CHAPTER IV

CASE STUDY

The South Bangkok Thermal Plant

The South Bangkok Thermal Plant is the largest power plant in the South-East Asia. It is located approximately 15 kilometers south of Bangkok on the northeast bank of the Chao Phya River, between the villages of Phrapradang in the north and Paknam in the south.

There are two units each with a nominal rating of 200 megawatts, completed in 1971; and the other two units each with a nominal rating of 300 megawatts, completed in 1973. In the future, it is possible that there will be an additional unit which will ultimately bring the site capacity to approximately 1300 megawatts, exclusive of the 60 megawatts gas turbine generating capacity.

At present, the South Bangkok Thermal Plant supplies the load of approximately 67 per cent of the system load. The load dispatching of the system is controlled by the Central Dispatching Center (CDC) which is located at Bangruay, Nonthaburee.

The fuel of this plant is the heavy oil (number 6) which is fed through the overland pipe line directly from an oil refinery to the storage tanks of the plant. The fuel consumption is approximately 5,400,000 litres per day. Since the fuel consumption rates of the units are not similar, it is very difficult to operate all the units to give a required output with the minimum energy input

(or minimum fuel consumption)

Data for Formulation

1. Input-output curve

The data in this case study are collected from the performance test data of each unit of the South Bangkok Thermal Plant. They are shown in Appendix A. The input-output curve of each unit is given by:

$$Y = a_o + a_1x + a_2x^2 + a_3x^3 + \ldots + a_nx^n \qquad (4\text{-}1)$$

The coefficients a_i, $i=o,\ldots,n$, are calculated using the least-square criterion. The details of these calculations are described in Appendix B and the results are shown in Table 4-1.

2. Capability of the plant

The South Bangkok Thermal Plant can deliver power within the specified range only. The maximum value of the delivered power depends on the maximum capacity of the equipments but the minimum value depends on the status of the burners. If the generated load is less than the minimum, the stability of the automatic burner control is affected. The automatic burner control is an electronic logic which can operate the boiler protective devices for the stability of the plant, i.e., it will close all burner shut-off valves if there are some conditions which may cause plant instability.

TABLE 4-1.

= INPUT DATA =

	UNIT-1	UNIT-2	UNIT-3	UNIT-4	
MINIMUM GENERATIVE LOAD	100.	100.	120.	120.	MW
MAXIMUM GENERATIVE LOAD	200.	200.	310.	310.	MW
A(0) =	-30.370	-9.448	20.380	37.130	
A(1) =	8.9170001	5.1670000	.4080000	-1.5580000	
A(2) =	-.4388000	-.2056000	.0672900	.1348000	
A(3) =	.0091150	.0043860	-.0008878	-.0016280	

WHERE OUTPUT Y = A(0) + A(1)*X + A(2)*X**2 + A(3)*X**3

AND INPUT X = GENERATIVE LOAD (MW) OF EACH UNIT.

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The maximum and minimum values of the generated load for all units within this plant are also shown in Table 4-1.

Formulation of the Problem

This problem can be solved by either using a graphical method or the nonlinear programming approach based on the new direct search method stated in Chapter III, but the graphical method is not a practical one. The graphical method is very rough and cannot find the exact solution for an economic dispatching.

The nonlinear programming approach based on the new direct search method, is more realistic and practical. The new direct search method is faster than an ordinary direct search method or the method of conjugate direction and it is unnecessary to find the derivative of the function that is the new concept method.

The computer source listing of the nonlinear programming approach used to solve the case study problem is shown in Appendix C.

Results

The problem is FORTRAN IV coded and run on UNIVAC 1106. It is found that the solution can be obtained after a small number of iterations, i.e., less than 19 iterations. It takes about 2 minutes in the CPU time for overall calculations.

The result of the problem is depicted in the graph of Fig. 4-1. The numerical details are given in Appendix D.

EGAT SUBJECT ______ SHEET No ______

EFFICIENCY SECTION WORK ______ UNIT No ______

SOUTH BANGKOK DATE ______

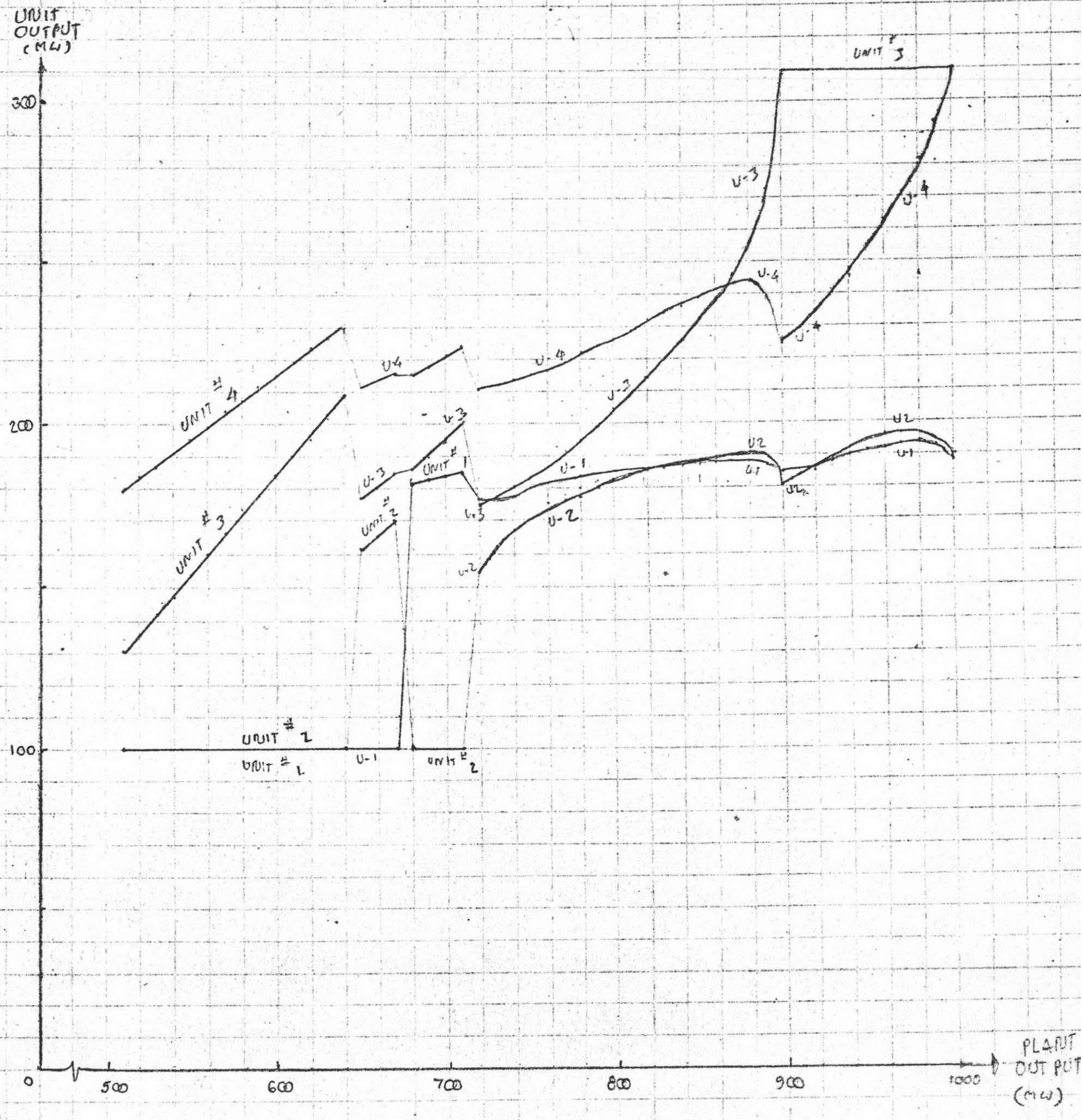

FIG. Δ-1. THE OUTPUT OF EACH UNIT VERSUS TOTAL OUTPUT OF THE PLANT FOR ECONOMIC OPERATION.

The Unit Shutdown Case

The program given in Appendix C can be used to solve this load distribution problem when some units are shutdown. A simple way is to reduce the dimension n which is the number of units. This method can be applied to other emergency conditions (e.g., a low condenser vaccuum condition, burner tripping condition, etc.) and periodical test conditions(e.g., turbine protective device test, turbine throttle valve and governing valve test). These conditions require the decrease of load down to the stable point, assumed to be x_s. Then the given total load demand has to be modified by the relation

$$XL' = XL - x_s$$

where XL is the old given total load demand, and

XL' is the new given total load demand.

For this case the dimension n is also reduced as described previously. For the case study of the South Bangkok Thermal Plant, one and two units shutdown cases are considered, seeking for all of the optimum operating points. The results are shown in Appendix E. The graphs of Fig. 4-2 and Fig. 4-3 depict the results.

EGAT SUBJECT ______ SHEET No ______

EFFICIENCY WORK ______ UNIT No ______

SECTION

SOUTH BANGKOK DATE ______

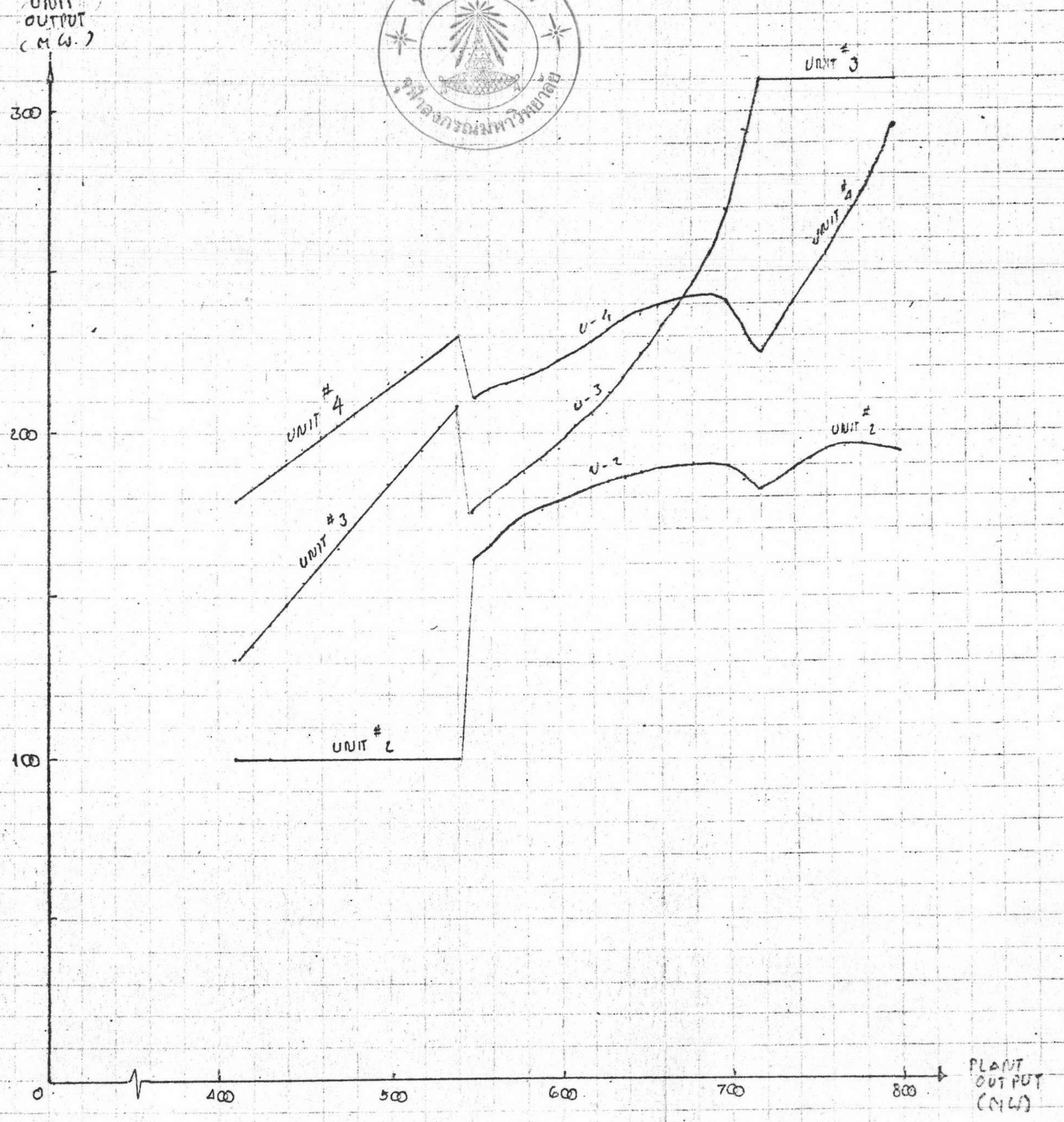

FIG. A-2 3. THE OUTPUT OF EACH UNIT VERSUS TOTAL OUTPUT OF THE PLANT IN CASE OF UNIT-1 SHUTDOWN

EGAT SUBJECT ______ SHEET No ______

EFFICIENCY WORK ______ UNIT No ______

SECTION ______

SOUTH BANGKOK DATE ______

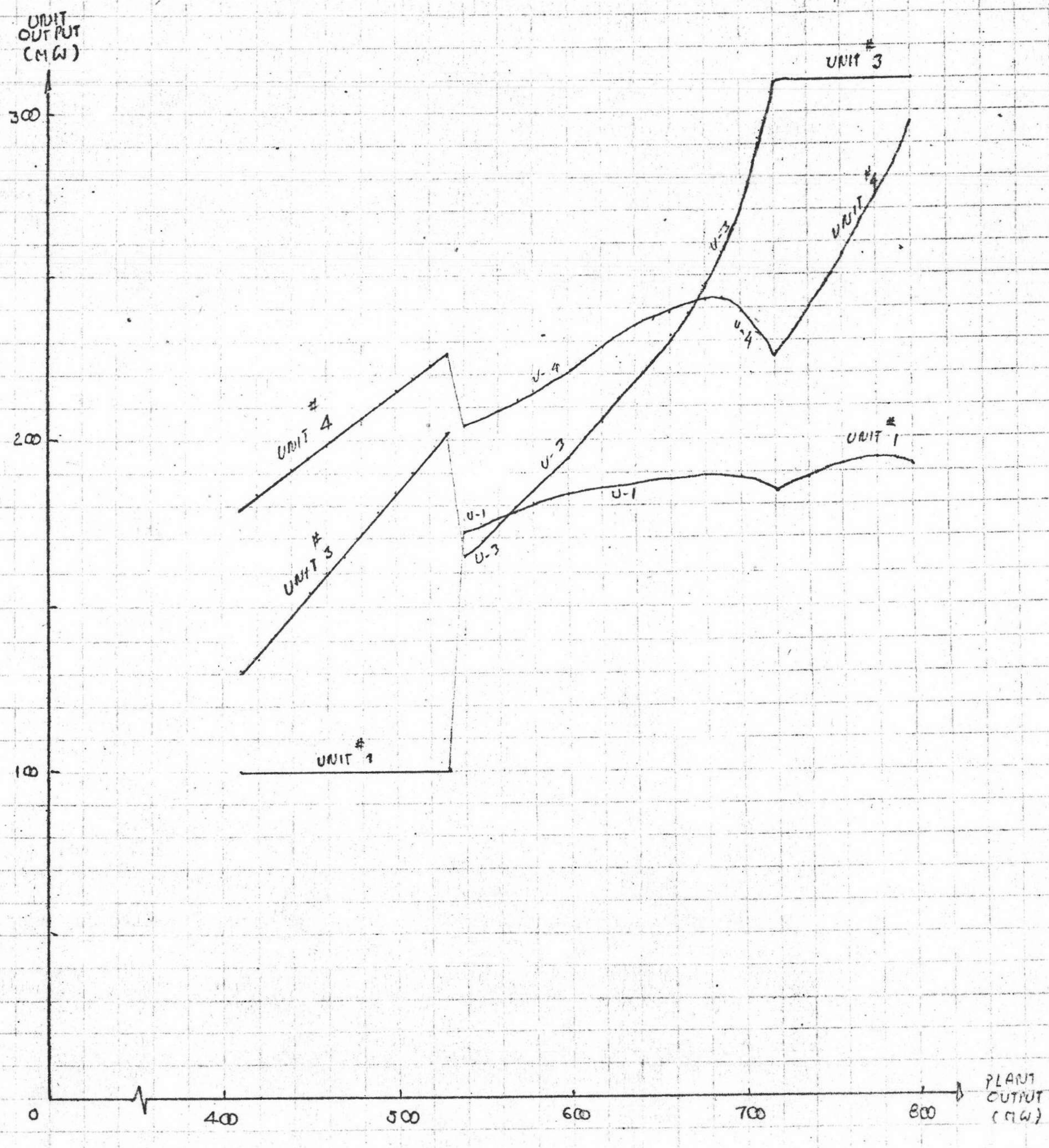

FIG. 4-2.b. THE OUTPUT OF EACH UNIT VERSUS TOTAL OUTPUT OF THE PLANT IN CASE OF UNIT-2 SHUTDOWN

EGAT SUBJECT SHEET No

EFFICIENCY WORK UNIT No

SECTION

SOUTH BANGKOK DATE

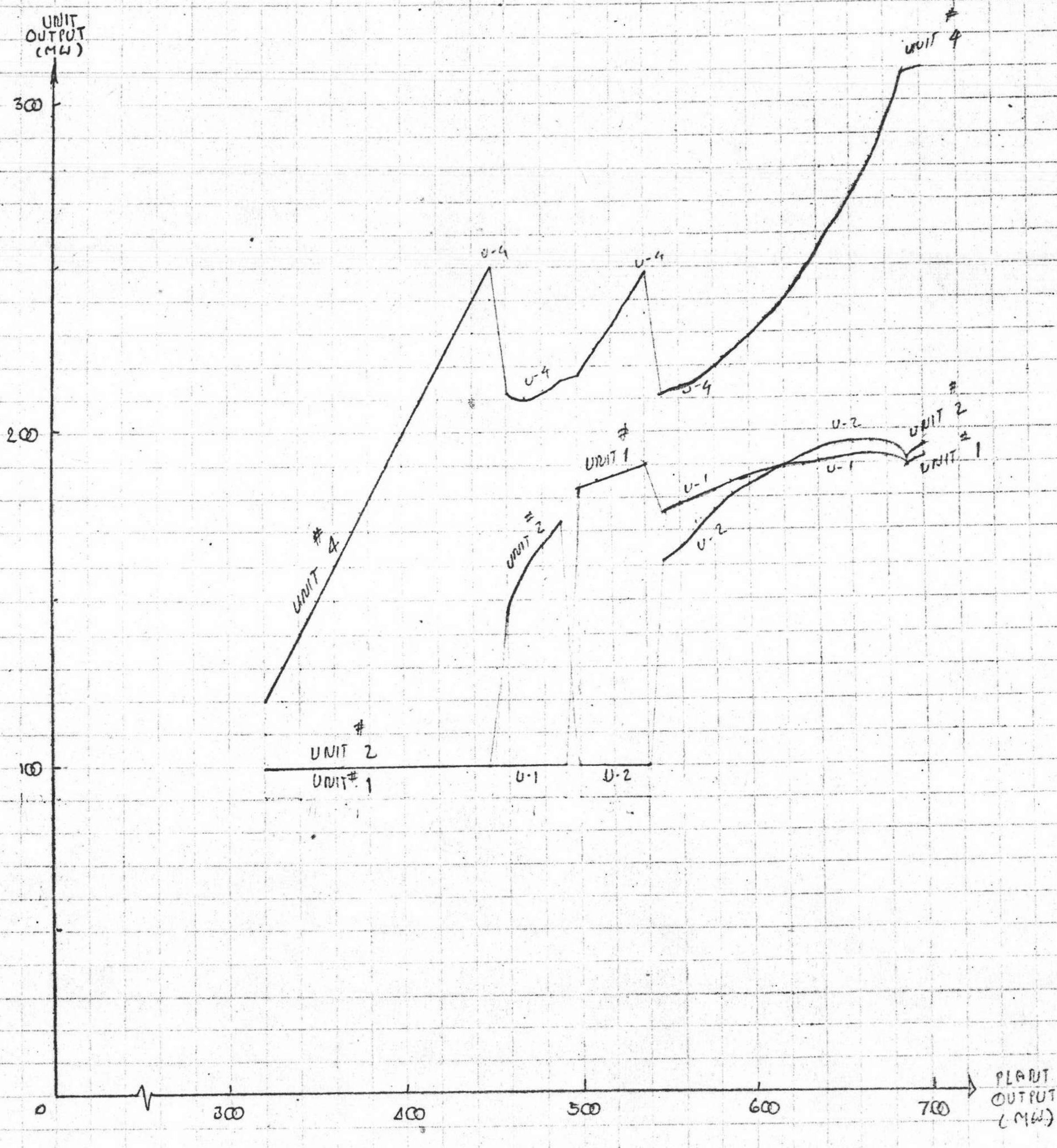

FIG. 4-2C. THE OUTPUT OF EACH UNIT VERSUS TOTAL OUTPUT OF THE PLANT IN CASE OF UNIT - 3 SHUTDOWN

EGAT	SUBJECT	SHEET No
EFFICIENCY	WORK	UNIT No
SECTION		
SOUTH BANGKOK		DATE

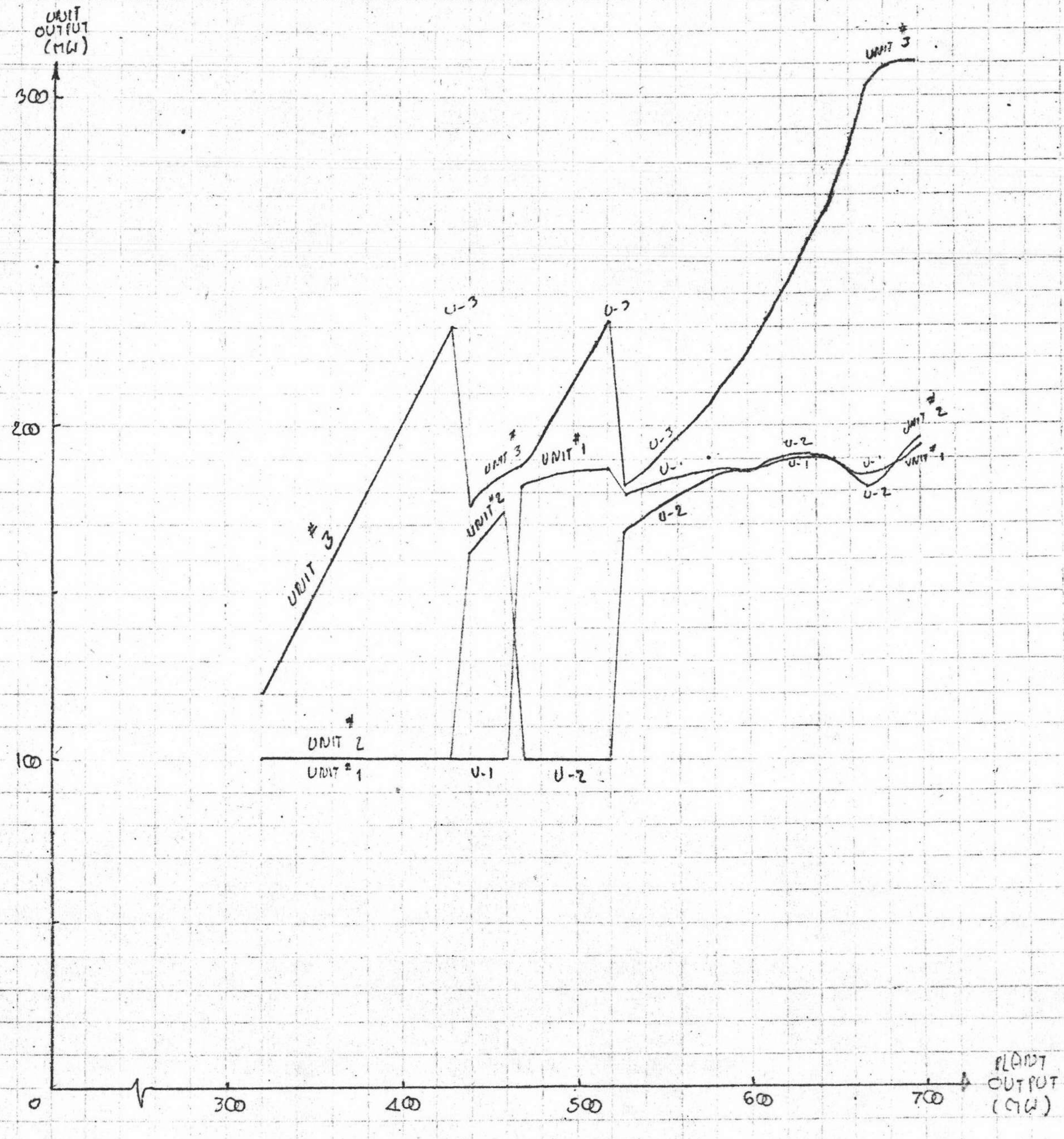

FIG. 4-2d. THE OUTPUT OF EACH UNIT VERSUS TOTAL OUTPUT OF THE PLANT IN CASE OF UNIT-4 SHUTDOWN

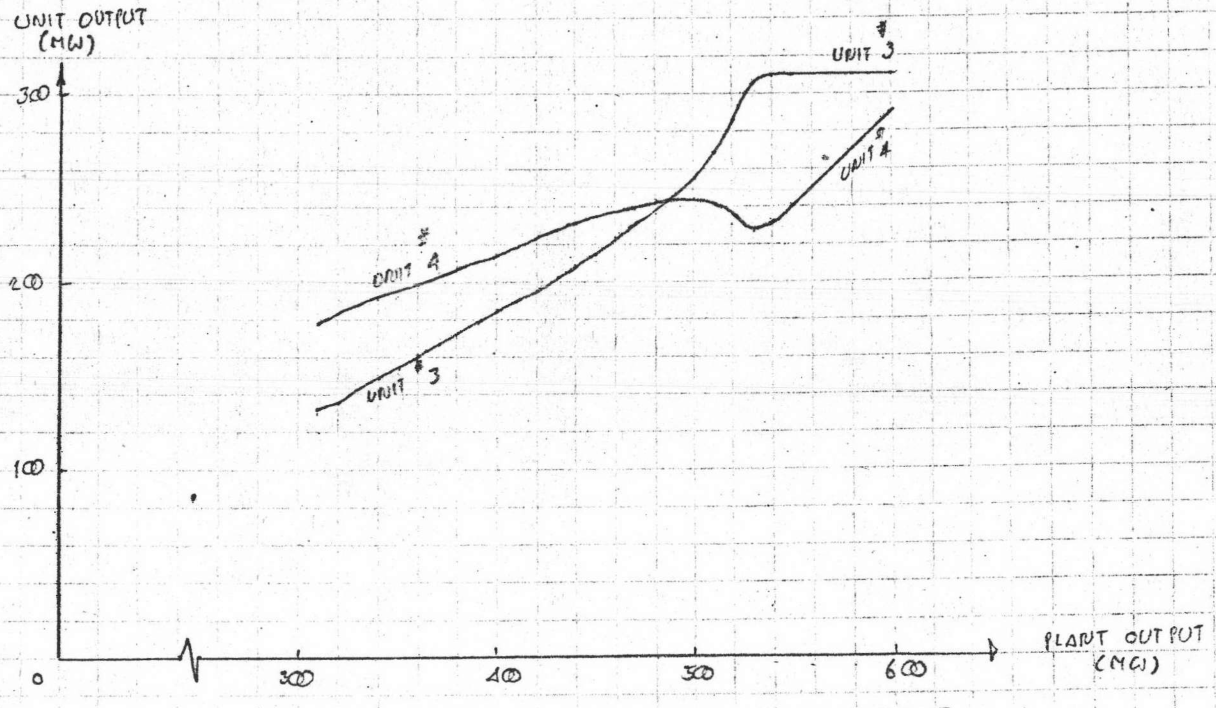

FIG. 4-3a. OUTPUT OF EACH UNIT VERSUS PLANT OUTPUT IN CASE OF UNIT 1 & 2 SHUTDOWN

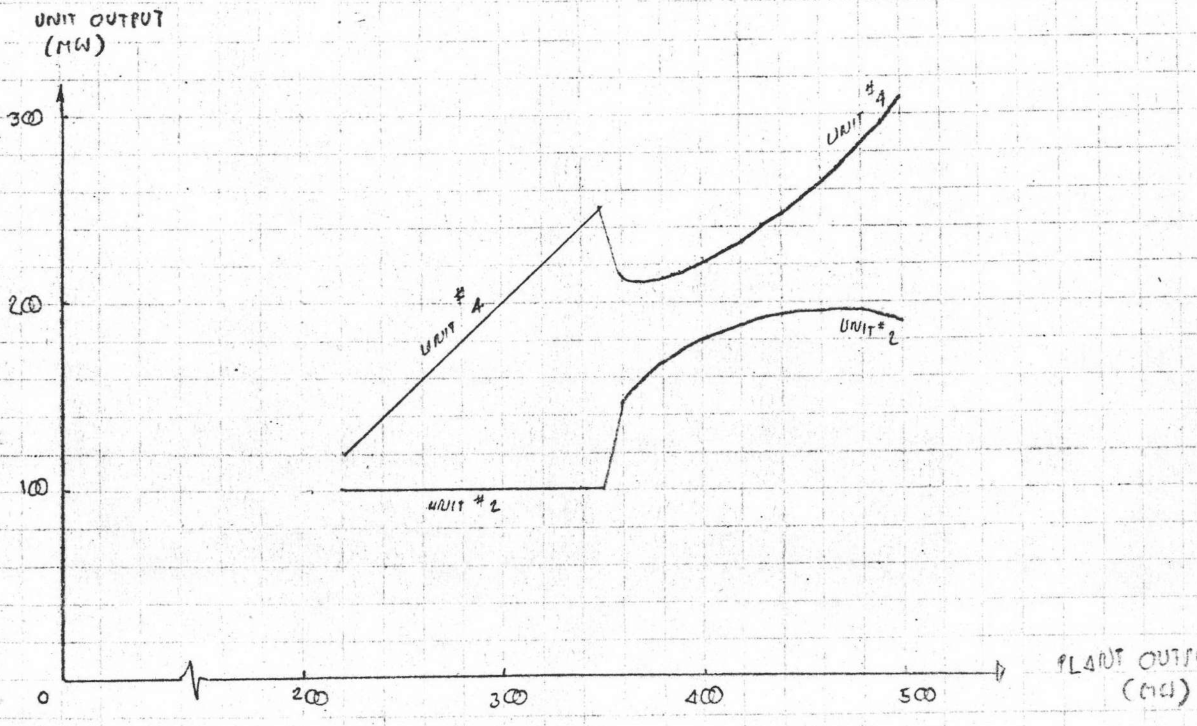

FIG. 4-3b. OUTPUT OF EACH UNIT VERSUS PLANT OUTPUT IN CASE OF UNIT 1 & 3 SHUTDOWN

EGAT SUBJECT ______ SHEET No ______

EFFICIENCY SECTION WORK ______ UNIT No ______

SOUTH BANGKOK DATE ______

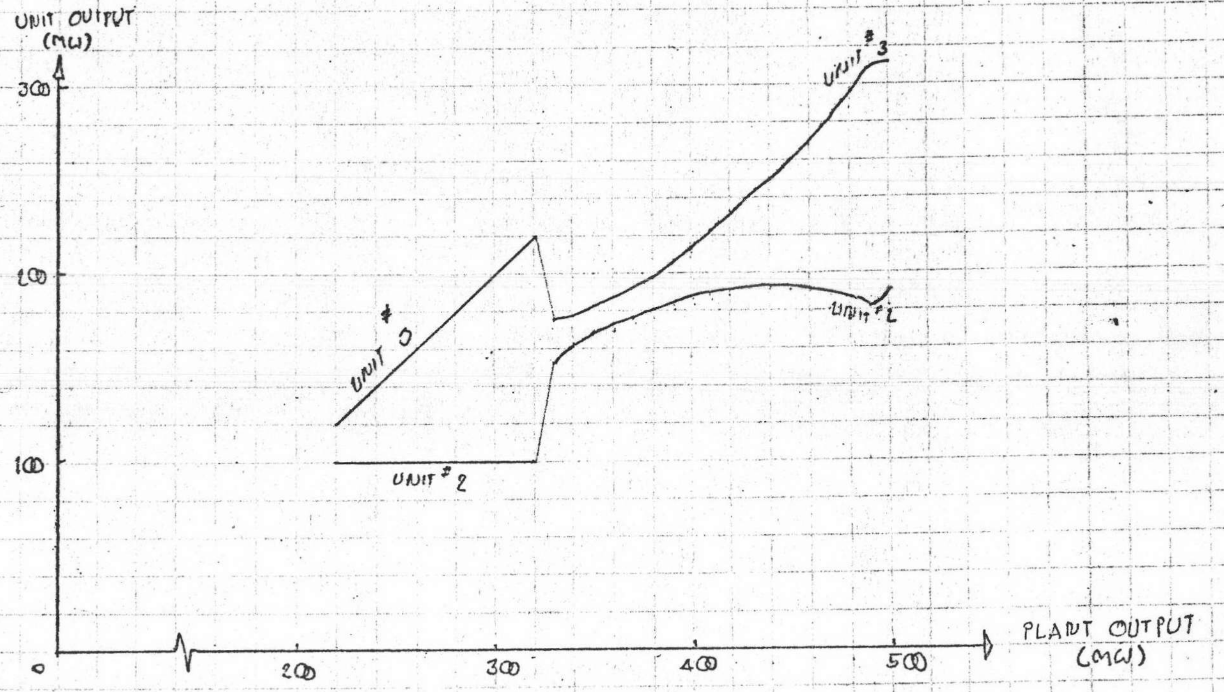

FIG. 4-3c. OUTPUT OF EACH UNIT VERSUS PLANT OUTPUT IN CASE OF UNIT 1 & 4 SHUTDOWN.

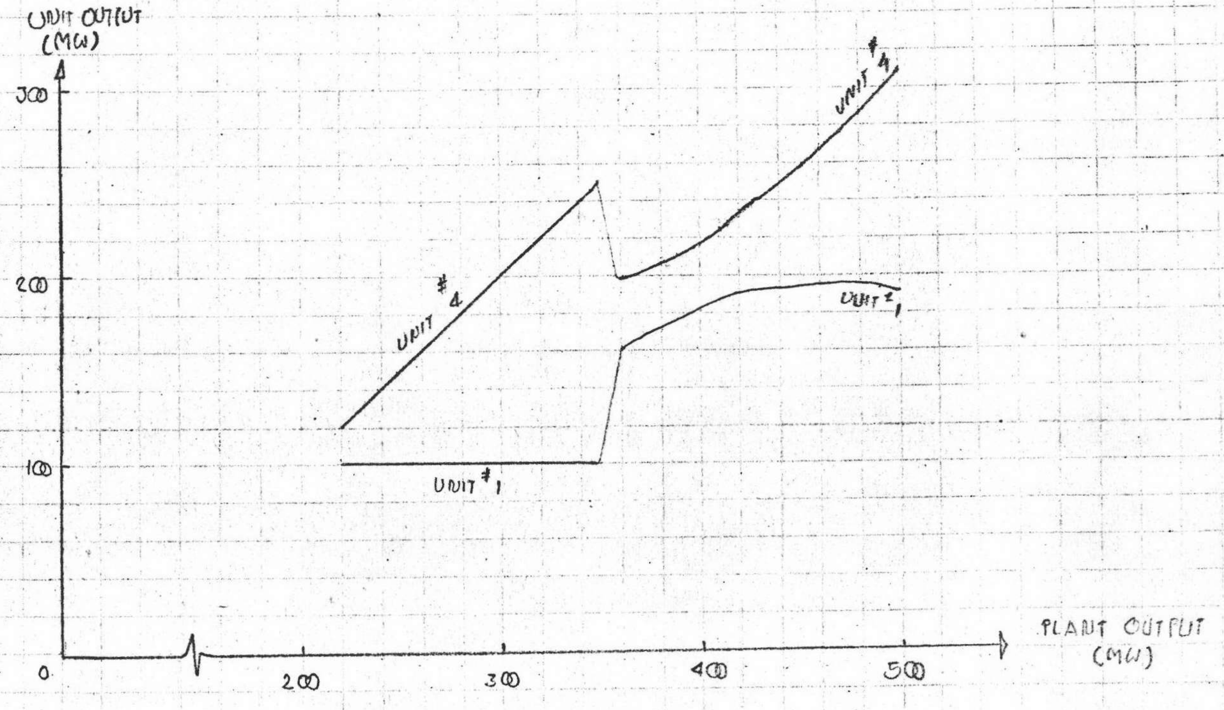

FIG. 4-3d OUTPUT OF EACH UNIT VERSUS PLANT OUTPUT IN CASE OF UNIT 2 & 3 SHUTDOWN

EGAT SUBJECT ______ SHEET No ______

EFFICIENCY SECTION WORK ______ UNIT No ______

SOUTH BANGKOK DATE ______

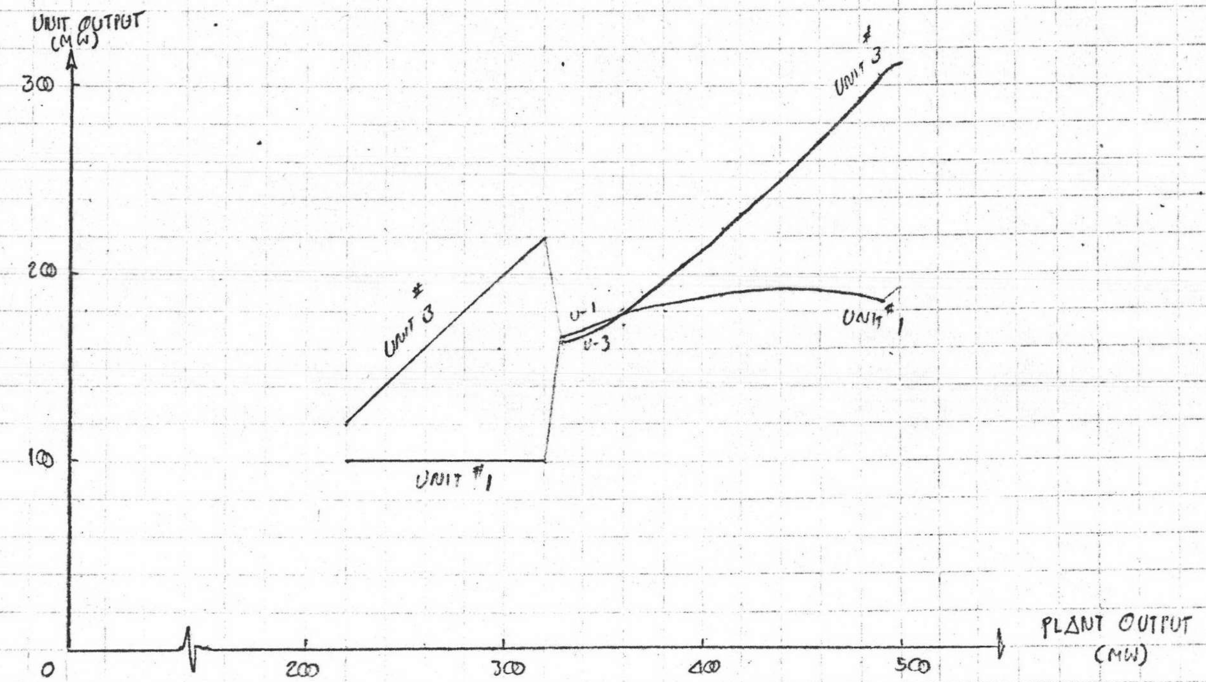

FIG. 4-3e. OUTPUT OF EACH UNIT VERSUS PLANT OUTPUT IN CASE OF UNIT 2&4 SHUTDOWN

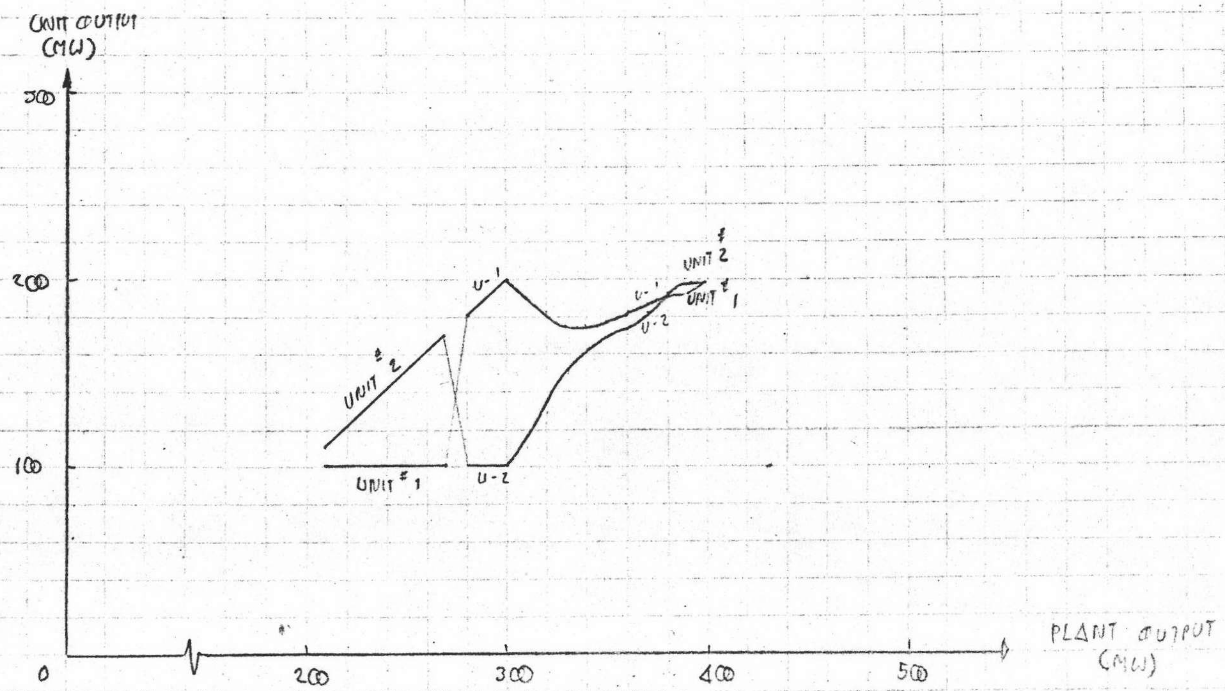

FIG. 4-3.f. OUTPUT OF EACH UNIT VERSUS PLANT OUTPUT IN CASE OF UNIT 3&4 SHUTDOWN