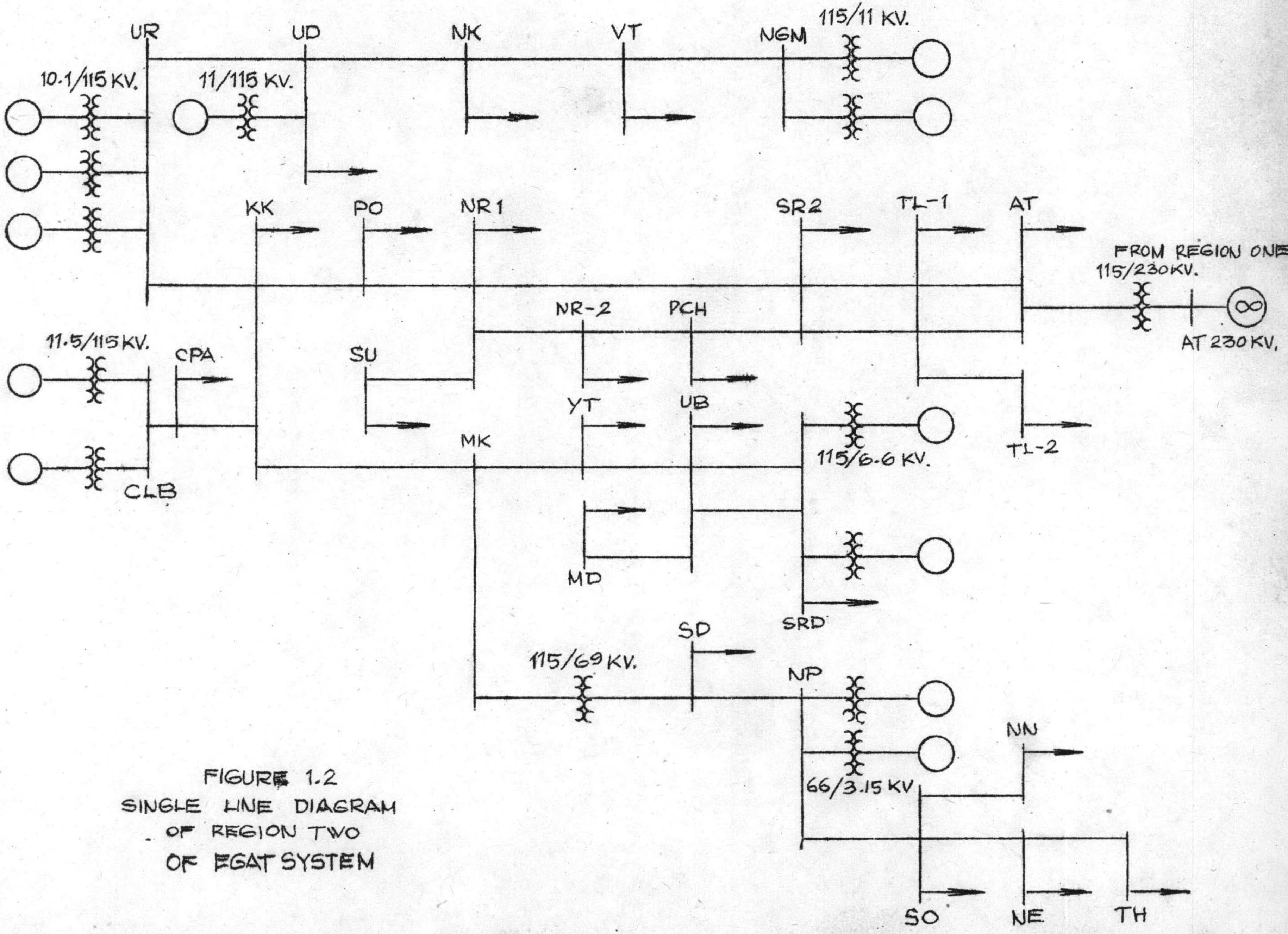

FIGURE 1.2
SINGLE LINE DIAGRAM
OF REGION TWO
OF EGAT SYSTEM

3) Sirindhorn (SRD) power station. It contains two generating units of 12,000 KW each.

4) Chulabhorn (CLB) power station. It has two generating units of 20,000 KW each.

Since the water inflows to the catchment area of these dams are small and their existing water level are under rule curve, they are programmed to generate a minimum power set by the policy of the EGAT in order to reserve the water for irrigation purpose. The rest of the generations are imported from Nam Ngum power station of Laos and from Region I. The problem now arises that there will be a little spinning reserve available in case of seperating Region I and Region II. A deficiency in generation will sure be occurred in Region II. In that case, a load shedding program is required to prevent system collapse.

1.2 Purpose of the Research

The purpose of the research is to study the performance of the region II power system of EGAT. By using the results obtained, an optimum load shedding program for the area will be developed. A computer program in FORTRAN IV language will be written and the IBM 360 Digital Computer will be used as an aid to the calculation in the development of the optimum load shedding program.