SYSTEM ANALYSIS AND APPLICATION
OF
CONSTRUCTION PLANNING

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By
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TO NİLGÜN

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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ABSTRACT

Taha Aksoy, M.S.
Middle East Technical University, 1972

The necessity of planning is analyzed from macro-economical, juridical and rationalization viewpoints. The function of planning in construction industry is also discussed.

The advantages and disadvantages of various construction planning methods are discussed in general. The fundamentals and logical background of network based planning techniques are explained and exemplified, for arrow and precedence diagrams separately. These two network types are compared and some criteria for selection are stated.

The network design procedure is illustrated for the case of Yeşilköy Airfield Infrastructure Project. The factors to be considered in all steps of network design are given.

The computational procedure for network based systems are illustrated systematically. The role of computers in network computations is described, by explaining the factors, benefits and problems of computer usage. The two available computer programs PCS and BKN are described in detail and compared in various aspects.

The role of project control in the overall planning effort is discussed and typical project control cycle is presented.

The factors which are to be paid attention for the effective planning and control of construction works are stated under the light of this study.

ÖZET

Taha Aksoy, Y.Lisans
Orta Doğu Teknik Üniversitesi, 1972

Bu çalışmada, plânlamanın makro-ekonomik gerekliliği üzerinde durulmakta ve inşaat endüstrisindeki yeri ve gereği rasyonalizasyon ve hukukî açılardan açıklanmaktadır.

İnşaat sektöründe kullanılan plânlama yöntemleri genel olarak eleştirilmekte, bu sektörde kullanılması en uygun bulunan, ancak uygulamanın yabancısı olduğu ağ diagramlarına dayalı plânlama yöntemlerinin temelleri ve mantıksal yapıları örneklerle açıklanmaktadır. Diagram tiplerinin karşılaştırılması sonucunda varılan bazı kıstaslar verilmektedir.

Ağ diagramlarının hazırlanışında izlenecek yol, Yeşilköy Havalimanı Altyapı İnşaatı örnek alınarak açıklanmaktadır.

Ağ diagramları ile ilgili hesaplamaların yöntemi ayrıntılı ve sistematik olarak sunulmakta, ayrıca elektronik hesaplayıcıların yeri ve önemi üzerinde durulmaktadır. Mevcut kompüter programları (PCS ve BKN) çeşitli yönlerden karşılaştırılmaktadır.

Proje denetiminin, plânlama çabaları içindeki yerinin ve öneminin açıklanmasından sonra, denetim mekanizmasının işleyişini gösteren tipik bir şema verilmektedir.

Yapılan çalışmanın ışığı altında, etkili plânlama için üzerinde önemle durulması gereken faktörler açıklanmaktadır.

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NOMENCLATURE

L_i	:	living standard in the year i
ΔL	:	annual increase in living standard
L'	:	annual rate of increase of living standard
P_i^o	:	total gross national product in the year i
ΔP^o	:	annual increase in gross national product
$P^{o\prime}$	:	annual rate of increase of gross national product
N_i	:	population in the year i
ΔN	:	annual increase in population
N'	:	annual rate of increase of population
$\bar{C}_N$	:	avarage consumption
V_c	:	total amount of consumption
C_v	:	unit cost of consuming goods
I_s	:	total annual saving
I_i	:	total investment in the year i
k	:	amount of investment needed for unit increase in gross national product
A	:	number of employed people
φ	:	ratio of employment
R	:	1971 worth of total net revenue
R_{1j}	:	1971 worth of annual net revenue due to passenger transportation in the j^{th} year of the period
R_{2j}	:	1971 worth of annual net revenue due to freight transportation in the j^{th} year of the period
R_{3j}	:	1971 worth of annual net revenue due to airport services in the j^{th} year of the period
n	:	number of years in the period of analysis

N_j : number of passengers to be transported in the j^{th} year

N_o : number of passengers transported in 1971

P_I : price of passenger transport to the avarage distance

C_I : cost of passenger transport to the avarage distance

i : the current interest rate

L_j : amount of freight to be transported in the j^{th} year

L_o : amount of freight transported in 1971

P_{II} : unit price of freight transportation to the avarage distance

C_{II} : unit cost of freight transportation to the avarage distance

M_j : gross revenue of airport services in the j^{th} year

M_o : gross revenue of airport service in 1971

I : 1971 worth of all investments

I_k : amount of investment made in the k^{th} year of the investment period

m : number of years in the investment period

E : 1971 worth of all annual maintenance expenditures

E_1 : annual maintenance expenditure

S : 1971 worth of salvage value

S_{15} : salvage value of all project elements at the end of their service life

r : rentability value

C : total cost of construction

C_1 : land cost

C_2 : interest cost

C_3 : consultation cost

C_4 : production cost

λ : factor of contractor's profit

C_{41} : cost of moving in

C_{42} : site overhead cost

C_{43} : business cost

C_{44} : capacity cost

C_{45} : cost of construction materials

e_1 : job efficiency

e_2 : management efficiency

a : labor efficiency

b : efficiency of machinery

A : number of manual laborers

B : quantity of machinery

h_A : working time of laborers

h_B : working time of machines

c_A : unit cost of labor

c_B : unit cost of machinery

S : quantity of construction materials used

c_s : unit cost of materials

l : transportation distance

c_T : unit cost of transportation

ε : time delay between two subsequent activities

t_{ij} : duration of activity (I, J) in arrow diagrams

t_a : optimistic time estimate

t_b : pessimistic time estimate

t_m : most likely time estimate

t_e : expected mean time

σ_{te} : standard deviation of activity duration

v_{te} : variance of activity duration

T_I^E or $EPOT_I$: earliest possible occurence time of event I

T_I^L or $LPOT_I$: latest permissable occurence time of event I

TF : total float

FF : free float

IF : interfering float

IND.F. : independent float

SF : scheduled float

T_{xe} : expected earliest event occurence time

V_{Txe} : variance of expected earliest event time

T_{xe} : expected latest event occurence time

V_{Tx} : variance of expected latest event time

T_x : expected mean time for an event

σ_{tx} : standard deviation of expected mean time for an event

T_s : event scheduled time

σ_{Tx} : standard deviation of expected project duration

ES : activity's earliest start time

EE : activity's earliest end time

LS : activity's latest start time

LE : activity's latest end time

CHAPTER I

INTRODUCTION

Construction sector, especially in developing countries, is of great importance from economical point of view. Because, as will be explained in Chapter II, a large portion of annual investments are allocated to this sector. In developing countries this share is even larger. It follows that the development efforts of these countries will be affected very affirmatively by the rational use of construction investments.

There are several measures to be taken to rationalize the construction sector among which construction planning has a sinificant role. The analysis and evaluation of construction planning techniques through application, constitutes the major aim of this study. For this purpose the Yeşilköy Airfield Infrastructure Project is selected for case study to analyze from planning viewpoint with cooperation of the Ministry of Public Works.

This project is a part of the Yeşilköy Airfield Extension Project which covers the following items(1):

- construction of a second runway,
- construction of a network of taxiways,
- extension of the present runway,
- construction of a new international air terminal and modernization of the present one,
- modification and/or extension of the various existing utilities.

The first two items of the extension project are, at this stage, the objectives of the infrastructure project.

This work, whose estimated cost is 84 425 923.- TL., was awarded to Fitzpatrick Overseas Ltd. on June 7, 1968; to be completed within 1200 calender days after the receipt of the written order to commence work(2). The contractor has started the work on site (Figure 1) on September 30, 1968 with an insufficient work capacity(3), which remained so until the end of April 1969. In this month he has enlarged his earthwork fleet which became mainly composed of: 17 bulldosers, 8 motorscrapers, 3 tractors, 3 excavators, 2 loading shovels, 1 backhoe and 7 compacting rollers. During the next 5 month the following were added to the equipment list: batch plant, 2 cement silos, 14 belt conveyors, 10 mobile cranes, 8 concrete mixers, 1 forklift, 1 concrete paver, 5 concrete spreading and finisihing machines, steel forms, air compressors etc.

The supervision of the project was to be carried out by the Directorate of 1. District of Airfields and P.O.L. (Petroleum, Oil and Lubrication) Installations Construction Department, which also prepared the documents for partial payments.

In the course of this study various problems related to construction planning are dealt with. The problems are analyzed in general on the example of the Yeşilköy Airfield Infrastructure Project wherever possible.

While discussing the construction planning methods in various aspects the emphasis is laid on the network based planning methods with which the Turkish practice is not familiar yet. Therefore these new management tools are handled in detailed, with the hope that they will serve Turkish construction sector in the shortest possible time.

In the preparation of job schedules by network systems the available computer programs (PCS and BKN) are employed. A great portion of computer outputs are included in this work in spite of their large volume, for better illustration purposes, enabling a detailed analysis of the project and comparison of the computer programs.

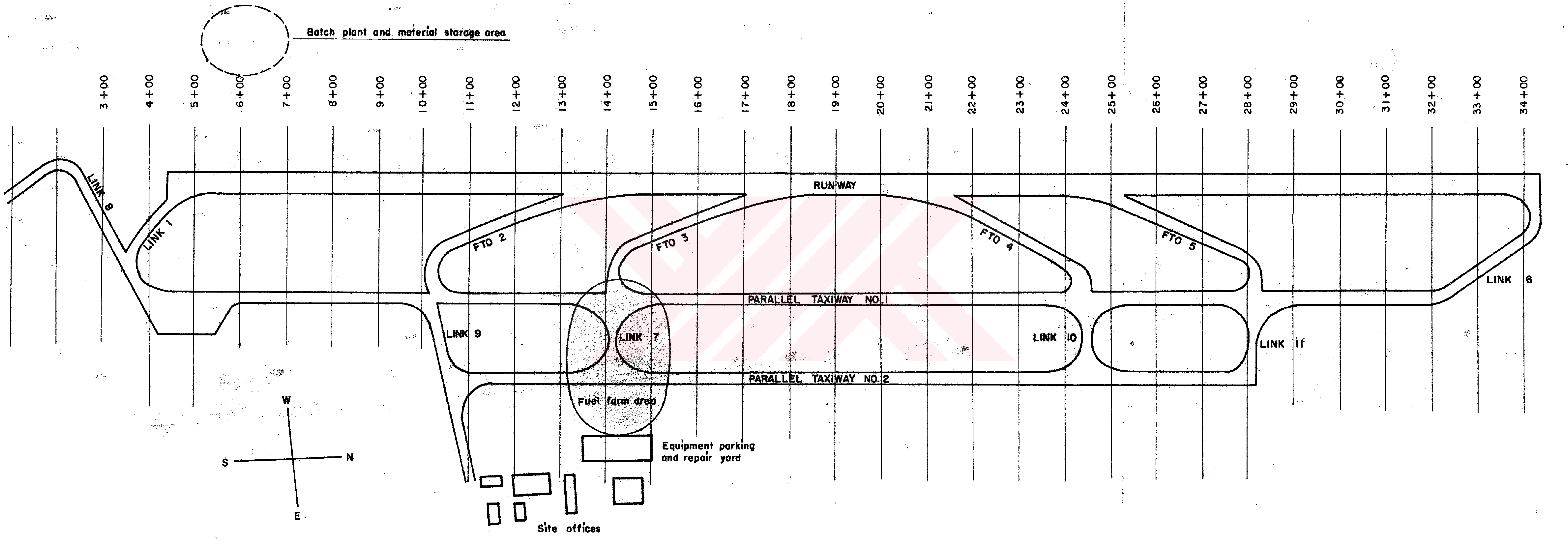


FIGURE 1 : YEŞİLKÖY AIRFIELD INFRASTRUCTURE CONSTRUCTION SITE LAYOUT

CHAPTER II

THE NECESSITY FOR PLANNING

A. MACRO-ECONOMICAL PLANNING

In all countries, the available resources are not sufficient to produce consuming goods and services by which the needs of citizens will be satisfied. This fact necessitates the existence of some mechanism that will make possible to decide on the needs to be satisfied and their priority in function of time and available resources. Such a mechanism, which is commonly called as "macro-economical planning", is needed more in developing countries, since the gab between the needs and the potentialities of these countries is larger than in industrialized ones.

Economical planning consists primarily of a twofold process of coordination:

i. Coordination of objectives; this involves laying down the priorities and allocating them to the selected targets,

ii. Coordination of resources to be employed to achieve these targets.

Coordination is necessary for both the overall development and the current running of an economy; it involves, first, analysis of interactions between the component parts of the economy and then controlling and rearranging the functioning of these parts to balance and to synchronize the whole system. Coordination must be projected several years ahead and this necessitates forecasting the factors which will govern the production and consumption. Therefore, economic planning may be defined as[4]: "high-level coordination based upon forecasts of certain basic factors in the economy".

Macro-economical planning is the only rational mean by which proper account can be taken of interactions between the various component elements of an economy. Planning, in a developing country, provides a general picture of developments in economical, technological, fiscal, social, juridical and other fields as well as the related changes in the structure of the economy.

The growth of any developing economy can neither be directed without planning nor can be properly controlled, since without planning there can be no clear concept of the interplays between the factors and mechanisms which control the operation and even more the development of an economic system towards a selected target. Therefore the growth of developing economies must be guided by planning.

There exists a strong interrelationship between the terms "planning" and "development", since what is meant by development automatically becomes the objectives of planning. In the broadest sense, the main target of planning is to promote the social welfare[5]. The economical way to achieve this target is to raise the living standard of citizens. If there exists an even distribution of income in a country, the standard of living can be expressed as[6]:

$$L_i = \frac{P_i^o}{N_i} \qquad (1)$$

where L_i - living standard in year i

P_i^o - total GNP in year i

N_i - population in year i

Then the annual rate of increase in living standard (L') becomes:

$$L' = \frac{\Delta L}{L_i}$$

$$= \frac{L_{i+1} + L_i}{L_i}$$

$$= \frac{\dfrac{P_{i+1}^o}{N_{i+1}} - \dfrac{P_i^o}{N_i}}{\dfrac{P_i^o}{N_i}} \qquad (2)$$

Defining annual rate of increase of GNP ($P^{o'}$) and annual rate of increase of population (N') as

$$P^{o'} = \frac{P_{i+1}^o - P_i^o}{P_i^o} = \frac{\Delta P^o}{P_i^o}$$

$$N' = \frac{N_{i+1} - N_i}{N_i} = \frac{\Delta N}{N_i}$$

Equation (2) may be rewritten as

$$L' = \frac{\dfrac{P_i^o(1+P^{o'})}{N_i(1+N')} - \dfrac{P_i^o}{N_i}}{\dfrac{P_i^o}{N_i}}$$

$$= \frac{1+P^{o'}}{1+N'} - 1$$

$$= \frac{P^{o'}-N'}{1+N'} \qquad (3)$$

By defining avarage consumption $\overline{C}_N$ as

$$\overline{C}_N = \frac{V_c \cdot c_v}{N_i} \qquad (4)$$

where V_c - total amount of consumption

c_v - unit cost of consuming goods

then, annual gross national product may written as follows

$$P_i^o = N_i \cdot \overline{C}_N + I_s$$

where I_s - total annual saving

If the number of employed people is A and GNP per employed person (overall productivity) is $\overline{P}^o$, then

$$A \cdot \overline{P}^o = N_i \cdot \overline{C}_N + I_s$$

Taking the annual savings approximately equal to annual investments

$$I_i = (A\overline{P}^o - N\overline{C}_N)_i$$

where I_i - total annual investment

Defining k as the amount of investment needed for a unit increase in GNP as,

$$k_i = \frac{I_i}{\Delta P^o}$$

Then the value of P^o becomes

$$P^{o'} = \frac{\Delta P^o}{P_i^o}$$

$$= \frac{\frac{I_i}{k_i}}{P_i^o}$$

$$= \frac{(A\overline{P}^o - N\overline{C}_N)_i}{P_i^o\ k_i}$$

Replacing P^o in equation (3) by this value of $P^{o'}$,

$$L' = \frac{\frac{(A\overline{P}^o - N\overline{C}_N)_i}{P_i k_i} - N'}{1 + N'}$$

Defining the ratio of employment (φ) as

$$\varphi = \frac{A}{N_i}$$

The rate of increase of living standard takes the following final form:

$$L' = \frac{N_i\ (\varphi\,\overline{P}^o - \overline{C}_N) - N' P_i^o\ k_i}{(1+N')\ P_i^o\ k_i} \qquad (5)$$

As the equation (5) clearly indicates, the following subobjectives should be achieved in order to accelarate the increase of living standard:

a. To create new economic fields of work increasing the ratio of employment (φ).

b. To raise the level of overall productivity ($\overline{P}^o$) by applying appropriate methods.

c. To reduce avarage consumption ($\overline{C}_N$) by decreasing either the amount of consumption (V_c) as in directed economies or the unit cost of consuming goods (c_v) as in free market economies.

d. To reduce the rate of increase of population (N') by birth control.

e. To reduce the adverse effect of k which tends to increase during the economical development by employing more advanced and rational technologies. The increasing tendency of factor k, due to the effect of succeeding investments, influencing the overall productivity adversely, can be controlled by optimisation of the investment structure of national economy.

B. FEASIBILITY ANALYSIS

In allocating the limited resources of a country to projects, a list of priority must be prepared, showing the contribution level of them to the development of the whole economy. The exact selection of economically sound projects is of extreme importance, because only by this way the overall productivity ($\bar{P}^o$) can be raised and also the increasing tendency of factor k can be controlled. Economical soundness of projects and their contributions to national economy can be determined by feasibility analysis. In the following paragraphs the methodology of such a feasibility study is presented on Yeşilköy Airfield Extension Project(7).

1. Objective: The economical objective of the proposed investments for the extension of Yeşilköy Airfield is to create additional capacity, thereby preventing the economical losses that will be caused by the demand for passenger and freight transportation which is expected to exceed the present capacity by 1972,

and to optimize the contribution of those investments to the national economy.

2. Period of Analysis: Since it was proposed that the project will be completed by 1972, this year is taken as the starting year of the period. A service life of 15 years is estimated for all project elements.

3. Benefits: The net revenues which are estimated to be realized due to extra capacity of passenger and freight transportation and of airport services over the existing capacity of the airfield are taken as the benefits of the project.

The computational procedure followed in the determination of revenues may be explained by the following set of relations in which 1971 worths of all revenues and expenditures are computed for comparison purposes.

$$R = \sum_j (R_{1j}+R_{2j}+R_{3j}) \qquad j = 1,2,\ldots,n.$$

where R – 1971 worth of total net revenue

R_{1j} – 1971 worth of annual net revenue due to passenger transportation in the j^{th} year of the period

R_{2j} – 1971 worth of annual net revenue due to freight transportation in the j^{th} year of the period

R_{3j} – 1971 worth of annual net revenue due to airport services in the j^{th} year of the period

n – number of years in the period of analysis

a. 1971 worth of annual net revenue due to passenger transportation:

$$R_{1j} = (N_j - N_o)(P_I - C_I)\frac{1}{(1+i)^j}$$

where N_j - number of passenger to be transported in the j^{th} year

N_o - number of passengers transported in 1971

P_I - price of passenger transport to the avarage distance

C_I - cost of passenger transport to the avarage distance

i - the current interest rate

The number of passengers to be transported are forecast for each year of the study period depending on the projections made [1] by means of available data.

P_I (and C_I) are determined separately for domestic and international lines by multiplying the weighed avarage distance of transportation by the unit price (cost) of travel.

b. 1971 worth of annual net revenue due to freight transportation:

$$R_{2j} = (L_j - L_o)(P_{II} - C_{II})\frac{1}{(1+i)^j}$$

where L_j - amount of freight to be transported in the j^{th} year

L_o - amount of freight transported in 1971

P_{II} - unit price of freight transportation to the avarage distance

C_{II} - unit cost of freight transportation to the avarage distance

c. 1971 worth of annual net revenue due to airport services:

$$R_{3j} = 0.35\ (M_j - M_o)\ \frac{1}{(1+i)^j}$$

where M_j - gross revenue of airport services in the j^{th} year

M_o - gross revenue of airport services in 1971

In this formula, it is assumed that 35 percent of the gross revenue is the net revenue (7).

4. Investments and Expenditures

a. Investments

According to the information obtained from the Airfields and P.O.L. Installations Construction Department (HATİR) the investment program of Yeşilköy Airfield Extension Project covers the investments to be made during the 1961-71 period for the following items:

i. Land expropriation

ii. Infrastructure

iii. Terminal buildings

iv. Installations for instrumental landing system

v. Maintenance installations of Turkish Airlines

The value of all investments at the end of 1971 can be computed as follows:

$$I = \sum_k \left[I_k (1+i)^{m-k} \right] \qquad k = 1,2,\ldots,m$$

where I - 1971 worth of all investments

I_k - amount of investment made in the k^{th} year of the investment period

m - number of years in the investment period

b. Expenditures

The annual expenditures that will be made for the maintenance and the repairs of all installations, which will not increase their inventory value and will not extend their service lives, are estimated. The operational expenditures are not considered, since they were included in the computation of net revenues. Then 1971 worth of all annual expenditures is computed as:

$$E = E_1 . \frac{(1+i)^n - 1}{i\ (1+i)^n}$$

where E - 1971 worth of all annual maintenance expenditures

E_1 - annual maintenance expenditure

5. Salvage Value

The theoretical economical lives of project elements varies between 25-50 years. But considering the fact that circumstances change very rapidly in air transportation field affecting the accuracy of demand forecasts adversely, the service lives of all project elements are taken as 15 years. The salvage values of installation are, thus, estimated for the end of this period. Then the 1971 worth of the total salvage value is computed as:

$$S = S_{15} \frac{1}{(1+i)^{15}}$$

where S - 1971 worth of salvage value

S_{15}- salvage value of all project elements at the end of their service life

6. Rentability

The result of a feasibility study can be expressed by the rentability value of the project. Two different formulas are being used for computing the rentability value. For instance, the State Highway Department takes the ratio of the difference between benefits and costs to costs, where the Airfields and P.O. . Installations Construction Department uses the benefit-cost ratio in rentability computation. Taking the latter one, the rentability value of the project can be expressed as:

$$r = \frac{R - E}{I - S}$$

where r - rentability value

If the current interest rate is 7% the value of r becomes 3.97 (397 %). This value is found to be 5.85 (585%) for Bursa Airfield Project[8].

C. CONSTRUCTION PLANNING

1. Economical Basis

a. Rationalisation

Construction sector is of great importance especially in developing countries. This fact can be observed from the investment distribution within the various sectors of economy in such countries. As the table 1 shows 60.8-76.4 % of total investments have been allocated to construction sector during the years 1956-1966, in Turkey.

Table 1. Construction Investments

Year	Total Construction Investment (10^6TL.)		Ratio of Construction Investments to Total Investment of Turkey (%)		
	Private	Public	Private	Public	Total
1956	1260.6	1191.0	37.5	35.4	72.9
1957	1417.8	1644.4	36.3	42.1	76.4
1958	1744.0	1824.6	35.6	37.2	72.8
1959	1985.4	2411.7	29.7	36.0	64.7
1960	2080.8	2736.4	27.7	36.4	64.1
1961	2107.5	2810.1	26.9	35.8	62.7
1962	2386.4	2906.3	27.4	33.4	60.8
1963	2637.7	3307.7	27.6	34.6	62.2
1964	2905.6	3807.5	29.1	38.9	68.0
1965	3438.6	4142.3	33.6	41.6	75.2
1966	4124.8	5162.7	30.1	37.6	67.7

Source: The Economic Report 1968 [10)]

Since construction investments have such a large share in total investments, any attempt to reduce construction costs would influence the productivity of overall investments. At the same time, if cost reduction can be realized in this field, it will directly affect the amount of avarage consumption ($\overline{C}_N$), because the unit cost of consuming goods and services (c_v) will be reduced. Consequently, the rate of increase of living standard (L') will speed up in connection with the decreased value of $\overline{C}_N$.

The cost structure of constructions must be carefully analyzed in order to be able to determine the necessary and effective measures to be taken for cost reduction. In the following paragraphs a cost model[11] will be given which clearly illustrates the cost structure of constructions:

$$C = C_1+C_2+C_3+(1+\lambda)C_4$$

where C - total cost of construction

C_1 - land cost

C_2 - interest cost

C_3 - consultation cost

C_4 - production cost

λ - factor of contractor's profit

Among these cost factors, production cost (C_4) has the largest share (up to 70%). Therefore the primary objective of rationalisation in construction sector should be the reduction of production costs.

The production cost (C_4) may be defined as:

$$C_4 = C_{41}+C_{42}+C_{43}+C_{44}+C_{45}$$

where C_{41}- cost of moving in (ie. cost of erecting equipment and plants)

C_{42}- site overhead cost (ie. costs in site office)

C_{43}- business cost (ie. administrative costs)

C_{44}- capacity cost (ie. cost of labor and equipment)

C_{45}- cost of construction materials

Generally in buildings, C_{45} constitutes 60% of the production cost (C_4) and the share of other factors in C_4 are:

C_{44}, 30 %; C_{41}, C_{42} and C_{43}, althogether, 10 %.

If we analyze further, the factors having large shares (C_{44} and C_{45}):

Capacity Cost (C_{44})

The primary elements of capacity are labor and machinery. Therefore the capacity cost (C_{44}) depends on the quantity of laborers (A) and of machines (B), their unit costs (c_A, c_B), their efficiencies (a, b) and their working times (h_A, h_B). The mathematical expression of this statement is:

$$C_{44} = \frac{1}{e_1 \cdot e_2} \left[\frac{1}{a} A\, h_A c_A + \frac{1}{b} B\, h_B c_B \right]$$

where
- e_1 - job efficiency
- e_2 - management efficiency
- a - labor efficiency
- b - efficiency of machinery
- A - number of manual laborers
- B - quantity of machinery (tons)
- h_A - working time of laborers (hrs)
- h_B - working time of machines (hrs)
- c_A - unit cost of labor (MU/hr /laborer)
- c_B - unit cost of machinery (MU/hr/ton)

It is obvious from this formula that the measures to be taken to reduce the capacity cost (C_{44}) are mainly:

i) maximization of the job efficiency (e_1) by preparing convenient designs for speedy, easy and well defined production;

ii) maximization of the management efficiency (e_2) by effective site planning and job scheduling considering repetitions and flow work;

iii) maximization of the labor and machinery efficiencies (a, b) by training the personnel, paying wages according to performance and by microplanning, ie., planning and organising the job place in order to create favorable job conditions in viewpoint of higher productivity and less strain.

iv) determination of the optimum grade of mechanisation ($d = h_B . B / h_A . A$) corresponding to minimum capacity cost (C_4).

Materials Cost (C_{45})

The materials cost (C_{45}) is a function of definite variables some of which reflects the influence of external conditions. Mathematically:

$$C_{45} = S\,(c_s + l . c_T)$$

where S - quantity of materials used (tons)

c_s - unit cost of materials (MU/ton)

l - transportation distance (Km)

c_T - unit cost of transportation (MU/Km/ton)

The measures to be taken to keep the materials cost (C_{45}) low are:

i) minimization of the amount of materials to be used by:

- increasing the ratio of useful area to construction area,
- preparing structural designs which save material,
- good quality control during construction,
- preventing the waste of material

ii) minimization of the unit cost of materials (c_s). This factor can be affected only by macro-economical measures such as:

- encouraging the mass production methods in construction materials industry,
- allocating sufficient financial credits for industrialisation in this field,
- standardisation of contruction materials
- creating a steady demand level (public demand) for construction materials,

iii) minimization of the transportation distance (l) and the unit cost of transportation (c_T) by using local construction materials wherever possible.

b. The Planning Function

Planning is the process of coordinating the elements of work (activities) and production (partners) in function of time, considering flow work and resource leveling which increase productivity and decrease costs. Therefore it involves the selection of the system of work to be adopted for a project from all the alternative ways and sequences in which it could be done.

The first step of construction planning process is the selection of the optimum capacity for the given project. In this step the optimum value of grade of mechanisation (d), qualification of workmanship and of equipment, and the local materials to be used are determined.

The second step is the sequencing of project activities. Atmost care should be experienced in sequencing the activities to increase the productivity of both labor (a) and machinery (b) by reducing time losses due to shifting of teams from one place to another. The labor productivity (a) can also be increased by providing a team to work on similar types of work. By proper sequencing of activities the need for extra capacity can be reduced to minimum without extending the project duration. This process is known as "resource leveling" and is a very effective measure for reducing the capacity cost (C_{44}).

In cases where the project completion date is not given, the project duration corresponding to the minimum value of project total cost should be selected. As discussed in Chapter V, total project cost includes losses due to late completion and benefits of early completion. Therefore accomplishing a project in its optimum duration increases its contribution to the national economy.

Based on the aforegoing discussion its possible to conclude that "planning is a very effective mean of rationalisation, i.e., in reducing the construction costs". The degree of effectiveness, of course, depends on many factors among which the followings may be stated: availability of reliable data, a suitable organizational structure which ensures the collection of them by information flow and acts accordingly with proper cooperation, and selection of an appropriate planning technique. These factors affect also the management efficiency.

These points will be fully discussed in the following chapters.

2. Juridical Basis

This forms the obligatory rules of action.

The general requirements for construction planning are stated in the Article 6 of the "General Provisions for Public Works"[13] which takes place among contract documents of all public biddings as:

"The contractor shall prepare a work program and shall have it approved by the administration. In this program all project days, excluding official holidays and days with unfavorable weather, will be taken as working days.

The contractor has to conform exactly with the work program approved by the administration."

On the other hand, "Annual Program - 1969"[14] which is prepared by the State Planning Organization in accordance with the "Second 5 - Year Development Plan" accepted by the Parliament, states that:

"In planning the projects having estimated costs upto 100 million TL, "bar chart" method will be used. The projects with estimated costs over 100 million TL will be planned by planning methods like CPM or PERT."

Further requirements may be included in general specifications of the related administration. For instance, the requirements of the Airfields and P.O.L. Installations Construction Department for the planning of Yeşilköy Airfield Infrastructure Project are[2] ;

"Within 15 days after the contractor is informed that the contract is approved, He shall submit a detailed work program prepared separately for each work section showing also the progress of work,

This program which shall be prepared in conformity with the type given by the Administration, shall also indicate the fixed dates of the progress of the work, specially of the various installations, material stockpiling and arrival of the main materials to the job site etc.

The contractor shall inform the Administration in writing, immediately after each delay in the work program and state the reasons of delay, and the period of delay, and the measures He should take to overcome this delay.

If during construction work the Control Engineer notices any deviation from the work program and warns the Contractor, the latter must prepare and submit a new work program, within 8 days after receiving this warning. This work program must have the necessary corrections in order to prevent any delay in completing the project within the allowed duration.

With the acceptance of this new program the Contractor has to make the necessary changes in his job site organization. All additional expenses as result of these changes shall be the responsibility of the Contractor.

In cases when the accepted new program cannot meet the given project end date, the contractor will not be released from any delay penalties.

An operation plan clearly showing the progress of work on the job site shall be submitted to the Control Engineer in three copies in every 15 days. This plan shall also include a scaled graph showing the completion percentages of all kinds of construction previously asked for and the gradual progress of work on the job site."

CHAPTER III

CONSTRUCTION PLANNING METHODS

A. GANTT CHART

The Gantt Chart is a series of horizontal bars plotted against a time scale, each bar representing beginning and completion times, together with duration of a work item in a project. In addition, a second line parallel to the first one may be drawn for each project element, to show actual work done against the required one given in the original plan, indicating the performance.

The Gantt Chart, which is also known as bar chart, has found wide area of application as a planning technique in various fields of industry, since Herny Gantt invented it around 1900. The advantages offered by this technique have led managers to adopt it. These advantages may be summarized as:

The Bar Chart can be understood very quickly and completely not only by the project managers, but also by their subordinates and superiors Becamse :

- The organizations are used to it, since it is an old method of planning,

- It is simple, since work is presented very clearly in function of time.

But as the contemporary management began to deal with large scale and complex engineering projects some fundamental weaknesses in bar charts were observed.

These weaknesses are:

i) The conventional bar charts do not display interdependencies between the project elements, which are general work items, each represented by a bar, and activities. Since such interdepencies should be kept in mind while preparing the bar chart, they should also be reflected in charts in order to control and discuss the plan easily. This is especially true in large-scale and complex projects involving numerous activities with various types of interrelations.

ii) Since bar charts do not show relationships between time and volume of works, they are one-dimensional. This fact limits their performance in comparison with other methods of planning, especially with cyclogrammes.

iii) The Gantt chart does not indicate critical activities which delay the project completion date if they cannot be completed within the assigned duration, and also those activities which have some extra time for their completion over their durations, and the amount of those extra times.

iv) Some large-scale and unusual type of projects, including those involving natural hazards and research works, may necessitate the consideration of uncertainties in planning. Since bar charts do not reflect uncertainties, they cannot be used for the planning of such projects.

The evaluation of both advantages and disadvantages of bar charts, results in the fact that they possess low efficiency in coordination, but high efficiency in communication. For optimization purposes, bar chart may be used as a planning technique in small construction projects which consist of a small number of activities having simple relationships between them. For larger projects bar charts are developed giving the interrelations between the bars. On the other hand the advantages of the Gantt Charts in communication, may be used by displaying the project program prepared by other improved planning methods with them, thus making the program more communicative. Such a chart is presented in Appendix F for Yeşilköy Airfield Infrastructure Project.

In spite of the conclusion reached above, many construction managers in Turkey employ this method, regardless of the size and the complexity of the project to be planned, because it is simple and requires, less effort and skill for its preparation than the other techniques do. The shortcomings of barcharts have almost never been taken account, mainly because of:

i) The concern of contractors which is usually the quick fulfillment of Article 6 of "General Provisions for Public Works[13]", to start with their construction work as soon as possible,

ii) The lack of data and experience of contractors in other systems due to considerable fluctuations in construction sector,

iii) The wrong policy of awarding contracts, according to which no sufficient time is left by the owner for detailed design and planning of work,

iv) The inefficiency of supervisory mechanism, due to the lack of adequate organization and quality, which prevents the diagnosis of the disadvantages of planning by bar charts.

B. CYCLOGRAMME

A cyclogramme is a graph displaying the project elements in relation to a common unit of work and time. It is, therefore, a two-dimensional system, originally used in railway time tables. In construction, it is commonly used for planning of highway and pipeline projects, the common unit of work, in these cases, being the length in kilometers. Cyclogrammes can also be used in building construction, the common unit being, this time, (%) of completion shown for different floor levels on a vertical axis.

All possible types of relationships between the project activities can be set while planning by cyclogrammes:

a. The start of activity J depends on the completion of activity I with an associated time delay of ε ($\varepsilon \geq 0$). For instance casting of concrete (J) requires the completion of formwork erection.

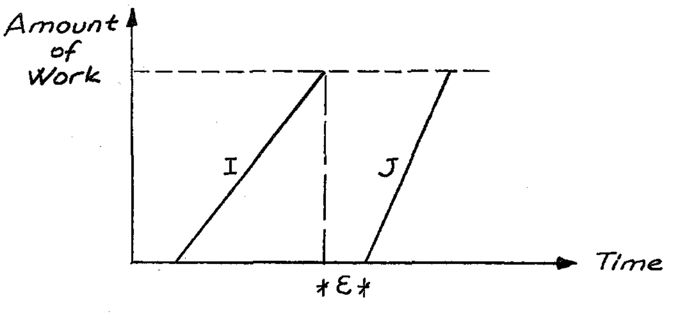


Figure 2 . End to start relationship in cyclogrammes.

b. The start of activity J depends on the start of activity I with an associated time delay of ε ($\varepsilon \geqslant 0$). For instance excavation operation (J) can be started ε time units after the start of ground water lowering operation (I).

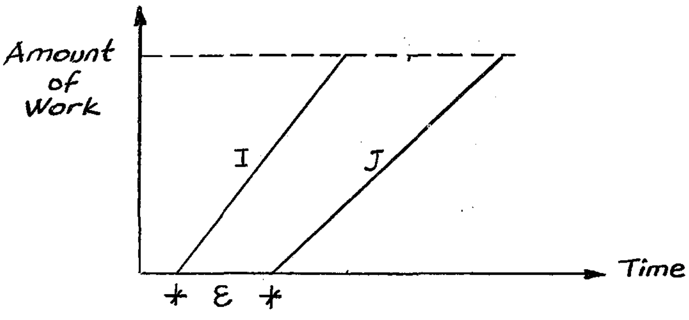


Figure 3 . Start to start relationship in cyclogrammes

c. The completion of activity J depends on the completion of activity I with an associated time delay of ε ($\varepsilon \geqslant 0$). For instance preparation of contract documents (J) cannot be finished before completing the bills of quantities (I).

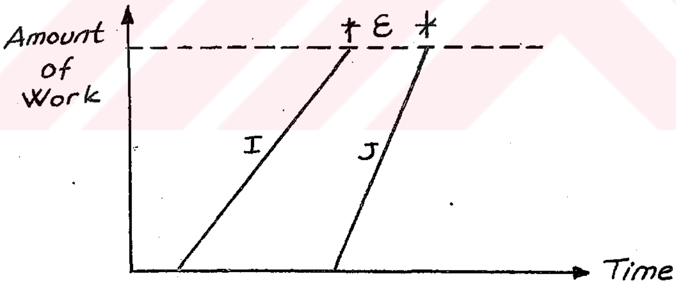


Figure 4 . End to end relationship in cyclogrammes

d. The completion of activity J depends on the start of activity I with an associated time delay of ε ($\varepsilon \geqslant 0$). For instance model analysis of a structure (J) can be finished if the provisional structural analysis (I) is started and a certain part of it (rough calculations) is completed.

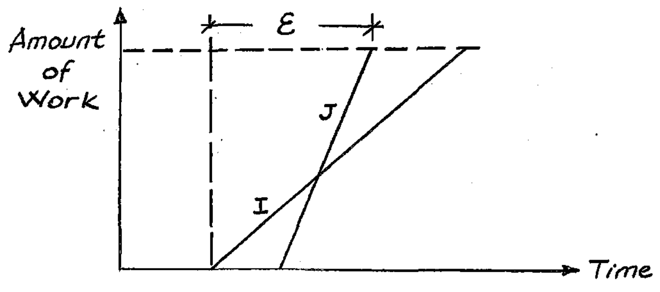


Figure 5. Start to end relationship in cyclogrammes

e. Either the start of activity J depends on the start of activity I or the completion of J depends on the completion of I with an associated time delay of ε ($\varepsilon \geq 0$). For instance such a relationship exists between the activities laying of pipes (J) and trench excavation (I).

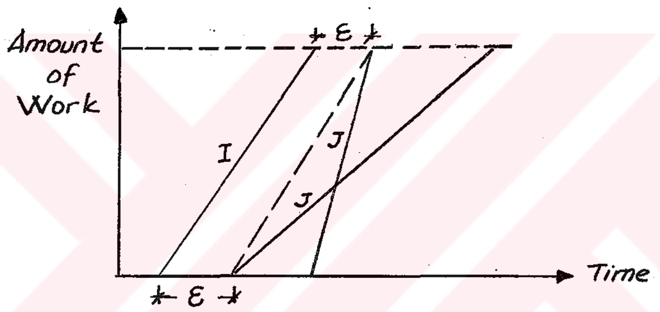


Figure 6. A combination of start to start and end to end relationship in cyclogrammes

Planning with cyclogrammes offers the following advantages.

i) All types of relationships between the project activities can be indicated.

ii) Each activity is plotted in such a way that its duration and volume can be easily observed.

iii) The production rate can be determined by dividing the volume of work by the time of execution (the slope of activity line). Also, the time and place of changes in the speed of activity execution can be seen.

Cyclogramme, as a planning technique, has some disadvantages:

i) Its usage is restricted to the projects whose activities can be expressed in terms of a single unit of work amount.

ii) In case of complicated or interfering flow of works, the job schedule becomes very confusing.

iii) The critical and noncritical activities cannot be distinguished, and, therefore, the amount of extra times for noncritical activities cannot be observed in cyclogrammes.

C. NETWORK BASED PLANNING METHODS

1. Introduction

In 1956 the E.I. du Pont de Nemours Company was under a series of contracts to construct major chemical plants in America. The projects required accurate estimation of both duration and cost. The planning and controlling technique developed by this company for the above mentioned projects was originally called "project planning and scheduling" (PPS). This method improved into the "critical path method" (CPM) which represented project logic in graphic form in 1957 when Univac Application Research Section joined the program.

On the other hand, the U.S.Navy was concerned with the control of contracts for its Polaris Missile Program. These contracts included research and development work as well as the manufacture of component parts which were never made before. Therefore neither cost nor time could be estimated accurately, as a consequence completion times had to be based on probability. Contractors were asked to estimate their time requirements on three bases: optimistic, pessimistic and most likely dates. Assuming a β distribution form these estimates were then mathematically assessed to determine the probable completion date for each project. This procedure was referred to as "program evaluation and review technique" abbreviated to PERT. This method did not consider cost as a variable but later the cost data on the same sort of probability basis has been introduced, and this system is known as PERT/COST.

Between the years 1963 and 1967 Prof. Burkhart, director of the Institute for Construction Management Science in the Technical University of Munchen has developed a new network based system and named as "Baukastennetz"[18] abbreviated to BKN, which handles only the projects having activities of definite durations. Later on, he has developed other programs to be used with the original one to handle the special aspects of planning. These are (see Appendix B.2.II): BKN-BAR, BKN-BLOCK, BKN-CUT, BKN-PERM, BKN-CONTROL, BKN-MOD , BKN-POT and BKN-COST.

Network based planning methods are new and powerful tools for planning and management of all types of projects. They involve, first the representation of a project implementation plan by a schematic diagram (network) that illustrates the sequence and interrelation of all component parts of the project, and then the logical analysis and manipulation of this network in determining the best overall program of operation. Among these methods CPM and BKN draw special attention in construction industry, and provide a more useful and precise approach than the conventional bar charts and cyclogrammes.

2. Advantages of Network Based Methods

Network based planning techniques have found a wide area of application especially in planning and controlling of large construction projects. The reasons of their rapid adoption may be summarized as:

i) The determination of critical path which is of prime importance in project implementation and control related with time scheduling.

ii) The abilityto show realistically and comprehensively the interdependencies between the project subelements enabling easy controls and discussion of alternatives.

iii) The potentiality for a more realistic estimation of the total length and cost of the project because of a fine breakdown of the project into many small activities provided that reliable data are available. The need for such data forces the development of data banks.

iv) During the execution of the project, the use of computers enable the systematic and rapid reviewing of current situations as well as evaluation of future developments so that allowance can be made at once in case of any deviation from the original plan. Short time controls increase the efficiencies of planning and management considerably.

v) The use of computers decreases the time of planning by cancelling routine calculation work originally made by engineer. This reduces the cost of planning and control and enables the consideration of possible alternatives, thus increasing again the efficiency of planning and control.

iv) Computer prints can be used as control documents showing deviations and responsibilities. They may also be used as contract documents in new agrements between the owner and the contractor, related with changes in the work schedule.

vii) The program evaluation and review technique (PERT) enables the planning and controlling of research and development projects whose activities are uncertain in terms of duration and cost.

The objections raised, in spite of the advantages offered, to network based systems focus at two points:

i) In comparison with the bar chart, the network systems are complex management tools. The bar chart is simple to prepare and its two coordinates, time and effort, are simple to visualize on the scales of the chart. But a network is basically nondimensional and does not provide scales for the measurement of time and effort.

ii) Since the network based methods are essentially computer oriented techniques,their application costs are high for small projects.

The objection related to the problem of communication can be nullified by displaying the network analysis results by bar charts. The second one holds true if computer is employed even for simple and small networks which can easily be analyzed manually.

3. Network Diagram

A network is a graph consisting of nodes and arrows representing activities and events.

Network diagrams are of two main types:

a. Arrow Diagrams

In an arrow diagram, each arrow represents one activity and the relation between activities is represented by the relation of one arrow to the others, covered by a mode; each node represents an event. The length of the arrow has no significance; it merely represents the passage of time in the direction of head. Each arrow of the network is identified by its tail and head events.

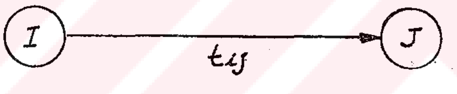
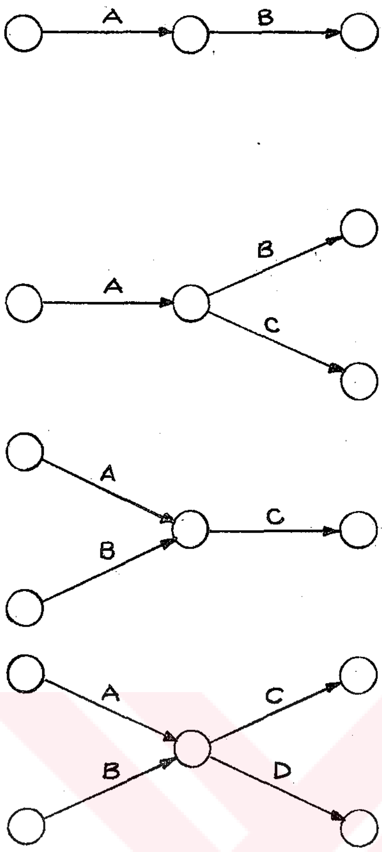


Figure 7. Activity notation in arrow diagrams

The simple logic behind this type of diagramming is that the start of all activities leaving a node, depends on the completion of all activities entering that node. This logical background is exemplified in figure 8. As the diagrams of figure 8 imply, only "end to start"type of relation can be set in an arrow diagram.

Diagram | Logic



(1) - Activity B can begin only after operation A is completed.

(2) - Neither activity B nor C can start before activity A is completed, but B and C can be performed concurrently.

(3) - Activity C can begin only after both activities A and B are completed.

(4) - Neither activity C nor D can begin until both A and B are completed, but C can be started independent of D or vice-versa.

Figure 8. Elementary network logic in arrow diagrams

In some cases, dummy and artificial activities are necessarily used:

i) Dummy activities are employed to keep the logical sequencing of activities, and their interrelationship, correct. Such a case is illustrated in figure 9. If the start of activity C depends on the completion of activity A, and the start of activity D depends on the completions of activities A and B where B and C are independent activities which can be performed concurrently, the employment of dummy activity E is unavoidable to keep the logical structure of the network correct.

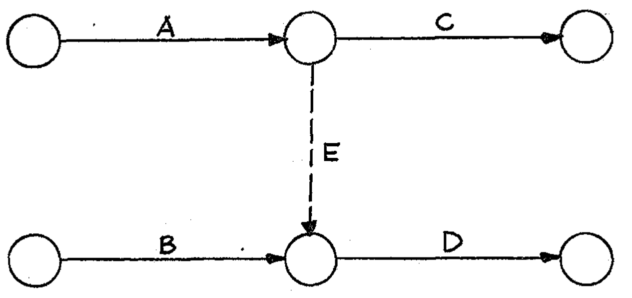


Figure 9. Use of dummy activity in arrow diagrams

ii) Dummy activities are also employed to keep the numeric designation unique,for event numbers at the tail and head of each arrow.

For example, if the starts of activities B, C and D depend on the completion of activity A and if their completions are required for the start of activity E, the use of two dummy activities is necessary, in order to be able to express activities B, C and D with different tail-head event number combunations. This case is illustrated in figure 10. a and b.

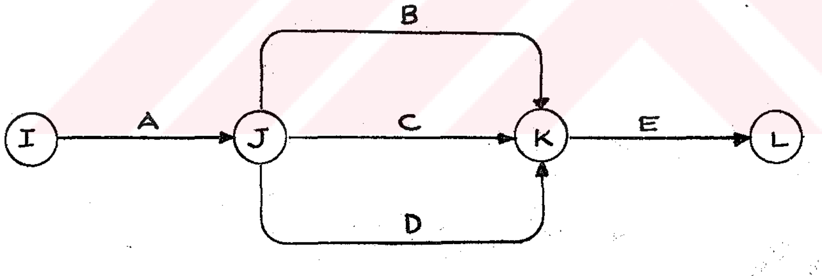


Figure 8. (a) Wrong diagramming. Because activity notation (J-K) represents B, C and D.

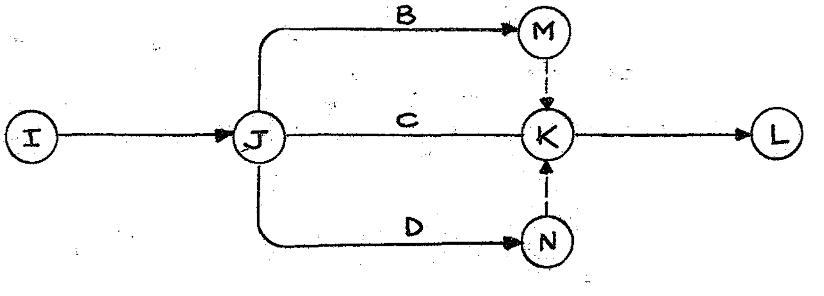


Figure 8. (b) Correct diagramming. Each activity has different numeric designation.

The use of artificial activities may be exemplified by such a case in which time lag ε is required between the completion of one activity and the start of another.

Figure 11. Use of an artificial activity (A_jk)

It is very difficult, if not impossible, to set "start to start" and "end to end" relation types between the project activities when such relationships exist. The employment of dummy and artificial activities, and breaking down some activities into pieces may assist to a certain extend in introducing such relationships into network diagrams. But resulting network does not reflect the exact logic of "start to start" and "end to end" relationships.

For instance, if the start of activity B depends on the start of activity A, it is commonly attempted to display this relationship by using a dummy from head event of A to that of B, as shown in figure 12 (a). But such a diagram portion, which is equivalent to the one in figure 12 (b), shows nothing but the independency of activities A and B. Therefore it can be concluded that "start to start" relation with no time lag cannot be set in arrow diagramming.

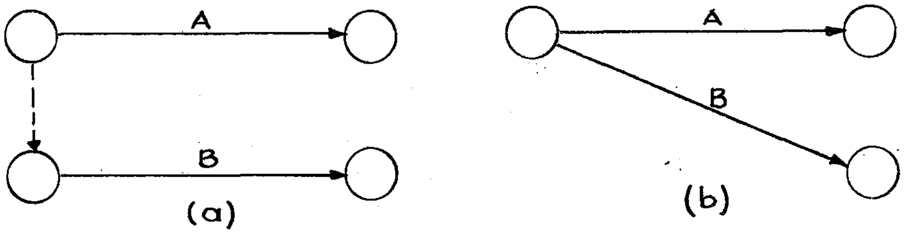


Figure 12. An attempt to set "start to start" relation.

If activity B can start ε time units after the start of activity A, the breakdown of activity A into two pieces, so that first part will have duration of ε and the second one (Figure 13) will have $(t_A - \varepsilon)$ as its duration, may help in diagramming. But if A is a continuous activity which cannot be performed piecewise, the continuity between its component parts must be provided while scheduling.

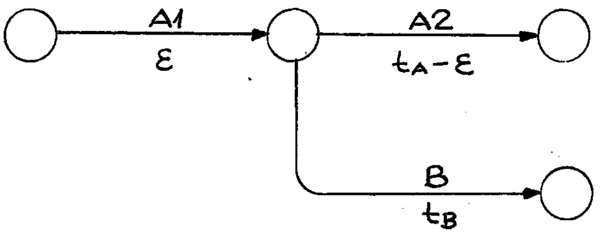


Figure 13. Partitioning of activity A to set "start to start" relation.

Another incorrect attempt is to use dummies when "end to end" relation exists between two activities (Figure 14).

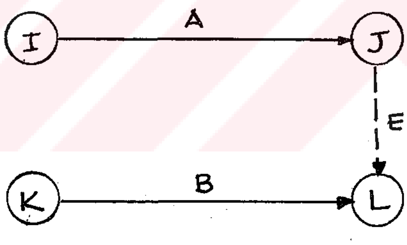


Figure 14. Incorrect use of dummy to set "end to end" relation.

The dummy activity E relates the start of activities leaving the node L to the completion of activity A. No relationship between activities A and B, other than their independency, can be observed from such diagramming. Therefore displaying "end to end" relations having no time lag is not possible.

If there exists a time lag ε from completion of A to the completion of B, it is useful to break activity B down into two pieces, first having a duration of $(t_B - \varepsilon)$ and the second having that of ε, to include the effect of existing relation into network computations. Again, if B is not an intermittent activity, the contunity of execution between its component parts must be provided.

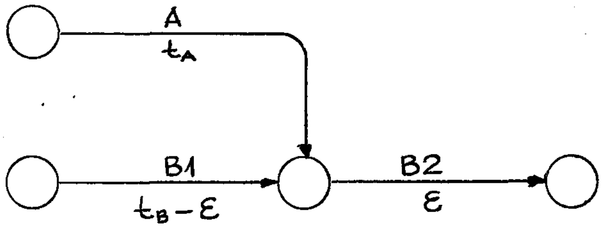


Figure 15. Partitioning of activity B to set "end to end" relation .

b. Precedence Diagrams

In a precedence diagram project activities are represented by nodes, and arrows are employed to show the relations between activities and sequence of work. Activities in a precedence diagram are identified by node codes.

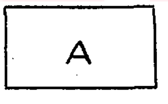
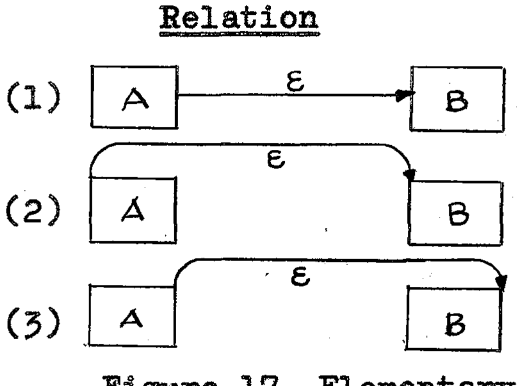


Figure 16. Activity notation in precedence diagrams.

Three types of relation can be set and displayed in precedence diagrams (Figure 17).



Logic

- Activity B can start ε time units after the completion of activity A.
- Activity B can start ε time units after the start of activity A.
- Activity B can be completed ε time units after the end of activity A.

Figure 17. Elementary relation types in precedence diagrams

4. Comparison of Network Types

The logic behind precedence diagramming is that each activity has those activities as its predecessors from which there comes an arrow to it, and those activities as its successors to which an arrow goes from its representing node. The arrows also show the relevant type of relation with the amount of related minimum lag value, if any. Therefore dummy activities are not needed any more, to keep the logical sequencing of activities correct. Since, activities are represented by nodes, each having its own code, there is no need to use dummies in order to keep the labeling of activities unique. This characteristic, also eliminates the need for the special technique in coding events to ensure that head events of activities have greater numbers than their tail events.

Since all relation types can easily be set in precedence diagramming, the need for breaking up some activities into pieces, merely for network construction purposes, is eliminated. Theoretically, there is nothing wrong with breaking an activity down into several parts as is required by arrow diagramming technique. But this causes confusion, especially, at field level. Because the foreman may recognize each part as a separate activity, although they altogether form a single activity. In addition some difficulties are likely to arise in preparing cost data and in reporting system. Precedence diagramming technique compares favorably from this viewpoint.

On the other hand, employment of dummies and artificial activities, and breaking some activities down into pieces, increase the number of activities in the network causing difficulties in its analysis. In an extreme case, the number of activities may exceed the maximum size that can be handled by the available computer programs.

In some computer programs (e.g. PCS of IBM/360) only precedence diagrams are processed. If the input data of an arrow diagram is entered, it is converted automatically into equivalent precedence network before starting with computations which consumes extra time, in turn extra cost. Therefore if such a computer program is to be used, precedence diagramming should be preferred.

The advantages of precedence diagrams over arrow diagrams can be summarized as:

i) Elimination of dummy and artificial activities

ii) Elimination of the necessity for breaking down some activities into pieces, thereby decreasing the number of activities in the network.

iii) Ease and rapidity with which the planner designs the network and the field personnel grasp the concept.

iv) Elimination of the necessity for conversion of event occurence times to activity times.

The use of arrow diagramming system may become advantageous under certain conditions. If the planner once decided not to use a computerized system, considering the factors to be discussed later on, the arrow diagramming technique has more chance in selection. Manual computation of networks becomes easier, faster and more accurate due to normal relationships between the activities. If durations and costs of activities are uncertain, dealing with these uncertainties is extremely difficult in precedence diagrams.

In arrow diagrams, it is quite easy to observe which events and then which activities are critical. Since thre exist direct links between events, tracing the critical path is a simple operation. But in precedence diagrams, the critical activities are determined usually through a computer run and because of eliminated events, tracing the critical path may become difficult.

The nature of a project, especially if it is large size one, may necessitate the preparation of different networks, by various organizations independently. The most realistic integration of these separate networks is possible through the use of interface events, placed between them. Precedence diagrams compare unfavorably in this respect, due to elimination of events.

Therefore compared to precedence diagrams, arrow diagrams have the following advantages:

i) Suitability for manual computations.

ii) Ease in tracing the critical path.

iii) Ability to employ interface events to integrate separate networks, thereby defining the transfer of responsibility from one organization to another more definitely.

iv) Suitability for the analysis of probabilistic projects due to presence of events.

5. Criteria for Selecting the Network Type

At this stage, it may be concluded that two points should be analyzed before deciding on the network type are:

i) Project characteristics (size and complexity),

ii) Availability of a computerized system (programmes).

It is obvious that as the number of activities to be coordinated in a project gets bigger, the need for a computerized system will increase. If such system is available, precedence diagrams, which are easy to prepare, become preferrable. Otherwise arrow diagramming has more chance to be selected, because it is more suitable for manual computations.

Complexity of a project is another criterion. In general the number of relationships as compared with number of activities and their types determine the project complexity. Since relation types which necessitate break-down of some operations into parts in arrow diagramming technique, can be easily shown in precedence diagrams, complex projects may necessitate the employment of precedence diagrams.

Availability of a computerized system favors the preferability of precedence diagrams, since they are easy to prepare and difficult to analyze manually.

6. Physical Layout of Network Diagrams:

There are mainly three ways of displaying a network diagram:

a. Free Networks - In free networks nodes are placed on the network where space is more convenient. This type is preferred in designing the preliminary network, because it enables the planner to concentrate his attention on dependency relations.

b. Banded Network - In banded network activities relating the same organization, function or of same type are laid out on horizontal bands. Banded networks provides easy and rapid recognition of work flow and responsibility distribution.

c. Time-Grid Networks - In time-grid networks, arrows representing the project activities are drawn horizontally, their lengths indicating the activity durations and available total float times. Non-horizontal arrows do not show any elapsed time, they merely indicate activity sequencing.

The advantages of bar charts may also be enjoyed if time-grid diagrams are put into banded form.

On the other hand, there exists another type of time-grid network showing the flow line of works in the horizontal bands and the connection of activities in vertical direction.

CHAPTER IV

NETWORK DESIGN

A. GENERAL

There are two basic ways to build up a network: forward and backward network construction. In the first one the planner selects a specific event marking the start of the project and proceeds forward establishing events and activities in chronological sequence until the terminal event marking the completion of the project reached. This method of network design is well suited to construction projects. In the second way of network design, the planner establishes the last activity at the first step, and proceeds backwards through the network, adding activities which must be completed before the object event can occur. This way is generally preferred in network design of research and development projects, since the planner often merely knows what the objective is.

In designing the network model of Yeşilköy Airfield Infrastructure Project the first way is followed. But, to enjoy the advantages of second one, forward construction technique is somewhat modified by answering the question: "what activities must be completed immediately before commencement of this activity?", in addition to the question: "what activities must be started immediately after completion of this activity?" which is to be answered necessarily in forward network construction method. Another reason of following such a modified method, is to simplify the data preparation for computarized systems PCS and BKN, both of which ask for the specification of preceding activities of the activity under consideration.

In this chapter, the procedure for network design is analyzed through four steps: project breakdown, sequencing of activities, determination of activity durations and coding the activities. Although the Yeşilköy Airfield Infrastructure Project is taken as the base of analysis; these are the four basic steps to be followed for designing a network model of any project.

In Appendix E the final form of the network diagram is given in a banded form. The details of improvements obtaining the final form are not discussed, since they have caused considerable changes in all steps of network design.

The network diagram submitted is a precedence diagram. Although the network may not be considered as a complex one precedence diagramming is preferred, since there was computer available free of charge offering a chance to make use of it, thereby to analyze its function in planning. Another factor making this selection favorable is the number of activities which exceeds 300.

B. PROJECT BREAKDOWN

After the general task of the project is clearly recognized, breaking it down into separate operations or processes necessary for its completion, is the first step towards effective planning, in all planning techniques.

The degree of breakdown is strongly effected by the nature of the selected method. If bar charts or cyclogrammes are selected for planning purposes, the number of activities resulting from project breakdown should be kept as low as possible. But network based systems enable the planner to deal with numerous activities, thus increasing the accuracy of plans.

At this stage, it is useful to point out that network plans, presenting the work process by which the project objectives and requirements will be handled, should be prepared by those who will be responsible for supervising the work by the effective cooperation of those who carry the direct responsibility for doing the work. If this fact is overlooked, the resulting plan is likely to be unrealistic. In case of the planning of Yeşilköy Airfield Infrastructure Project the author's attempts to secure the cooperation of contracting firm did not yield the desired results, merely because of the fact that its managers had no faith in planning, some information which would possibly make this study more accurate could not be obtained. Thus, for instance, material deliveries could not be included in project breakdown due to lack of information, in spite of their importance.

The factors to be considered while breaking down a project into its component activities are given below. The order of the factors is the sequence followed in the breakdown procedure of Yeşilköy Airfield Infrastructure Project, and has no relation with the order of their importance.

Factor 1. The costing data required by the management

It is preferable to have activities for which the necessary cost figures can be computed easily. Since the necessary information could not be obtained from the contractor this factor did not have a strong effect.

Factor 2. The itimized bill of quantities

It is found very useful to break the project down into such activities that each activity will have its own unit price in the itemized bill of quantities. But an attempt to satisfy this requirement fully, may result in a very detailed breakdown making the plan impracticable.

Factor 3. The distribution of responsibility within the organization

Project activities should not, preferably, fall into responsibility area of more than one division of the organization. In this study, only the controlling organization is considered, however the responsibility structure of the contracting firm is very similar to that of controlling organization.

By the consideration of the factors 1, 2 and 3, the following general breakdown is reached for this project:

a. Earth Work

b. Lean Concreting

c. Pavement Quality Concreting

d. Shoulder Stabilization

e. Forming Asphaltic Concrete Layer on Shoulders

f. Constructing Drainage Structures

g. Laying PVC Cable Pipes under Shoulders

i. Top Soiling

Factor 4. The location of the work on the site

In the projects requiring the execution of same type of activities over a large area, such as airport, highway and pipeline construction projects, the location of the work on the site becomes a significant factor in breakdown process. The planner can make activity descriptions readily understandable for anyone involved in the execution of the project, by referring to the locations of activities. It is found out that the breakdown of general work items in accordance with their locations is not likely to yield desired results, unless the following requirements are met:

- All general work items should be subject to the same locational breakdown, if possible;

- The breakdown should result in clearly defined and continuous activities.

In the arrow diagram, prepared and submitted by the contractor the site was divided into four zones, namely A, B, C and D, as shown in figure 18, and the locations of activities were indicated by the symbol of the zone in which they are going to take place.

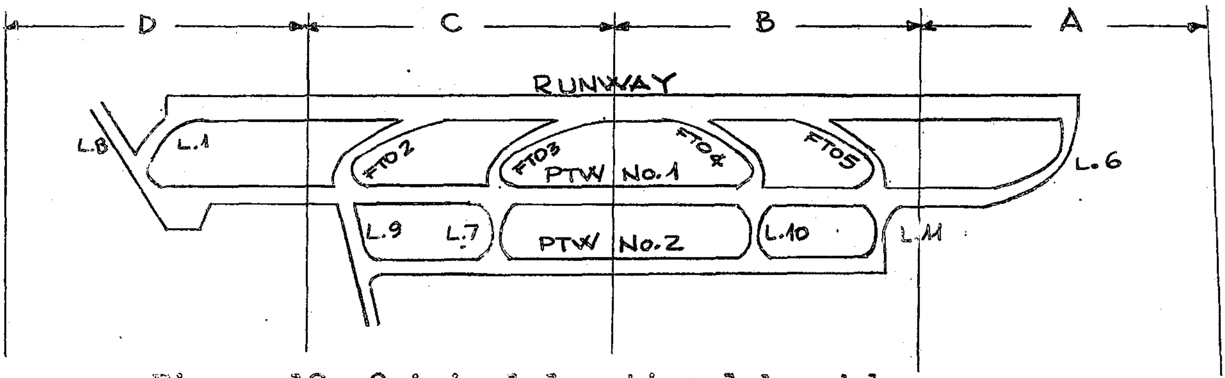


Figure 18. Original locational breakdown

Such a broad locational grouping is, of course, very advantageous in satisfying the first requirement. But a finer breakdown is needed for the satisfaction of the second one. Because any reference to one of the four zones was found to be insufficient to make the activity description clear enough. In addition, since it cannot be expected that it will be economical to complete on activity within the zone in which it is started, without any interruption, all activities will become intermittent, causing difficulties in scheduling and resource leveling. Therefore this locational breakdown has come out to be impracticable in a very short time.

After these shortcomings were observed, the contractor tried another approach to locational breakdown. In this approach, the areas to be paved were taken as bases of breakdown. The general work items were divided into parts according to their place of execution with reference to runway, taxiways, fast turn-offs and links. But even this breakdown did not yield the expected practicability.

An analysis of items of general breakdown will show that items 1 and 9 are to be performed over the whole site, where items 2 and 3 only on pavements, and items 4, 5, 6, 7 and 8 on the shoulders. This rough breakdown can make only the descriptions of component activities of items 1 and 9 clear enough. A finer breakdown is still necessary for the other items. For example, physical constraints prevents the contractor to lay pavement quality concrete on the same fast turn-off or link without interruption, so these activities will remain intermittent. On the other hand shoulder activities should be performed at least in two steps, in order to maintain work flow.

Taking the above discussion into consideration the following locational breakdowns are obtained for general work items:

a. Earth Work

Since a small amount of earth work was left when this study was started, this item is subjected to a rough breakdown. First, the remaining earth work is divided into two parts according to the nature of work to be done; then each part is divided into its component activities considering the location of the work on the site.

i) Earth Moving

1. On the Area to Paved in North and East
2. Outside the Area to be Paved in North and East
3. On the Fuel Farm Area.

ii) Borrowing and Filling the Selected Material

1. Outside the Fuel Farm Area

2. On the Fuel Farm Area

b. Lean Concrete (LC)

The amount of work left at the starting date of this study was suitable for a rough breakdown:

1. From Parallel Taxiway No.1 (24+60) to the End of Link No.6
2. Parallel Taxiway No.2 (Fuel Farm Area)
3. Link No.10
4. Link No.11
5. Fast Turn-off No.4
6. Fast Turn-off No.5
7. Parallel Taxiway No.1 (Fuel Farm Area)
8. Link No.7 (Fuel Farm Area)

c. Pavement Quality Concrete (PQC)

The nature of work in this item has necessitated a detailed locational breakdown. It has been tried to obtain such a breakdown that the resulting activities will be clearly defined and continious, and they will permit any sort of sequencing. This aim is achieved by dividing each pavement element into its strips. In addition, the strips of runway and taxiways are divided into parts, in order to be able to set their relations to shoulder activities correctly.

The locational breakdown of PQC item is:

1. Runway Strip No.6 (04+36 - 19+50)
2. Runway Strip No.6 (19+50 - 34+36)
3. Link No.1 South-West Strip

4. (Zone 1) Link No.1

5. (Zone 1) Runway

6. (Zone 1) Fast Turn-off No.2

7. (Zone 2) Fast Turn-off No.2

8. (Zone 2) Runway

9. (Zone 2) Fast Turn-off No.3

10. (Zone 3) Fast Turn-off No.3

11. (Zone 3) Runway

12. (Zone 3) Fast Turn-off No.4

13. (Zone 3) Parallel Taxiway No.1

14. (Zone 4) Fast Turn-off No.4

15. (Zone 4) Runway

16. (Zone 4) Fast Turn-off No.5

17. (Zone 4) Parallel Taxiway No.1

16. (Zone 4) Fast Turn-off No.5

17. (Zone 4) Parallel Taxiway No.1

18. (Zone 5) Fast Turn-off No.5

19. (Zone 5) Runway

20. (Zone 5) Link No.6

21. (Zone 5) Parallel Tawiway No.1

22. (Zone 6) Link No.7 (Fuel Farm Area)

23. (Zone 6) Parallel Taxiway No.2

24. (Zone 7) Link No.7 (Fuel Farm Area)

25. (Zone 7) Parallel Taxiway No.1

26. (Zone 7) Link No.10

27. (Zone 7) Parallel Taxiway No.2

28. (Zone 8) Link No.10

29. (Zone 8) Parallel Taxiway No.1

30. (Zone 8) Link No.11

31. (Zone 8) Parallel Taxiway No.2

32. Link No.11 North Strip

33. Parallel Taxiway No.1 East Strip (Between Links No.11 and 6)

34. Link No.6 North East Strip

35. Parallel Taxiway No.2 East Strip (Zone 6)

36. Parallel Taxiway No.2 East Strip (Zone 7)

37. Parallel Taxiway No.2 East Strip (Zone 8)

38. Fast Turn-off No.2 Interior Strip

39. Fast Turn-off No.3 Interior Strip

40. Fast Turn-off No.4 Interior Strip

41. Fast Turn-off No.5 Interior Strip

42. Link No.7 Interior Strip (Fuel Farm Area)

43. Link No.10 Interior Strip

44. Link No.11 Interior Strip

45. Parallel Taxiway No.1 Interior Strip (Zone 3)

46. Parallel Taxiway No.1 Interior Strip (Zone 4)

47. Parallel Taxiway No.1 Interior Strip (Zone 5)

48. Parallel Taxiway No.2 Interior Strip (Zone 6)

49. Parallel Taxiway No.2 Interior Strip (Zone 7)

50. Parallel Taxiway No.2 Interior Strip (Zone 8)

51. Parallel Taxiway No.1 West Strip (Fuel Farm Area)

52. Parallel Taxiway No.1 East Strip (Fuel Farm Area)

53. Parallel Taxiway No.1 Interior Strip (Fuel Farm Area)

54. Parallel Taxiway No.2 West Strip (Fuel Farm Area)

55. Parallel Taxiway No.2 East Strip (Fuel Farm Area)

56. Parallel Taxiway No.2 Interior Strip (Fuel Farm Area)

57. Runway Strip No.3 (34+36 - 04+36)

58. Link No.6 Interior Strip

59. Runway Strip No.2 (04+36 - 13+00)

60. Runway Strip No.2 (13+00 - 25+30)

61. Runway Strip No.2 (25+30 - 34+36)

62. Runway Strip No.5

63. Runway Strip No.4

Shoulder Activities:

d. Shoulder Stabilization

e. Forming Asphaltic Concrete on Shoulders

f. Constructing Drainage Structures

g. Laying PVC Cable Pipes under Shoulders

h. Laying Multi-cell Cable Passes Under Shoulders

As pointed out before all of the above general work items are going to take place on shoulders. Therefore all of them are subjected to same locational breakdown in such a way that the resulting activities are well defined and continuous and their relations to PQC activities can be set easily and precisely.

Since some of the drainage activities were already completed they do not appear on activity list given in Appendix A.

1. Runway West Side (04+36 - 19+50)
2. Runway West Side (19+50 - 34+36)
3. Link No.8 Both Sides
4. Link No.1 South-West Side
5. (Zone 1) Link No.1
6. (Zone 1) Runway
7. (Zone 1) Fast Turn-off No.2
8. (Zone 1) Parallel Taxiway No.1
9. (Zone 2) Fast Turn-off No.2
10. (Zone 2) Runway

11. (Zone 2) Fast Turn-off No.3

12. (Zone 2) Parallel Taxiway No.1

13. (Zone 3) Fast Turn-off No.3

14. (Zone 3) Runway

15. (Zone 3) Fast Turn-off No.4

16. (Zone 3) Parallel Taxiway No.1

17. (Zone 4) Fast Turn-off No.4

18. (Zone 4) Runway

19. (Zone 4) Fast Turn-off No.5

20. (Zone 4) Parallel Taxiway No.1

21. (Zone 5) Fast Turn-off No.5

22. (Zone 5) Runway

23. (Zone 5) Link No.6

24. (Zone 5) Parallel Taxiway No.11

25. Parallel Taxiway No.1 East Side and Link No.9 South Side

26. (Zone 6) Link No.9

27. (Zone 6) Parallel Taxiway No.1

28. (Zone 6) Link No.7 (Fuel Farm Area)

29. (Zone 6) Parallel Taxiway No.2

30. (Zone 7) Link No.7 (Fuel Farm Area)

31. (Zone 7) Parallel Taxiway No.1

32. (Zone 7) Link No.10

33. (Zone 7) Parallel Taxiway No.2

34. (Zone 8) Link No.10

35. (Zone 8) Parallel Taxiway No.1

36. (Zone 8) Link No.11

37. (Zone 8) Parallel Taxiway No.2

38. Link No.11 North Side

39. Parallel Taxiway No.1 East Side (Between Links No.11 and 6)

40. Link No.6 North and North-East Sides

41. Parallel Taxiway No.2 East (10+80 - Fuel Farm Area)

42. Parallel Taxiway No.2 East (Fuel Farm Area)

43. Parallel Taxiway No.2 East (Fuel Farm Area-28+23)

i. Top Soiling

The nature of this work item permits rather a rough breakdown, without causing any difficulty in satisfying the condition requiring the resulting activities to be well defined and continuous.

1. Runway West Side (04+36 - 19+50)
2. Runway West Side (19+50 - 34+36)
3. Area Between Links No.1 and No.8
4. Link No.8 South-East Side
5. Parallel Taxiway No.1 East-Side and Link No.9 South Side
6. Parallel Taxiway No.2 East Side and Link No.11 North Side
7. Parallel Taxiway No.1 East Side and Link No.6 North-East Side
8. Zone 1
9. Zone 2
10. Zone 3
11. Zone 4

12. Zone 5

13. Zone 6

14. Zone 7

15. Zone 8

The presence of the fuel farm area (figure 1) has caused an increase in the number of project activities through the project breakdown process. Its effect will be felt more strongly and adversely in formulating the construction logic, and also in the attempts to sustain an effective work flow.

C. SEQUENCING OF ACTIVITIES

After the list of project activities has been prepared (Appendix A) the next step is to set the relationships between these activities. The planner can set two types of relationship between project activities: causal and operational. Causal relationships are set due to physical constraints. Any relationship of this nature cannot be subject to change through network refinement process, if they are set correctly unless some technical invention is introduced into practice. However the planner should consider only the existing level of technology in order to be realistic. The second type of relationships are set under the consideration of operational constraints which are namely: safety, resource, finance and management (including team work) constraints. The interrelations between the project activities, which are due to operational constraints may be subject to change when an effective change occurs in the existing conditions.

The relationships between the general work items of Yeşilköy Airfield Infrastructure Project due to physical constraints are set as follows:

a. Earth Work

i) Earth Moving - There exist no physical limitation preventing the start of the remaining earth moving operation. Consequently these activities are to be preceded by a dummy activity "Project Start".

ii) Borrowing and Filling the Selected Material - Activities of this item cannot be started with unless their corresponding "Earth Moving" activities are finished.

b. Lean Concrete - The start of LC activities depends on the completion of the corresponding portion of "Borrowing and Filling the Selected Material" activities. But some LC activities can immediately start since their predecessors have been already completed.

c. Pavement Quality Concrete - In general for the start of PQC activities, completion of LC activities on the location concerned is required with a time lag of at least 7 days which is necessary for lean concrete to gain its strength. PQC activities, on the locations satisfying this requirement, can start.

Once one strip of pavement quality concrete is laid, minimum waiting time of 5 days is required to lay concrete on the adjacent strip. Since all pavement elements, except runway, are composed of three strips, there are three alternative ways to be followed to complete an element:

Order of Execution	Alternatives I	II	III
1	Side strip	Interior strip	Side strip
2	Interior strip	Side strip	Side strip
3	Side strip	Side strip	Interior strip

Although selection of the alternative way to be followed is entirely free of physical constraints, this decision has to be made at this stage. Because each of these alternatives necessitates different physical relations to be set, as shown in figure 19, and no single diagrammatic representation can enable the planner to make this decision later.

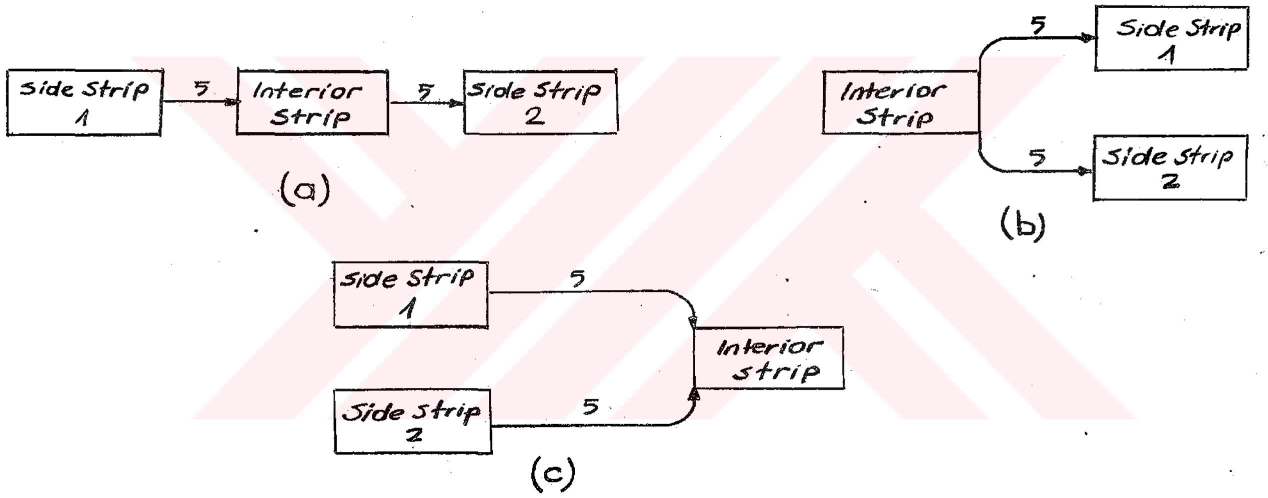


Figure 19. Alternative ways to lay PQC on pavement elements other than runway.

It is found more preferrable to suggest the third alternative which gives priority to side strips, thereby preventing probable delays in starting with shoulder activities or interruptions in their flow. This selection implies that the both edges of each side strip will require steel forms, then interior strip will be laid without form. Since the amount of steel forms available is found to be sufficient, the shortage of steel forms is not likely to occur. Another problem may be accumulation of water between two side strips. This problem will be solved in sequencing the activities, under the consideration of operational constraints, by completing the interior strips of pavement elements whose side strips are already finished, before the rain season.

d. Shoulder Stabilization - It is obvious that shoulder stabilization activities can take place only after the completion of required installations under shoulders. These installations are PVC pipes, multi-cell cable passes and drainage pipes. Since PVC pipes may be damaged during the compaction operations, they will be planned to be laid after shoulder stabilization. On the other hand the side strip of the adjacent pavement element should be finished leaving a sufficient amount of time lag for PQC to gain its strength and for the removal of steel forms. Therefore laying down the multi-cell cable passes and drainage pipes, and concreting the side strip of the adjacent pavement element are required to precede shoulder stabilization activities. But only"multi-cell cable passes" activities are shown as preceding work items in the network. Because the start of "multi-cell cable passes" activities are related to the completion of relevant PQC and drainage activities.

e. Forming Asphaltic Concrete on Shoulders - An asphaltic concrete layer is required to be formed on stabilized shoulders. Since PVC pipes are planned to be placed after shoulder stabilization, the relation set requiring PVC pipes to be placed before forming asphaltic concrete layer on shoulders, also indicates that shoulder stabilization activities will be completed before the start of asphaltic concrete activities.

f. Constructing Drainage Structures - Although the completion of earth work on the related location constitutes a physical constraint for the start of drainage activities, accepting the lean concreting of the adjacent pavement element as the predecessor of drainage activities is more realistic; because such an application will give better results from alignment viewpoint.

g. Laying PVC pipes under Shoulders - In order to prevent any probable damage, PVC pipes are planned to be placed after shoulder stabilization.

h. Laying Multi-cell Cable Passes under Shoulders- This group of activities are to be preceded by PQC of the side strip of the adjacent pavement element with a minimum time lag of 8 days which is necessary for setting of concrete and removal of steel forms. Also the related drainage activities are taken as predecessors in order to prevent multi-cell cable passes functioning as drainage pipes.

i. Top Soiling - The activities of this item are to be executed over the whole site, excluding pavements and shoulders, and has a finishing nature. Therefore drainage activities must be finished on the related location before top soiling starts, because drainage pipes are going to remain under the top soil.

The final stage of top soiling will be smooting the top soiled area. For this reason, asphaltic concrete layers should be finished on the adjacent shoulders for better leveling of top soiled area.

In sequencing the activities under the consideration of operational constraints the emphasis is laid on the management constraint which requires the maintenance of an effective and uninterrupted work flow within each general work item. It is expected that limitations imposed by resource and team constraints will not be exceeded if a single flow line can be established for each general work item. In this project, it is not expected that any problem will arise due to safety constraints. The problems which are likely to occur due to finance constraints are tried to be minimized by setting rather a smooth rate of execution and resource leveling.

At this level of sequencing the following points are paid atmost attention:

- Priority is given to those activities whose predecessors were already completed at the beginning of the planning process,

- Time necessary for shifting of some equipment is tried to be minimized,

- Same flow patterns are proposed for concreting and shoulder activities, wherever possible.

The presence of installations on fuel farm area whose removal time is uncertain, affected the effectiveness and continuity of any alternative work flow, adversly. Therefore the activities which are going to take place on this area are shifted towards the end of project.

The flow lines exhibited here (figure 20, 21 and 22) are the results of several trials. The procedure to obtain the given patterns is as follows:

i) The flow line for PQC item is established as key line, giving the emphasis on side strips which will be preceding activities of shoulder activities. The PQC activities whose predecessors are already completed are given the priority, and much effort has to be spent to minimize the adverse effect of completed portions. Some internal strips are included in this sequence list, in order to prevent equipment transfers.

ii) The flow line for LC item is set, paying attention not to cause any interruption in PQC flow. When interriptions could not be prevented by re-sequencing of LC activities, the flow line of PQC item is revised.

iii) The order of execution of "Earth Work" item is determined. Since the amount of work left was small in comparison with total amount, only simple arrangements are done not to disturb flow of LC activities.

iv) The work flow lines of shoulder activities are established such that they follow the same path of execution as PQC side strip activities do. When any interruption occurs in the flow of either PQC or shoulder activities, either one or both flow lines are revised and new flow patterns are checked whether any disturbance of other flow lines is caused.

v) The sequence of "Top Soiling" activities are determined according to order of their predecessors completions.

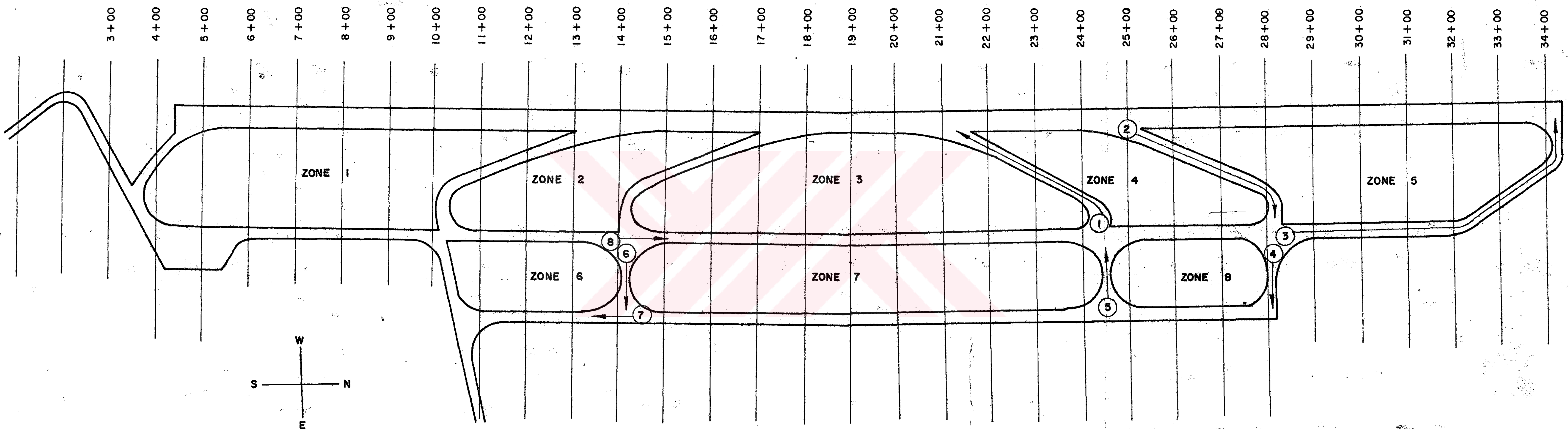
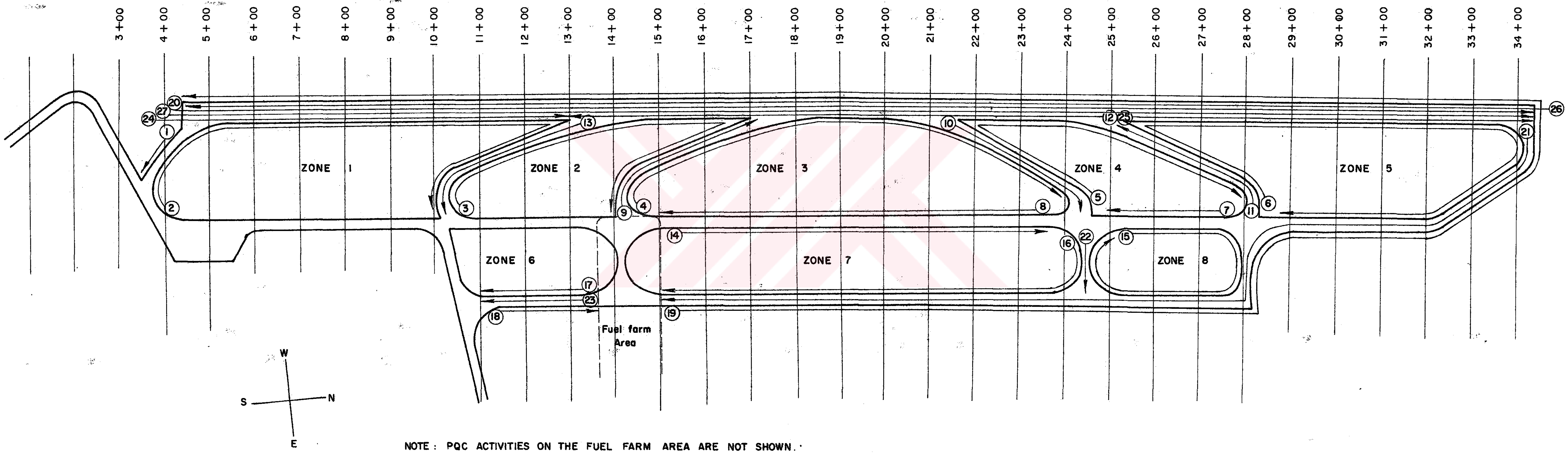


FIGURE 20: WORK FLOW LINE FOR "LEAN CONCRETING" ACTIVITIES



NOTE : PQC ACTIVITIES ON THE FUEL FARM AREA ARE NOT SHOWN.

FIGURE 21 : WORK FLOW LINE FOR "PAVEMENT QUALITY CONCRETING ACTIVITIES"

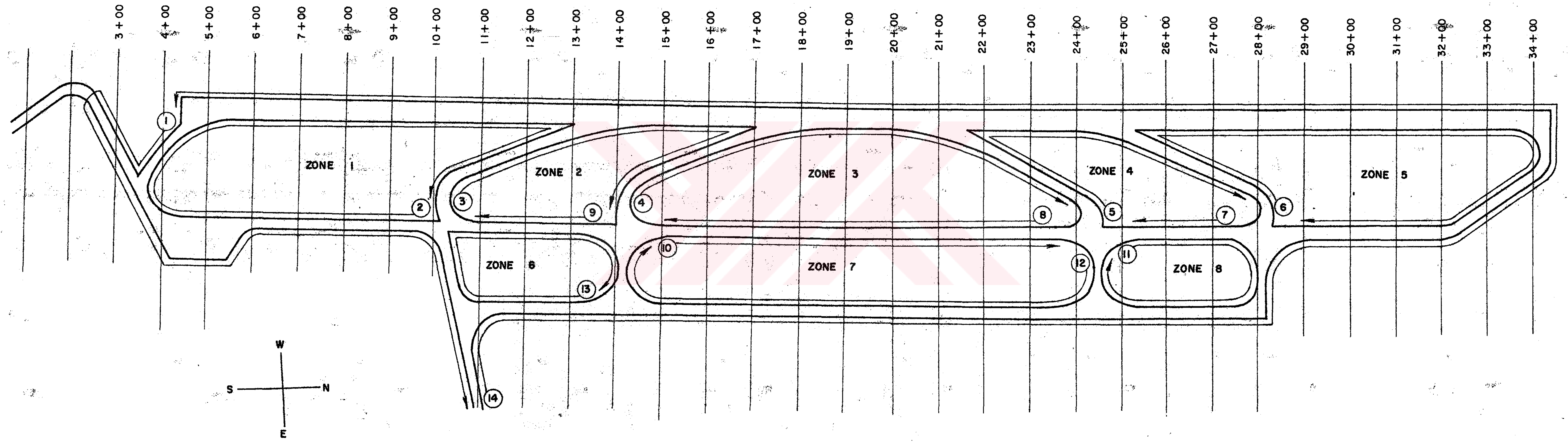


FIGURE 22 : WORK FLOW LINE FOR " SHOULDER ACTIVITIES"

vi) The flow lines are further revised, during the scheduling process. The interior strips of those pavement elements whose side strips will be completed before rain season are so scheduled that they will also be finished before rain season, in order to prevent accumulation of water between side strips.

D. DETERMINATION OF ACTIVITY DURATIONS

It is a common practice to determine activity durations after the planner has decided on specific sequencing of project activities. This is an acceptable approach, because during the sequencing process it may be found more useful to combune or to divide some activities, or to change their contents, and such an approach eliminates the need for re-determination of activity durations after each network refinement.

In general, project activities can be executed in several ways each associated with a different duration and direct cost. Some American literature[20] related to construction planning suggest that the time-cost relation for each project activity should be analyzed in detail. As the result of this analysis time-cost information obtained for each activity can be displayed in graphical or tabular form. The former one is known as "utility curve" whose theoretical and practical forms are shown in figure 23., and the latter as "utility data".

As the curves display, an activity may be performed in many different durations at the related direct costs. Among these, the normal time is selected as the project duration, since it gives the lowest direct cost to complete. If realistic utility curves can be developed for each project activity, then the optimum project duration which corresponds the minimum project total cost, can be determined by means of network compression or decompression computations.

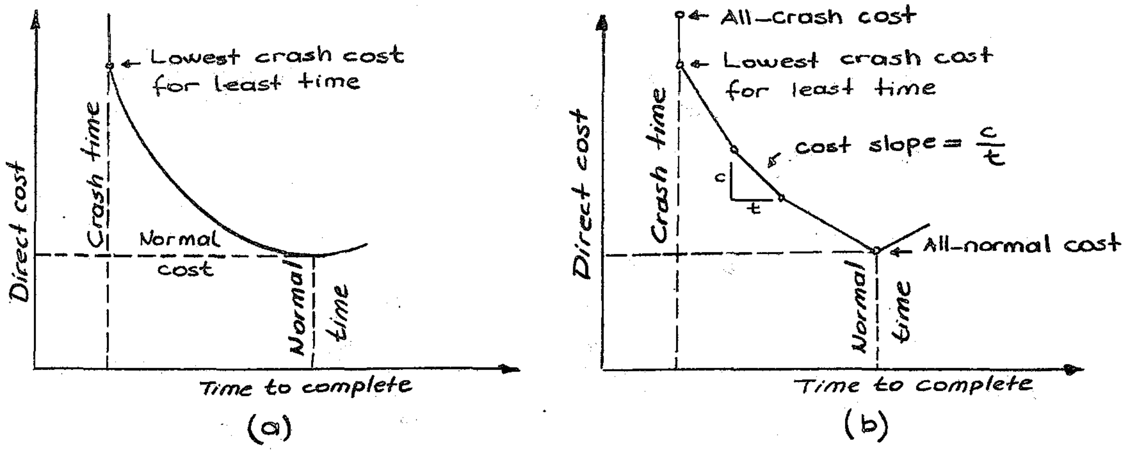


Figure 23. Time-direct cost curves for an activity a) Theoretical curve. (b) Practical curve.

It is obvious that only a regular and continuous data collection and recording system (data bank) can enable such a detailed analysis. Since this system has never existed especially in construction industry, the estimators have no choice other than being dependent on the experience gained by the people who has involved in similar projects in the past.

As stated before, one of the major advantages of network approach is that it produces a more realistic estimate of the total length of a project, through subdivision of major elements into many smaller activities which can be estimated more accurately. This advantage can be realized properly, if dependable statistical data are provided to the planners. Therefore, data collection in construction industry should be started immediately.

Since the project under consideration is a construction project, time estimates are assummed to be certain to a reasonable extend. The bases of duration estimates in Yeşilköy can be grouped into two:

i) If the activity, whose duration is to be determined, is a part of a general work item some of whose activities were already finished upto the starting date of this study, the realized rate of execution is taken as the basis for time estimations. The general work items considered in this group are: Earth work, lean concreting, pavement quality concreting and constructing drainage structures. Some modification is necessarily made in the durations of PQC activities since the realized rate of execution was too slow to meet the requirement of the contract.

ii) The estimates of the experienced competent personnel of both contractor and public owner, are accepted to be essential for duration estimation of the activities of other general work items. These estimated durations are revised when different rates of execution were observed of their commencement.

The activity durations computed by dividing the volume of work to be done by the rate of execution are given in activity list of Appendix A.

Table 2. Daily Execution Rates of General Work Items

General Work Item	Daily Rate of Execution
Earth Work	18000 m^3
Lean Concreting	250 m^3
Pavement Quality Concreting	700 m^3
Constructing Drainage Structures	150 m
Shoulder Stabilization	375 m^3
Forming Asphaltic Concrete on Shoulders	200 m*
Laying PVC Cable Passes under Shoulders	265 m*
Laying Multi-cell Cable Passes under Shoulders	175 m*
Top Soiling	1400 m^3

* in terms of shoulder length.

In some projects, the durations of activities may be uncertain. This is true especially for research and development projects many of whose activities have never been carried out before or have been carried out only a few times under very different circumstances. In such cases the uncertainty involved must be introduced into activity and project durations. The Program Evaluation and Review Technique (PERT) is the result of this need. PERT uses an activity duration called "the expected mean time" (t_e) with an associated measure of uncertainty either as standard deviation (σ_{te}) or variance (v_{te}).

The expected mean time is intended to be a time estimate, having approximately 50% chance to overrun and 50 % chance to underrun the actual duration realized. (Figure 24). Three estimates of activity's duration enable the determination of the expected mean time, as well as the standard deviation and the variance:

- Optimistic time (t_a) estimate is the estimate of the shortest possible time in which an activity can be completed under optimum conditions. The optimistic time estimate assumes that the activity will be accomplished in an ideal environment, free of even normal amount of delays and setbacks.

- Pessimistic time (t_b) estimate is the estimate of the longest time that it may take for its accomplishment taking all possible delays and setbacks into account.

- Most likely time (t_m) estimate is the estimate of the mean time of completion if the activity were repeated a number of times under almost the same conditions.

Mathematical expressions for the expected mean time, the standard deviation and the variance are given as[21]:

The expected mean time : $$t_e = \frac{t_a + 4t_m + t_b}{6}$$

The standard deviation : $$\sigma_{t_e} = \frac{t_b - t_a}{6}$$

The variance : $$v_{t_e} = \left(\frac{t_b - t_a}{6}\right)^2$$

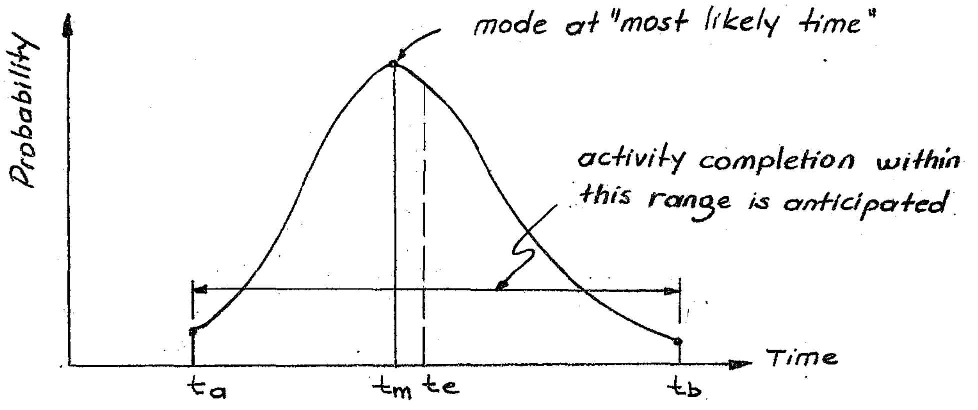


Figure 24. Probability distribution (β) curve for activity durations.

E. CODING THE ACTIVITIES

In arrow diagrams activities are identified by the numbers of their tail and head events. There is a rule that is commonly obeyed while numbering the events of a network which can be stated as: "the number at the tail of any arrow should be smaller than the number at the head of the arrow". The simple procedure to satisfy this requirement is: "start by labeling the first event and proceed forwards by assigning a larger number to the events to which tails-numbered arrows come". Some advantages of this coding technique are:

- Selection is immediate; by looking at the diagram it is easier to pick out numbers than words on arrows;

- Reference is abbreviated, but exact;

- Sequence is immediately evident; for example the activity (I, J) is preceded by all activities which have I as their head event number and followed by those which have J as their tail event number, and is concurrent with all those activities having I as their tail event number.

The activities in precedence diagrams are identified by their own codes. Activity codes may be numeric or alphameric. There is no rule to be followed in labeling the activities, therefore the planner should take the advantage of this flexibility. Each numeric or alphabetic character in the code of an activity may be use to denote something meaningful. For instance, the activities in the precedence diagram of Yeşilköy Airfield Infrastructure Project are coded by paying attention to two points:

i) First numeric character after zero indicates the number of the general work item in which the activity concerned takes place.

ii) Last two numbers are used as location references.

CHAPTER V

NETWORK COMPUTATIONS

A. BASIC NETWORK COMPUTATIONS

The computational prodcedures of network based planning methods differ from each other depending on the type of diagramming technique used in constructing the network model. Therefore the procedures for arrow and precedence diagrams will be described separately. The procedure to be followed in PERT, which is a probabilistic system, will be explained briefly as a part of the procedure of arrow diagrams.

There are three main steps in network computations: which are common to both diagrams:

i) forward pass computations,

ii) backward pass computations,

iii) float analysis.

1. Arrow Diagrams

a. Critical Path Method

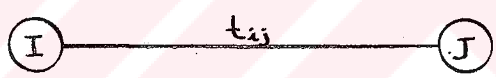
i) Forward Pass Computations

If the network is in the form of an arrow diagram the step of forward pass computations involves the computation of earliest possible occurence time (EPOT= T^E) for each event. The earliest possible occurence time for an event, may be defined as the time taken to complete all activities on the most time consuming path from the start of the project to the event under consideration.

The first thing to do in forward pass computations, is to assign an EPOT to the first event of the network. It is a common practice to assume the project base date or EPOT of the first event as zero, and to compute EPOTs of other events in terms of an appropriate time unit. The other alternative is to set the project base date as a calender date and then to compute the EPOT of each following event in calender dates. But this may cause some errors in computations due to holidays and non-working days involved.

As the two possible cases illustrated below clearly indicate, to compute the EPOT of an event the EPOTs of all events from which an arrow comes to that event must be known.

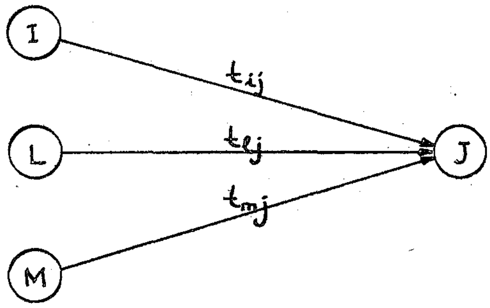
Case 1. When a single activity terminates at the concerned event, its EPOT is determined by adding the duration of the terminating activity to the EPOT of the preceding event.



$$T_J^E = T_I^E + t_{ij}$$

Figure 24. Single activity terminating at event J.

Case 2. When there are more than one activity terminating at event J, the EPOT of this event is determined by selecting the largest number (or latest date) among the EPOTs computed assuming each activity as the only activity terminating at that event.



$$T_J^E = \max\left[(T_I^E + t_{ij}), (T_L^E + t_{lj}), (T_M^E + t_{mj})\right]$$

Figure 25. More than one activity terminating at even J.

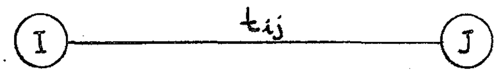
The forward pass computations end when the EPOT for the last event of the network is computed.

ii) Backward Pass Computations

Then backward pass computations start which involve the determination of latest permissable occurence times (LPOT = T^L) for network events. The latest permissiable occurence time for an event is the maximum time available for the completion of the activities, terminating at that event, without causing any delay in total project duration.

The LPOT for the last event of the network must be determined in order to start with backward pass computations. The common practice is to assign the EPOT of the last event to it as its LPOT. But when the permitted duration is more than the EPOT value for the last event, this may be accepted as LPOT for the last event. If the directed project duration is less, then this value may be assigned to the last event as its LPOT value. The last two cases may prevent precise network analysis, since the first one will give positive floats even on the critical path and in the second, the planner will have to deal with negative floats. If the pre-assigned project completion date is different than the EPOT of the last event and if the former must be met, the planner may employ network compression or decompression technique, which will be mentioned later in this chapter, for this purpose.

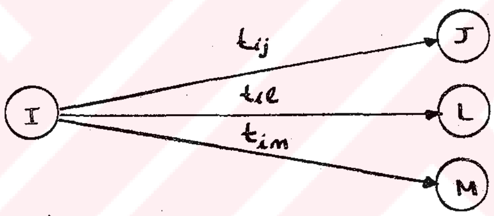
Case 1. When a single activity starts at the event under consideration, its LPOT is determined by subtracting its duration from the LPOT of the succeding event.



$$T_I^L = T_J^L - t_{ij}$$

Figure 26. Single activity starting at event I

Case 2. When there are two or more activities starting at an event, its LPOT is determined by selecting the smallest number (or earliest date) among the LPOTs computed assuming each activity as the only activity starting at that event.



$$T_I^L = \min\left[(T_J^L - t_{ij}), (T_L^L - t_{il}), (T_M^L - t_{il})\right]$$

Figure 27. More than one activity starting at event I

After the completion of backward pass computations, the critical path(s) which is commonly defined as the most time consuming path through the network, can be determined.

An event lies on the critical path if its EPOT and LPOT are identical. Obviously any delay in satisfying such an event will cause project delay. For an activity to lie on a critical path two conditions must be satisfied:

- Its both head and tail events must be critical.

- Its duration must be equal to the difference in event times of the head event and the tail event.

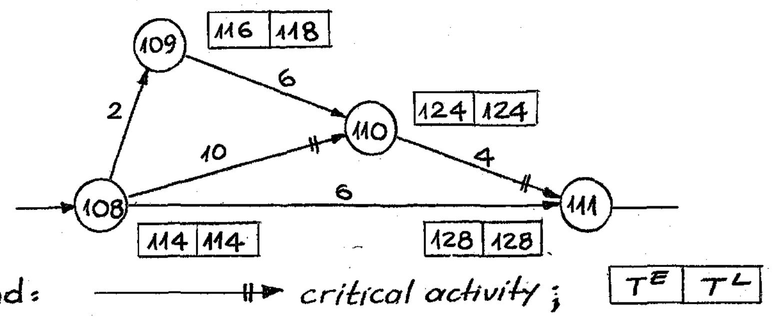


Figure 28. Critical activities on a network portion

In the network portion given in figure 28. the activities (108-110) and (110-111) are critical where the activity (108-111) is not, since it violates the second condition.

Critical path is one of the major factors which makes the network based methods superior to conventional planning methods, since it clearly indicates the activities which must be kept on time in order not to cause any delay in project completion.

iii) Float Analysis

There are a variety of float measurements whose definitions and formulas are given below:

Total float (TF) is the spare time available to complete a particular activity, when all preceding activities are completed at the earliest possible times and all succeding activities start at the latest possible times.

$$TF_{ij} = T_J^L - (T_I^E + t_{ij})$$

Free float (FF) is the spare time available when all preceding activities end at the earliest possible times and all succeding activities start at the earliest possible times.

$$FF_{ij} = T_J^E - (T_I^E + t_{ij})$$

Interfering Float (IF) is the spare time available for the completion of an activity after its FF is fully consumed. Therefore if any part of IF is consumed, it will be necessary to reschedule all the following activities in that chain. If the IF is fully used, subsequent activities in the chain will become critical; if it is exceeded the project duration will be increased.

$$IF_{ij} = TF_{ij} - FF_{ij}$$

Independent float (IND.F) is the amount of time that an activity may be delayed, regardless of the state of the preceding and succeding activities within the project, without affecting the project duration.

$$IND.F_{ij} = T_J^E - (T_I^L - t_{ij})$$

Scheduled Float (SF) is the amount of extra time that the planner specifically assigns to an activity for suitable scheduling of the project.

b. Program Evaluation and Review Technique

Although the time analysis of an activity requires the evaluation of three time estimates from which the expected mean time, standard deviation and variance are computed, in PERT computations only the expected mean time and the variance of each activity are used, since this is sufficient to introduce into the network diagram the uncertainty of each individual activity. Because a single time estimate is used, PERT network calculations differ from the corresponding CPM calculations only in the introduction and handling of activity variances.

i) Forward Pass Computations

In forward pass computations expected earliest event occurence times (T_{xe}) are computed. In addition to this, variances of expected earliest event times (v_{Txe}) are determined by summing up the variances of expected activity mean times along the most time consuming path leading to the event under consideration.

ii) Backward Pass Computations

In backward pass computations, in addition to expected latest event occurence times (T_{xl}) which are computed in exactly the same way as LPOTs in CPM calculations, the corresponding event variances (v_{Txl}) are derived, starting from the last event of the network and assigning zero variance to it. Then other event variances are found by adding up the variances of expected activity mean times following the path which was followed in the computation of expected latest event times.

Two variances are now applicable to each event V_{Txe} and V_{Txl}. The first measures the uncertainty in the most time consuming path up to the event under consideration; and the second measures the uncertainty still to be encountered along the longest time path from this event to the project completion.

iii) Slack Analysis

For some events the T_{xe} and T_{xl} values are different; this difference is called "event slack" and mathematically expressed as:

$$Event\ Slack = T_{xl} - T_{xe}$$

Slack in PERT calculations corresponds to the total float concept in CPM and it is a measure of flexibility available in project schedule. Therefore an event with zero slack must lie on an expected critical path. An activity whose head and tail events are critical, lies on the critical path, if its duration is equal to the difference between its head and tail event times.

Once the expected mean time for an event (T_x) and its standard deviation (σ_{tx}) are determined, it is possible to calculate, from probability theory, the chances of meeting a given "event scheduled time" (T_s). To do this, the event completion time is assumed to have a normal probability distribution with the mean value T_x and a standard deviation σ_{tx} determined as before by summation of individual activity beta-distribution curves. This hypothesis implies that the effect of adding a series of independent beta-distribution curves gives a normal-distribution curve; this is true only for an infinite series, but is approximately true in practice with reasonable sized networks.

To calculate the chances of meeting the time T_s, the practical approach is to use the standard probability tables prepared for normal distribution functions, of which a condensed one is given in table 3. To use this approach, the difference between the scheduled and expected mean times for the event is scaled down to a normal distribution curve, by computing a factor Z, where:

$$Z = \frac{T_s - T_x}{\sigma T_x}$$

Using the computed value of Z, a direct entry into a standard probability table gives the probability of meeting the scheduled time T_s.

Similarly, the scheduled time for an event can be determined for a given risk level,

$$T_s = T_x + Z\,\sigma_{Tx}$$

where the value of Z is obtained from standard probability tables for a given probability or risk level.

Table 3 Approximate Values of the Standard Normal Distribution Function

Z	Probability	Probability	Z
-2.0	0.02	0.98	+2.0
-1.5	.07	.93	+1.5
-1.3	.10	.90	+1.3
-1.0	.16	.84	+1.0
-0.9	.18	.82	+0.9
-0.8	.21	.79	+0.8
-0.7	.24	.76	+0.7
-0.6	.27	.73	+0.6
-0.5	.31	.69	+0.5
-0.4	.34	.66	+0.4
-0.3	.38	.62	+0.3
-0.2	.42	.58	+0.2
-0.1	.46	.54	+0.1
0.	.50	.50	0.

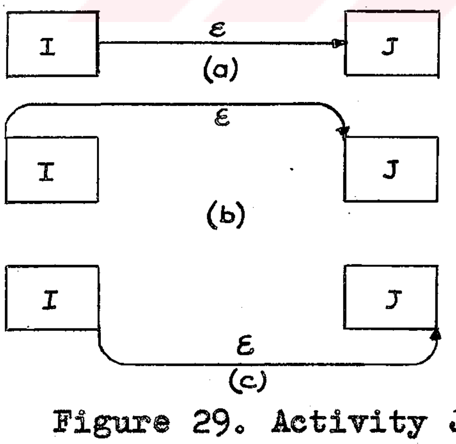
3. Precedence Diagrams

i) Forward Pass Computations

If the network is prepared as a precedence diagram, earliest start (ES) and earliest end (EE) times of activities are obtained as the results of forward pass computations. In this case the computation is started by setting an earliest start date for the first activity of the network, then ES and EE of other activities are determined. The existence of aforementioned three relation types and their possible combinations cause difficulties in network computations. For this reason each possible case will be illustrated separately in order to prevent any probable misunderstanding.

Case 1. When the activity under consideration has a single predecessor:

- The activity is related to its predecessor by a single relation



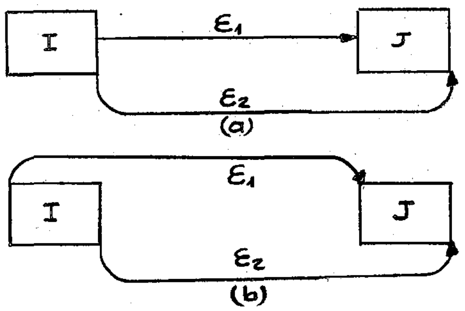
$$ES_J = EE_I + \varepsilon$$
$$EE_J = ES_J + t_j$$

$$ES_J = ES_I + \varepsilon$$
$$EE_J = ES_J + t_j$$

$$EE_J = EE_I + \varepsilon$$
$$ES_J = EE_J - t_j$$

Figure 29. Activity J is related to its predecessor by a single relation
(a) E-S (b) S-S (c) E-E

- The activity is related to its predecessor by more than one relation.



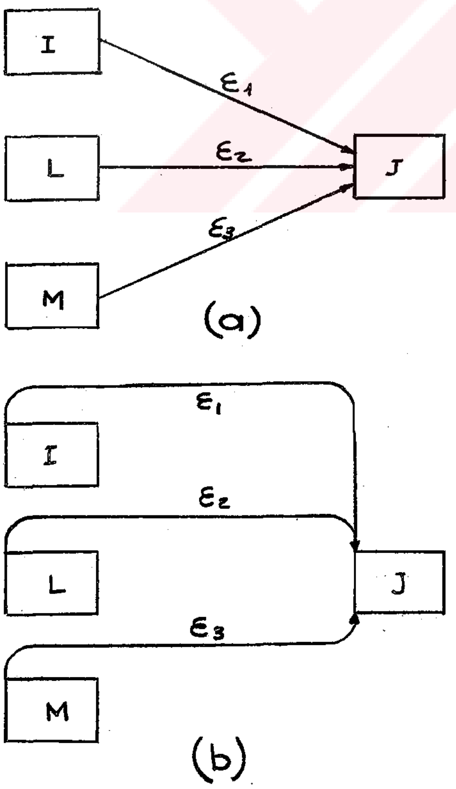
$$ES_J = max[(EE_I + \varepsilon_1),(EE_I + \varepsilon_2 - t_j)]$$
$$EE_J = ES_J + t_j$$

$$ES_J = max[(ES_I + \varepsilon_1),(EE_I + \varepsilon_2 - t_j)]$$
$$EE_J = ES_J + t_j$$

Figure 30. Activity J is related to its predecessor by a combination of two relation types: (a) E-S and E-E, (b) S-S and E-E

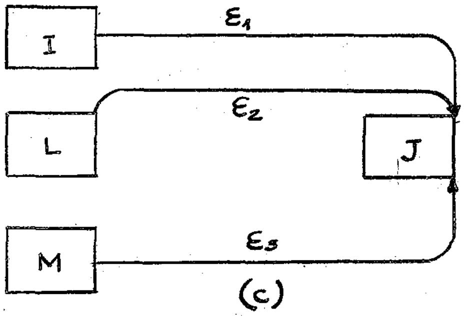
Case 2. When the activity under consideration has more than one predecessor:

- The activity is related to its predecessors with the same relation type.



$$ES_J = max[(EE_I + \varepsilon_1),(EE_L + \varepsilon_2),(EE_M + \varepsilon_3)]$$
$$EE_J = ES_J + t_j$$

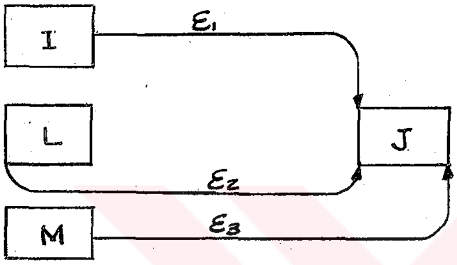
$$ES_J = max[(ES_I + \varepsilon_1),(ES_L + \varepsilon_2),(ES_M + \varepsilon_3)]$$
$$EE_J = ES_J + t_j$$



$$EE_J = max[(EE_I+\varepsilon_1),(EE_L+\varepsilon_2),(EE_M+\varepsilon_3)]$$
$$ES_J = EE_J - t_j$$

Figure 31. Activity J is related to its predecessors with same relation type: (a) E-S, (b) S-S, (c) E-E.

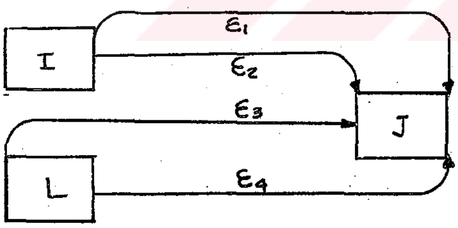
- The activity is related to its predecessors with different relation types.



$$ES_J = max[(EE_I+\varepsilon_1),(ES_L+\varepsilon_2),(EE_M+\varepsilon_3-t_j)]$$
$$EE_J = ES_J + t_j$$

Figure 32. Activity J is related to its predecessors with defferent relation types.

- The activity is related to each of its predecessors with more than one relation type.



$$ES_J = max[(EE_I+\varepsilon_1-t_j),(EE_I+\varepsilon_2),(ES_L+\varepsilon_3),(EE_L+\varepsilon_4-t_j)]$$
$$EE_J = ES_J + t_j$$

Figure 33. Activity J is related to its predecessors with combinations of two different relation types.

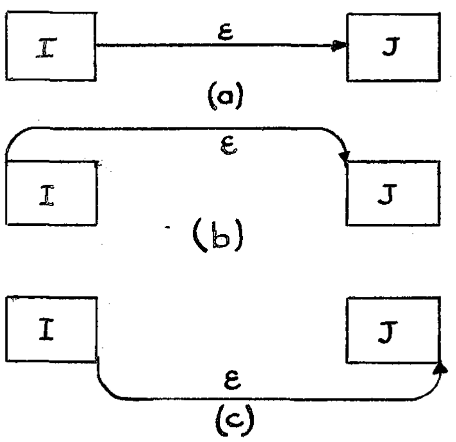
After the illustration of the cases which are likely to be faced while performing forward pass computations in precedence diagrams, attention should be drawn to the point that when the start of an activity is not related to any of its predecessors, although it may be thought that its ES is the project base date, ES should be taken as the difference between EE and duration of the activity in order to secure its continuity.

ii) Backward Pass Computations

Forward pass computations end when the ES and EE of the terminating activity are determined. At that point backward pass computations start which aim the determination of latest start (LS) and latest end (LE) times for project activities. The first step of these computations is setting the LS and LE of the last activity equal to its ES and EE respectively. The cases that the planner will possibly be faced while performing backward pass computations are illustrated below:

Case 1. When the activity under consideration has a single successor.

- The activity is related to its successor by a single relation type.



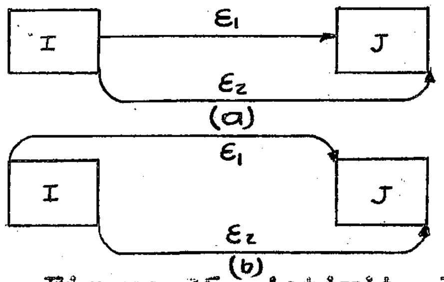
$$LE_I = LS_J - \varepsilon$$
$$LS_I = LE_I - t_i$$

$$LS_I = LS_J - \varepsilon$$
$$LE_I = LS_I + t_i$$

$$LE_I = LE_J - \varepsilon$$
$$LS_I = LE_I - t_i$$

Figure 34. Activity I is related to its successor by a single relation (a) E-S, (b) S-S, (c) E-E.

- The activity is related to its successor by more than one relation type.



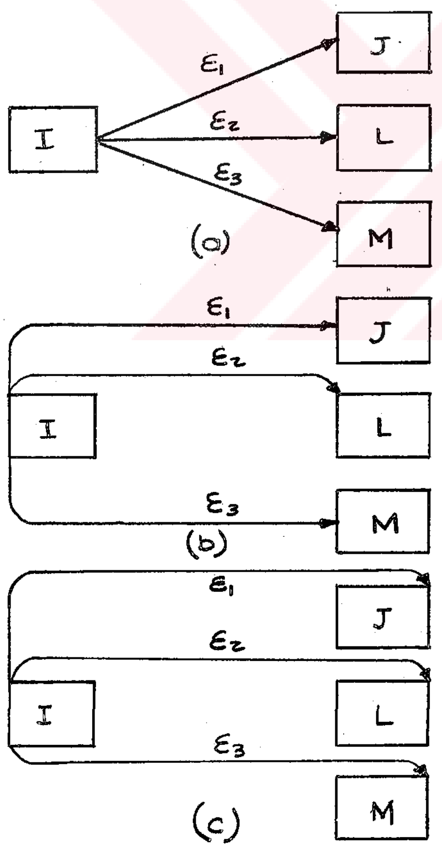
$$LE_I = \min[(LS_J - \varepsilon_1), (LE_J - \varepsilon_2)]$$
$$LS_I = LE_I - t_i$$

$$LE_I = \min[(LS_J - \varepsilon_1 + t_i), (LE_J - \varepsilon_2)]$$
$$LS_I = LE_I - t_i$$

Figure 35. Activity I is related to its successor by a combination of two relation types: (a) E-S and E-E, (b) S-S and E-E.

Case 2. When the activity under consideration has more than one successor.

- The activity is related to its successors with the same relation type:



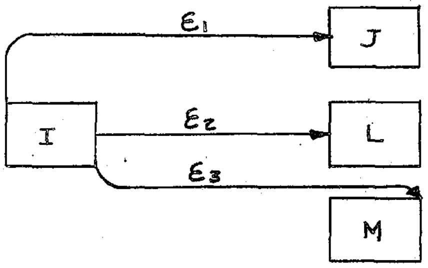
$$LE_I = \min[(LS_J - \varepsilon_1), (LS_L - \varepsilon_2), (LS_M - \varepsilon_3)]$$
$$LS_I = LE_I - t_i$$

$$LS_I = \min[(LS_J - \varepsilon_1), (LS_L - \varepsilon_2), (LS_M - \varepsilon_3)]$$
$$LE_I = LS_I + t_i$$

$$LE_I = \min[(LE_J - \varepsilon_1), (LE_L - \varepsilon_2), (LE_M - \varepsilon_3)]$$
$$LS_I = LE_I - t_i$$

Figure 36. Activity I is related to its successors with same relation type (a) E-S, (b) S-S, (c) E-E.

- The activity is related to its successors with different relation types.

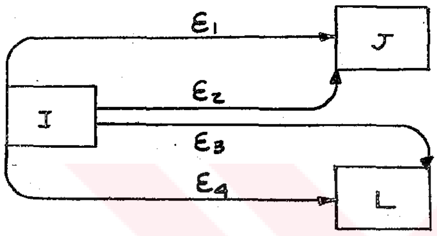


$$LE_I = \min[(LS_J - \varepsilon_1 + t_i), (LS_L - \varepsilon_2), (LE_M - \varepsilon_3)]$$

$$LS_I = LE_I - t_i$$

Figure 37. Activity I is related to its successors with different relation types.

- The activity is related to its successors with more than one relation type:



$$LE_I = \min[(LS_J - \varepsilon_1 + t_i), (LS_J - \varepsilon_2), (LE_L - \varepsilon_3), (LS_L - \varepsilon_4 + t_i)]$$

$$LS_I = LE_I - t_i$$

Figure 38. Activity I is related to its successors with combinations of two different relation types.

Backward pass computations end when the LS and LE times for the first activity of the network are determined. In backward pass computations it should be pointed out that when the end of an activity is not related to any of its successors, its LE should be taken as the summation of its LS time and duration, but not the project end date.

iii) Float Analysis

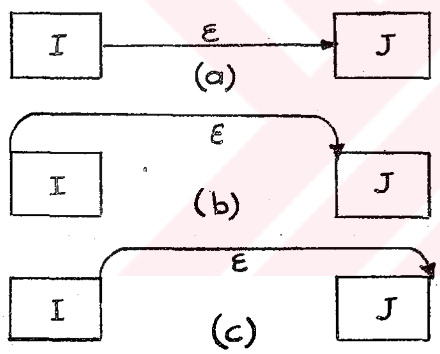
The determination of critical path(s) and analysis of floats is the next step. Keeping the definitions of floats the same as given before, their mathematical expressions are modified as:

Total float (TF)

$TF_I = LS_I - ES_I$ or $TF_I = LE_I - EE_I$

Activities having zero total float will appearantly take place on a critical path.

Free float (FF) of an activity cannot be formulated by a single expression due to various relation types in precedence diagrams. The formulas for three possible cases are given below. If the activity whose FF will be computed, is related to more than one succeding activity with various combinations of relation types, each relation will be considered individually and free float due to each single relation will be computed separately, then the minimum of them will be assigned to the relevant activity as its free float.



$FF_I = ES_J - \varepsilon - EE_I$

$FF_I = ES_J - \varepsilon - ES_I$

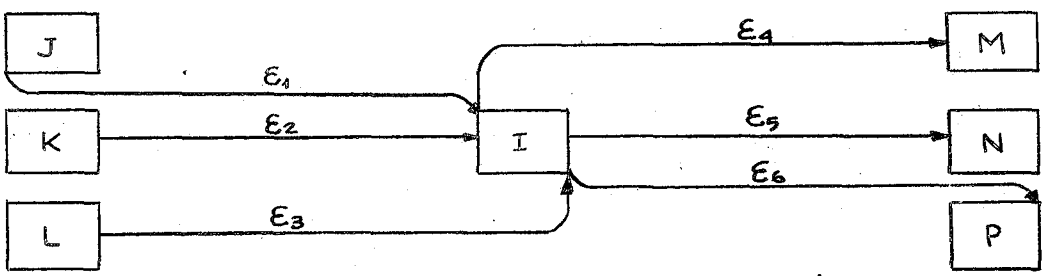
$FF_I = EE_J - \varepsilon - EE_I$

Figure 39. Activity I is related to its successor by (a) E-S, (b) S-S, (c) E-E relation types.

Interfering float (IF)

$I.F._I = TF_I - FF_I$

Independent float (IND.F) may also be defined as the maximum additional time that can be made available for the accomplishment of an activity such that all of its predecessors will end at latest permissible times and all of its successors will start at earliest possible times. A general case is illustrated below; if the activity under consideration has more successors and predecessors, or more than one relation type exist between the activity considered and its predecessors or its successors, individual float may be calculated by taking relations into account one by one.



$$IND.F_I = \max\left[(LS_M - \varepsilon_4 + t_i), (LS_N - \varepsilon_5), (LE_P - \varepsilon_6)\right] - \min\left[(ES_J + \varepsilon_1), (EE_K + \varepsilon_2), (EE_L + \varepsilon_3 - t_i)\right]$$

Figure 40. Independent float of activity I.

B. ROLE OF COMPUTER IN NETWORK CALCULATIONS

The mathematical structure of networks make them suitable for electronic data processing. All necessary time, cost and resource computations can thus be performed by computers.

In this section, the major considerations involved in deciding to use the computer, advantages and some problems faced in using them will be described.

In general, computers are preferred to manual computations when they cost less. But in cost calculations, irreducible factors like the value of time must be carefully analyzed since early warnings may affect the profit appreciably. For instance there may be a case in which manual computation costs less than computerized one, but if the computerized system supplies information to managers weeks before than they would otherwise get, the use of computer becomes preferrable.

1. Factors of Using Computers

There are "several factors to be considered in deciding whether or not to use computer for network computations. These are:

a. Network Type- Arrow diagrams are more suitable for manual computations than precedence diagrams are. Because the various relation types and lag values involved in precedence diagrams may cause errors or at least inaccuracy and time loss as the number of activities goes above hundred.

b. Network Size and Complexity - It is a common practice to express the network size by the number of activities in it. The degree of complexity may be determined by the number of relations between the project activities and their types. In deciding whether or not to use computer, size and complexity of the network should be considered. It is advisable to use computer if the network is composed of at least few hundred activities, unless it is a very simple one such as a network with long independent paths.

c. Degree of Detail in Data - In addition to activity decriptions and durations, the planner may wish to deal with cost and resource informations. Also, if the selected planning method is PERT or any version of it, three time estimates for each individual work item, which are to be known for the calculation of expected mean time, standard deviation, variance and probabilities of meeting the scheduled completion dates, becomes an integral part of the data. As the data becomes more detailed to perform the required network calculations, the use of computers becomes favorable.

d. Types of Reports Required - Computer programmes provide managers with various types of reports which are prepared in detail. For example, Project Control System (PCS) of IBM can produce 14 different types of output reports. If only the earliest and latest, start and end times, and total floats of activities are required; and if consideration of other factors results in favor of manual computations the planner may prefer to prepare the reports manually.

e. Updating Frequency - If a network is to be analyzed only once and never updated to monitor progress, manual analysis can be justified even if the network is a large one. Because the preparation of data for only one computer run may take more time than manual analysis. But if the network is to be updated frequently, the use of computer may become profitable.

f. Periodicity of Reports - The results of a network analysis should be made available to managers periodically. Time consuming manual methods compare unfavorably with computer except on small and simple networks.

g. Formality of Reports - If the network analysis results are to be used by the planner himself or by a few persons in an informal manner, all calculations may be shown on the network diagram itself. Computer processing with multiple copies, eliminates the need of preparing formal reports for different partners. They can even be used as contract documents.

In many cases, manual computations to find the critical path at the beginning of planning works is very useful for the logical refinement of the network. It is obvious that this will be a very tedious work especially if the network is large and complex. But, since the logical refinement will change duration and cost estimates, and even the activity codes and descriptions, this procedure eliminates the time loss, cost and difficulty involved in changing the input data of computer program until it is completely refined.

2. Benefits of Using Computer

a. Speed - The computer perform calculations considerably faster than a person. For example IBM/7030 needs only one second for 400 000 multiplication operations where a person can perform only one multiplication in 60 seconds[32].

The speed of computer enables the submission of network analysis reports to managers in exact periods of time.

b. Accuracy - Computers never introduce errors through calculation and data manuplation processes. Therefore output reports of a computer process are more dependable than those obtained by manual manuplations. But errors may occur in preparing input data, some of which are diagnosed by editing and self-checking features built into well-designed computer programs. Since logical faulty in input data will cause erroneous results, the network should be carefully refined; and also the planners must analyze the results to ensure the correctness of input data.

c. Economy - As the size and complexity of the network model increase, the use of computer becomes more economical than manual systems. The cost saving grows rapidly as the volume of data increases beyond the break-even point which is quite hard to define due to irreducible factors involved.

d. Ability to Handle Large Volumes - Network based planning systems are accepted to be superior to other systems due to several reasons one of which is enabling very detailed project breakdown, thereby making possible to estimate duration and costs of activities more accurately. But detailed breakdowns result in large volume of data which are very difficult to handle without computers. For instance Project Control System of IBM/360 can process networks upto 5000 activities which are impracticable to analyze manually.

f. Uniform Format of Reports - A computer with a well-designed program matching the network based system introduces dicipline and standardization to reporting system. This increases the efficiency of the management.

3. Problems Faced in Using Computer

a. Over-estimation of Computer Capability - Many people, including some managers who do not have a clear idea what the computer can and cannot do, expect more from the computer than it is possible to get. Consequently they get dissappointed, when they acually use the computer.

b. Strict Dicipline - The computer imposes a strict dicipline which is quite hard to become accostumed. It requires all necessary data to be provided and to be entered properly and precisely. The computer detects errors in input data and return them for correction; this may cause delay, where in manual systems if any missing information or errors are detected they can be corrected before proceeding further.

c. Administrative Problems - A bureaucracy grows up around computer, calling for forms to be filled out and for approvals to be obtained. If an error is detected in data, even though it may take only a few minutes to correct it, at least 24 hours are needed for a new try at computer. This time consuming procedure may cancel out some of the advantages gained due to the speed of computer.

C. COMPARISON OF PCS AND BKN

PCS and BKN are the two available computer programs for network analysis. The network model of Yeşilköy Airfield Infrastructure Project has been analyzed by both of them, and the reports obtained are submitted in Appendix C. The preparation of input data and output reports are discussed in Appendix B.

In this part these two programs will be compared in various aspects. Before going into detail, it should be pointed out that PCS is a complete program; whereas BKN is composed of a main part, computing the work schedule, and additional ones to be used with the basic part. Most of these programs are not available yet in Fortran language.

1. Activity

a. Identification and Description

In both systems activities of a network are identified by their identification codes and described in such a way that they will not be confused with any other activity in the network.

- PCS permits the user to use 10 alphameric characters for each identification code, and 44 alphameric characters for each activity description (see "Work Item Card", Appendix B.1)

- BKN permits the user to use 10 numeric characters for identification codes and 30 alphameric characters for descriptions (see "Activity Description Card", Appendix B.2)

b. Duration

- In PCS activity durations are specified as decimal numbers carried out to tenths; and the user is allowed to use 7 different time units which are internally converted to days: days, hours, half-days, one-shift days, two-shift days, three-shift days and weeks (see "Work Item Card" Appendix B.1). In addition, the number of hours in a day can be entered (see "Processing Control Card", Appendix B.1).

- In BKN each activity can be assigned a duration which has to be expressed in whole days (see "Relation Card", Appendix B.2).

c. Cost

- PCS produces two cost reports, lump sum and monthly cost, using three different categories of cost: total estimated cost, actual cost of this period and actual cost to date.

Total estimated cost is a seven digit number that represents the estimated number of whole dollars it will cost to perform the activity. The user may specify total estimated cost for an activity using the resource cards (see "Resource Card", Appendix B.1).

Actual cost of this period is a seven digit number representing the number of whole dollars spent in performing an activity during the current reporting period (see "Progress Reporting Card", Appendix B.1).

Actual cost to date is a seven digit number that represents the number of whole dollars spent in performing an activity since work on that activity has started (see

"Progress Reporting Card", Appendix B.1).

- For cost analysis a special BKN program should be employed (see "BKN-COST", Appendix B.2.II).

d. Resource

- PCS can perform some computations related to resources and produces two reports: Resource Assignment Report and Resource Utilization Report (Appendix B.1.II)

A resource element is defined as the number of whole units of the resource required to perform the relevant activity and is identified by a resource code. A resource element may be specified as the number of units of the resource required to perform the relevant activity for the period of one unit time or for the duration of that activity (see "Resource Card" Appendix B.1).

- For the analysis of the resource aspect of a project, there is a special BKN program (BKN- POT) which is briefly described in Appendix B.2.II.

e. Float

- PCS computes two types of float for each activity: start float and completion float. The start float is the number of days between the early and late start dates and the completion float is the difference between the early and late completion dates. Both of them are printed as decimal numbers carried out to tenths of a day (see "Schedule Report", Appendix C.1).

In fact both of these floats are identical to total float unless there exists a time blockade area. In computing these float values PCS considers holidays and special nonwork days in addition to working days.

- BKN computes two different floats for each activity: gross (total) float and free float. These float values are printed in schedule report in terms of whole days (see "Schedule Report" Appendix C.2). BKN considers only working days in float computations.

f. Milestones

- In PCS the start or the completion of an activity whichever is of major interest or importance to the project may be specified as a milestone. Upto 480 milestones may be specified (see "Milestone Card", Appendix B.1). Once the user has specified Milestones for a network, he may obtain a Milestone Report that shows the dates PCS calculates for each of them.

- No milestone can be specified in BKN program. But, a general network with major activities may be prepared at the beginning of work, and controlled during the project execution for the same purpose.

g. Exogene Dates

- PCS allows the user to specify one of five different types of scheduled date for an activity (see "Schedule Card", Appendix B.1):

Type 1. These dates have no effect on the system

Type 2. This represents the earliest date desired for PCS to schedule the start or the completion of an activity.

Type 3. This represents the specific date desired for PCS to schedule the start or the completion of an activity, regardless of the early or late start or completion dates the system computes.

Type 4. This fixes the late start or completion of an activity on a desired date.

Type 5. This sets the late completion time of the work item equal to the calculated early completion time.

- BKN permits the user to fix either the start or completion of an activity on a desired date (see "Exogene Date Card", Appendix B.2). If the start of an activity is fixed, its both early and late start times are set equal to that scheduled date. Similarly early and late finish times of an activity are taken equal to the scheduled date on which the completion of the activity is desired to be fixed.

2. Network

a. Type

- PCS is designed to process procedence networks. However if the network submitted is an arrow diagram, it internally converts it into precedence diagram (see "Processing Control Card", Appendix B.1).

- BKN processes only precedence networks.

b. Size and Complexity

- PCS can handle networks upto 5000 activities. The maximum number of preceding activities can be 12 500.

- The available BKN program can process networks upto 2199 activities and 4199 relationships.

c. Relationships

The relationships that exist in a network are the dependencies that exist between various activities contained in the network.

- PCS accommodates three different relationships (see "Preceding Work Item Card", Appendix B.1).

i) Start to start,

ii) End to end,

iii) End to start.

The user of PCS may specify more than one relationship for the same pair of activities, as long as no two relationships are of the same type. If more than one relationship is specified for the same activity, PCS uses the relationship that produces the longest time delay.

- All types of relationship processed by PCS, can also be handled by BKN. But the relationships are categorized in a different manner (see "Relation Card", Appendix B.2):

Type 0. End to start with no time delay,

Type 1. End to start with some time delay,

Type 2. Start to start,

Type 3. A combination of start to start and end to end,

Type 4. End to end.

In recently developed BKN programs type 0 and type 1 relationships are combined and called as type 0, for which time delay may be zero or greater than zero. In these programs type 1 is "start to end" relationship which does not exist in PCS.

In BKN a single type of relationship can be set for the same pair of activities. When type 3 relationship is set between two activities the system determines the relation producing a longer time delay, and uses it for computations.

d. Time Delays

The time delays, in both systems, are the amount of minimum time distance required between:

i) The start of one activity and the start of a previous activity in a "start to start" relationship.

ii) The completion of one activity and the completion of a previous activity in an "end to end" relationship.

iii) The start of one activity and the completion of a previous activity in an "end to start" relationship.

- PCS permits the user to specify a time delay either in time units in which the duration of the base work item (preceding activity in "start to start" and "end to start" relationships, and succeding activity in "end to end" relationship) or as a percentage of the estimated duration of that base work item. The user is allowed to change the base work item if he wishes.

Whenever a time delay is assigned for either "start to start" or "end to end" relationship, the working days of the base work item are considered for the passage of this delay, but in "end to start" relationship, holidays and special nonwork days are also utilized.

- In BKN system the user has to specify time delays only in whole days. The days of the calender submitted to the system are considered for the passage of time delays.

A new version of BKN program permits the user to specify maximum time distances, required between project activities, regardless of the existing relationship type, providing flexibility in planning.

e. Calender

- PCS allows activities to be subjected to any of these three calenders (see "Calender Card", Appendix B.1):

i) Standard Calender- A normal year of 365 days, leap years having 366 days.

ii) Holiday Calender- The standard calender, less specified holidays.

iii) Special Calender - The standard calender less specified holidays and specified nonwork days.

In addition, the work week specification provides for the exclusion of specific days of the week for an activity (see "Work Item Card", Appendix B.1).

Since the standard calender is already contained within the system, the user specifies only those days to be deleted from the standard calender (see "Calender Card", Appendix B.1).

- In BKN only one calender can be assigned to all activities of the project. The user specifies the days on which work will be scheduled, using the calender cards described in Appendix B.2.

f. Critical Path

- PCS does not print out the critical activities. The critical activities can be observed either from bar chart" on which their durations are shown by special marks (see "Bar Chart", Appendix C.1) or from "Schedule report" since activities on the critical path have zero total float. But for some critical activities PCS may compute float values slightly greater than zero (see "Schedule Report" Appendix C.1).

– BKN program provides the user with a list of critical activities. Also the status of a critical activity is reported as:

Normal– If compression of an activity causes a reduction in the project duration, it is called as a normal critical activity. No remark is made for these activities.

Neutral– The critical activities are classified as "neutral" if their compression do not yield any reduction in the duration of the project. An example of neutral critical activity is the activity 0906 in the network model presented in Appendix E.

Negative– The critical activities having this message beside their identification codes are of great significance, because the project duration will be prolonged if such an activity is compressed.

3. Input

All input data are to be submitted in form of card images to both of these programs. The types of input cards and their formats are described in detail in Appendix B.

On update and maintenance runs PCS requires the specification of only those information which are to be added to or deleted from the data submitted to the system on a generation run. But for this purpose a special permission to occupy the storage of the computer must be obtained. This is not permissable in most cases.

If the user employs a special version of BKN programme (see "BKN-MOD", Appendix B.2.II), he can load all necessary information about a network on a tape, then make all necessary modifications on that network.

When only schedule report and bar chart of a project are required, BKN requires more input cards than PCS mainly because activity description cards are submitted twice in BKN, one set being for schedule report and the for bar chart. In addition, the user of PCS can specify upto three relationships on a single preceding work item card, if the network is designed as a precedence diagram, where BKN requires the submission of a different relation card for each relationship.

On the other hand, as the descriptions of the programs given in Appendix B clearly show, the rules to be obeyed are more detailed and the formats to be followed are more complex in PCS than those in BKN.

4. Output

Both systems can produce their reports either in working days or in calender dates. But the "working day" term has been used to mean different things for each system; PCS takes the "project base (start) date" as 1 and assumes all days on the standard calender as working days (or project days), where BKN takes the project start date as 0 and assumes the days on which work to be scheduled as working days.

PCS can produce 14 different reports on a single run, whereas BKN can produce only schedule, calender, critical path and bar chart reports with its basic part.

The order, in which the activities appear in schedule report and bar chart of BKN is that of the activity description cards in the input card deck. Therefore the order of appearance of activities can be affected only by resorting the activity description cards. PCS provides a great flexibility in this respect enabling the user to have 8 different ways of activity sequencing in output reports (see "Output Request Card", Appendix B.1).

PCS uses each printing position as one day on standard calender while producing bar chart. But the user of BKN is allowed to change the scale of bar chart as he wishes (see "Scaling Card", Appendix B.2).

Although PCS produces its reports for the whole project length, it can produce some reports such as bar chart, lump sum cost, monthly cost, resource assignment, work status and progress, and schedule reports, for a desired interval of time within the project duration; where bar chart and schedule report of BKN covers the whole length of the project.

5. "Diagnostic Program Messages" (Error Messages)

PCS prints diagnostic program messages to indicate errors made in input preparation or errors discovered during network processing, or output preparation. The system is provided with detailed editing and self checking features by which almost all possible errors are located[33]. The error messages printed by PCS are of four types:

i) Type R - indicates an error for which the program has attempted to make a logical adjustment. Card reading and/or processing was then resumed. There are 24 error messages of this type. Example:

ERROR 12049 TYPE R

Explanation: An invalid work week start day, cc 67 in the work item card, has been specified. The program assigned a value of 1 (Monday).

Action: Check, and if necessary, change and resubmit.

ii) Type I - indicates an error that the program has ignored. Card reading and/or processing was resumed. 66 errors that do not critically affect other data and/or processing, but for which no logical adjustment is apparent, fall into this class. Example:

ERROR 12072 TYPE I

Explanation: The scheduled start day, in cc 20-26 of schedule card, is invalid. The program ignored the date.

Action: Check the card, and if necessary, correct and rerun.

iii) Type W - indicates a warning to the user that the system has taken some type of specific action based upon a user request. There are 3 error messages of this type.

Example:

ERROR 12299 TYPE W, RPT. xx/y

Explanation: The time span of one or more work items in the network extends beyond the implied, or user-specified, upper span date from the output request card for this report. These work items will not appear on the report. The report identification is printed following the letters "RPT" in the message, where xx is one or two digits specifying a particular report, and y specifies the number punched into the output request card used to request the report.

xx	Report
4	Work Status and Progress Report
5	Schedule Report
6	Bar Chart
9	Lump Sum Cost Report
10	Monthly Cost Report
11	Precedence Report

Action: If the user desires to have all work items to appear on the particular report, he should specify an upper span date greater than the calculated dates for all work items and submit a PCS report run.

iv) Type F - indicates an error that critically affects other data and/or calculations. The program may continue to read any remaining input cards in order to locate other errors, or immediately terminate the run. If an error of this type occurs during network processing, the run is always immediately terminated. There are 27 error messages in this group. Example:

ERROR 12002 TYPE F

Explanation: No network identification code has been specified in cc 2-5 of card B.

Action: Enter the network identification code in cc 2-5 of network title card.

The error messages that may be given by BKN are:

i) DOUBLE DURATION - This message is printed out with the identification of the activity for which different durations are punched on different relation cards. The system assumes the duration that appears first in the input card deck, as the correct duration and continues processing.

ii) STOP 1- This message indicates that the number of activities contained in the network exceeds 2199.

iii) STOP 2- This message warns the user that he has specified more than 4199 relationships.

iv) UNDEFINED JOB - The activity whose identification code is printed next to this message has no preceding activity, although it is not the starting activity of the network.

v) Loop - The codes of activities constituting a loop are printed out. The program breaks the dependency between the last two activities of the loop and continues to search for other loops before stopping.

vi) N CALENDER DAYS MISSING - This message indicates that the submitted calender is N days shorter than the project duration. The working day option is used for the activities taking place on those missing days.

vii) POSITION OF CALENDER CARD N. CONTROL PLEASE- This message warns the user that the calender cards are not sorted in accordance with their sequence numbers punched on cc 79-80 (see "Calender Card", Appendix B.2).

D. DETERMINATION OF THE MOST ECONOMICAL PROJECT DURATION

The most economical or optimum duration for a project may be defined as the project duration which corresponds to minimum total cost. Total project cost has two components: direct cost and indirect cost. The direct project cost is the sum of all direct expenditures made in accomplishing the work. In other words, it is the summation of direct cost of all project activities. The indirect cost (general overhead cost) consists of all expenditures made for supervision and direction of the project. It is affected by bonus to be gained in case of early completion and penalty to be paid for late accomplishment as well as by interest costs, and other advantages and disadvantages related to project duration such as the time of release of the personnel and installations.

In order to determine the optimum duration for a project, the direct and indirect cost curves whose summation gives the total cost curve must be known (fig.41). In general, indirect cost curve for a project can be plotted based on the estimates of competent personnel of the firm. But for the determination of the project direct cost curve a complex computational procedure, which is commonly known as "network compression", must be followed.

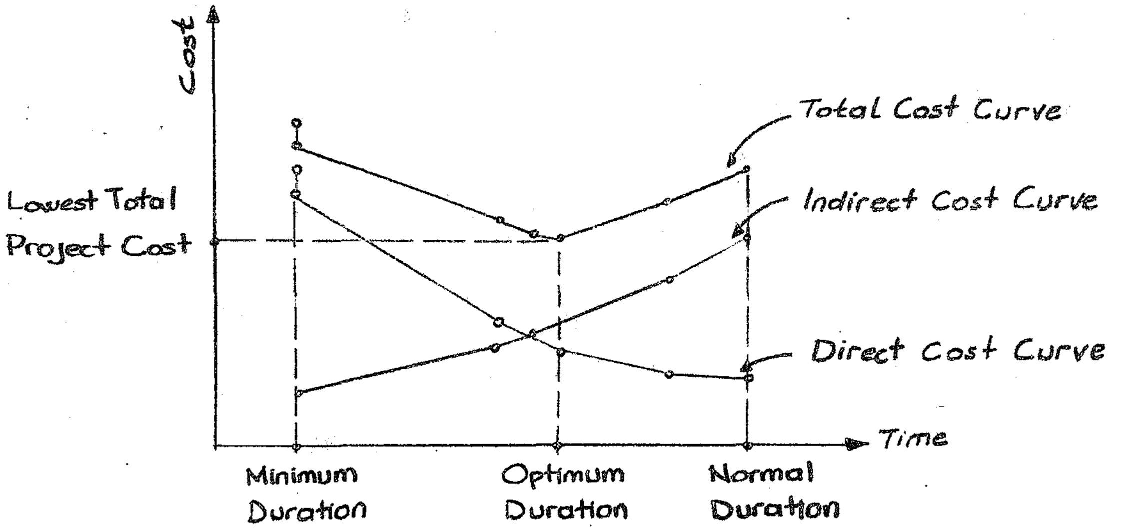


Figure 41. Most economical duration for a project.

Network compression computations involve systematic and progressive reductions in project duration through the use of additional resources, thus speeding up individual activities in economical limits. The speeding up an activity depends upon the availability of resources and the form of its utility curve, and independent of its position in the network. Therefore duration of any activity can be reduced, unless there exists some preventing physical constraints or shortage of additional resources.

Since the critical path is the longest time path through the network, only the compression of the activities, laying on the critical path, can reduce the project duration. In order to have an economical compression, the critical activity having the flattest cost slope should be selected.

Network compression calculations consist of following steps:

Step 1. The activities on the critical path are listed.

Step 2. The critical activities having zero potential for compression are excluded. These include activities whose normal and crash durations are identical as well as those already fully crashed in previous stages.

Step 3. The activity, having the flattest cost slope among the listed activities, is selected, since this will give the cheapest compression.

Step 4. The amount by which this activity can be compressed and its relevant cost are determined.

Step 5. The compression is carried out within the limitations imposed.

Step 6. The new project duration and the corresponding direct cost are determined.

Step 7. If any noncritical path becomes critical during the compression process, the activities on this path are included in the list of compressible critical activities.

Step 8. The steps 1 through 7 are carried out until any reduction in the project duration becomes impossible.

As the above explanation clearly indicates, the planner must be provided with complete information about the utility data of all project activities, if he is expected to determine the most economical project duration. But almost in all construction projects the network compression calculations are not carried out due to lack of dependable data.

The complexity of network compression calculations is directly proportional with the size and the complexity of network. If utility curves of activities are not linear and continuous, the compression process becomes extremely difficult to carry out.

E. RESOURCE LEVELING AND SCHEDULING

The schedules prepared, under the influence of physical and operational constraints, by PCS and BKN, are submitted in Appendix C.1.a. and C.2.a. respectively. In these schedules, activities of the same general work item do not overlap, because they are sequenced to form a single chain, considering the resource limitations imposed. Therefore, at this stage, the need for additional resources is eliminated. But an analysis of aforementioned reports will prove that there are some interruptions, between the subsequent activities of a general work item, causing considerable amount of idle time. The project activities have to be rescheduled now, in order to cancel out those interruptions, thereby to maintain effective flow and smooth execution of work.

In the following paragraphs the procedure followed to achieve this aim will be illustrated for each general work item of the Yeşilköy Airfield Infrastructure Project. Also, the differences between the schedule reports obtained by PCS and BKN will be explained.

i) Pavement Quality Concreting (PQC)

The schedule reports presented in Appendix C.1.a. and C.2.a have indicated that many of the PQC activities are on the critical path. Therefore, these activities are given the priority in scheduling.

All critical PQC activities (0322 - 0329) are scheduled to start at their computed starting times. The noncritical PQC activities are scheduled to start at their earliest starting times, keeping the available floats as future safety margins.

The BKN program gives a list of critical activities (Appendix C.2.b), but PCS does not provide the planner with a list of critical activities. These activities can be seen in the schedule report, since, by definition, the activity of critical status has no total float. The reason behind the fact that some critical activities having their total floats slightly greater than zero have appeared in PCS schedule reports, can be explained by an assumption made in designing the system. This assumption may be stated as "when a time delay is assigned in an end-to-start relationship, holidays and special nonwork days are also utilized for the passage of this time delay". This assumption is not valid for the end-to-start relationships between the PQC activities, since the time delays in these relationships are used to indicate the amount of time that will be needed for shifting of equipment and team from the location of one PQC activity to that of subsequent one. Therefore only working days should have been considered for these time delays.

Another fact which can be observed at this stage is that the noncritical PQC activities have different total floats on PCS and BKN schedule reports. The reason of these differences is the expression of activity durations and time delays in different ways. As explained in Appendix B, the user of PCS can assign durations to project activities in tenths of a day. But, in BKN, activity durations and time delays must be expressed in whole days. Therefore all time delays between the PQC activities are set equal to zero, and activity durations are rounded off while using BKN program.

ii) Lean Concreting (LC)

The LC activities whose codes are 0207, 0208 and 0201 are come out to be critical. Therefore, they are scheduled to start at their computed starting times. Then the activities 0206 and 0205 are scheduled to follow this critical chain without any interruption. The LC activities which take place on fuel farm area (0210, 0203, 0209) are so scheduled that they will be completed before the scheduled start times of their succeding PQC activities, leaving the required amount of time lag.

iii) Earth Work

The schedule of the critical earth work activities (0100, 0101, 0110) are left as they are, but noncritical ones are arranged in accordance with the related LC activities.

iv) Constructing Drainage Structures

A group of drainage activities, which can be finished before winter, are scheduled to start as early as possible, by fixing the completion of the last activity of this group (0611) on the day before the first day of the winter holiday, and a total float of 2 days is left for them. This float value is appeared as 1 day on BKN schedule report (Appendix C.2.c), because BKN considers only working days in float computations.

The remaining part of drainage activities are scheduled to start after winter holiday by fixing the starting day of the activity 0630.

v) Laying Multi-cell Cable Passes under Shoulders.

The following activities of this group have come out to be critical in the first PCS schedule report (Appendix C.1.a): 0829, 0826, 0825, 0828, 0827, 0840, 0841 and 0842. On BKN schedule report (Appendix C.2.a.) only the activity 0829 is critical, the others above, are nearly critical having only 1 day total float. Therefore these activities are scheduled to start at their computed starting times. The schedules of subsequent activities of this chain are determined by fixing the completion of 0800 which is the last activity of the chain. If all preceding "multicell cable passes" activities are to be started at their latest starting times, there will be no interruption in this chain. But, there is an opportunity to schedule some reasonable amount of float for these activities.

vi) Shoulder Stabilization

Shoulder stabilization activities are the most time consuming ones among all the shoulder activities. Therefore, for these activities, work will be scheduled on 7 days of the week, excluding official holidays, while using PCS, in order not to delay the project completion date given to the contractor. Since BKN program does not permit the specification of different work weeks for project activities, the work week, for this group of activities, will also be six days as the others. Consequently more shoulder stabilization activities will be on the critical path, and the project duration will come out to be longer in BKN reports.

In PCS schedule report (Appendix C.1.a) 0442 is the only critical shoulder stabilization activity. If the schedule of this activity is kept as it is, the computed project duration will not be affected. But the preceding shoulder stabilization activities cannot be completed until the start of 0442, if the "multi-cell cable passes" activities are to be executed in accordance with the schedule determined at the previous step. Because a shoulder stabilization activity cannot start before the completion of related multi-cell cable passes activity. Therefore, the start of the first activity of the shoulder stabilization chain (0403) is fixed on such a date that neither any interruption in the flow of multi-cell cable passes activities will be caused, nor any interruption in the flow of shoulder stabilization activities will occur. But, it is obvious that, in this case, the critical activity 0442 will be shifted, causing the extension of the project duration.

In BKN schedule report (Appendix C.2.a), the shoulder stabilization activities 0429, 0426, 0425, 0428, 0427, 0440, 0441 and 0442 have appeared as critical activities. Due to the same reason, these critical activities are shifted towards the project end. The extension caused in this case is more than the one observed in PCS reports, due to specification of

6-day work week.

vii) Laying PVC Pipes under Shoulders.

The total length of the chain of "laying PVC pipes under shoulders" activities is consiredably less than that of shoulder stabilization chain. Therefore the schedules of activities in this group is determined by fixing the completion of the last activity in the chain (0700) on a date which will occur, a time interval, equal to the duration of this activity, later than the completion of activity 0400. Then the activities are scheduled so that there will be no time lag between the activities of the chain.

viii) Forming Asphaltic Concrete Layer on Shoulders

The procedure, described in the above paragraph, is followed while scheduling this activity group, because the length of this chain is shorter than that of "laying PVC pipes under shoulders" chain. Therefore, the scheduling of "forming asphaltic concrete layer on shoulders" activities is started by fixing the completion of 0500 on the date which will occur a time interval, equal to the duration of activity 0500, later than the completion of the activity 0700.

ix) Top Soiling

The top soiling activities whose codes are 0906, 0914, 0913, 0912, 0905, 0900 and 0901 have appeared as critical, on reports obtained by both programs (Appendix C.1.b. and C.2.c). The computed completion time of activity 0901 is the project completion date since it is the last activity of the critical chain. Therefore the schedules of these critical activities are left as they are, and the noncritical top soiling activities are so arranged that there will be no time gab between the activities of this chain.

The final schedule obtained is presented in Appendix F in a bar chart form.

CHAPTER VI

PROJECT CONTROL

A. NECESSITY FOR PROJECT CONTROL

One of the fundamental principles of management was stated by Henry Gantt: "The authority to issue an order involves the responsibility to see that it is executed"(15). Therefore when a manager has issued instructions that certain things are to be done, it is also his responsibility to provide a mechanism which will keep him continuously informed as to whether or not his orders are being carried out, so that he can decide on the corrective measures, if the progress is not satisfactory. It is obvious that no paper-plan will work continuously in practice, even if it is theoretically perfect. Unpredictable conditions and unknown factors may become effective at any time during the execution of the project causing delays and disturbing the smooth run of operations.

Based on the above discussion, the primary objective of project control may be formulated as: "to review the current situations in the light of previous experience and to forecast the future requirements, so that the work may be completed succesfully".

B. PROJECT CONTROL CYCLE

The control of a project must be dynamic and must respond immediately to changing conditions. Also, it is necessary to have a monitoring system, to measure the differences between the planned and actual performances, which forms the basis of revising the original plan. Measurement of actual achievements and comparison with the planned ones is, therefore, an essential feature of an effective control system.

The fundamental stages of project control cycle are: instruction, execution, measurement and correction by new instruction. The system used in a dynamic project control is shown diagrammatically in figure 42[34].

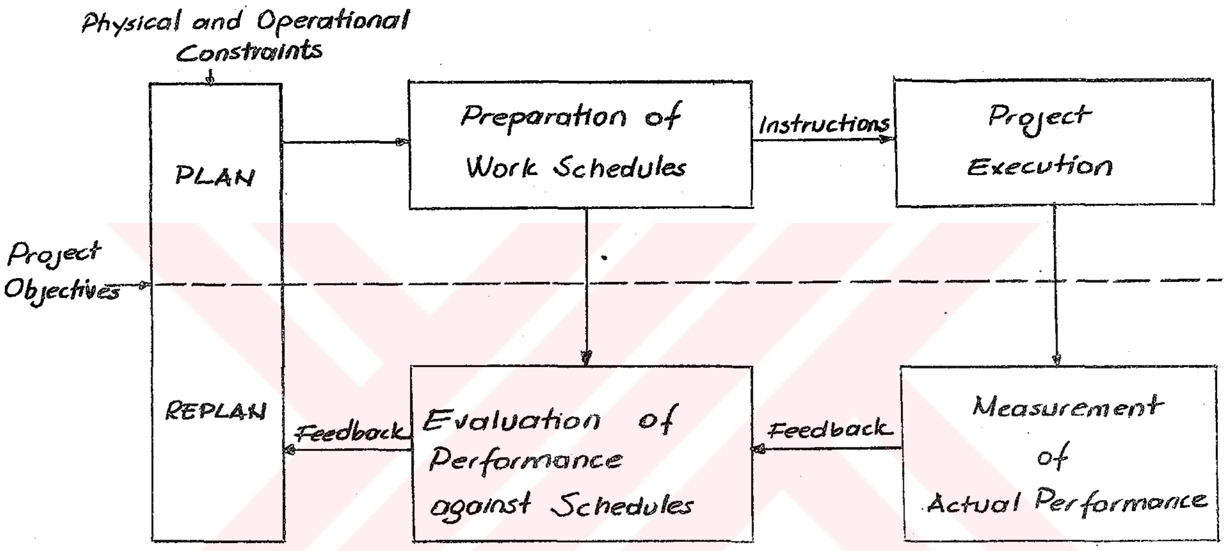


Figure 42. Project control cycle

The functioning of project control cycle may be illustrated as:

i) An original plan is formulated to meet the project objectives under the influence of existing physical and operational constraints.

ii) The plan is put into the form of job schedules.

iii) Instructions are issued in accordance with these schedules.

iv) The execution of instructions results in the accomplishement of a certain part of the project.

v) The actual performance on the project is measured at regular intervals whose frequency is influenced by following factors: the degree of uncertainty, the magnitude of the project, the time to completion and the troubles encountered. But, in general, two-weekly periods are accepted to be sufficient for contractors where monthly periods for owners.

Information for periodic reviewing of site operations is collected by activity status reports. A simple form of such a report[20] is given in figure 43.a, and the one used by TÜBİTAK (Turkish Scientific and Technological Research Center) in the control of Keban Dam Project is presented in figure 43.b.

Report on Activity Status

Works Section: ________ Date: ________

Reported by: ________

Activity Code	Activity Descript.	Started / Not Started / Finished	Scheduled Start Date	Scheduled Start Date	Status (%)	Expected or Actual Finish Date	Reasons for Delay, if any

(a)

Activity Status Report

Period Start: ________

Period End: ________

Activity Code	Activity Description	In This Period Start Date (If Started)	In This Period Finish Date (If Finished)	% Completed In This Period	Expected Completion Date

(b)

Figure 43. Activitiy status reports

The accuracy and reliability of the data collected at this stage are of extreme importance. Because all the decisions that are to be made for corrective actions will be founded on these data.

vi) The results of this measurement are fed back for comparison against original work schedules.

vii) If the job is found to be delaying the remedial measures are to be determined in a very short time. Consequently, the network, with its schedules and bar charts, should be revised appropriately in order to have a new plan for the uncompleted part of the project.

The usual causes of time delay in construction works include:

- incorrect estimates of activity durations,
- unforeseen weather conditions,
- unpredictable delays in delivery of materials,
- strikes or other labor troubles,
- unexpected subsoil conditions,
- extras or deductions in work quantities.

When the project is behind the schedule, the network diagram may be revised and appropriate future activities may be shifted, or compressed by employing additional resources. The tendency to concentrate on critical activities in periodic reviews of work progress may be explained by the general rule that only by the compression of these activities, the delay can be compensated. But some noncritical activities may become critical if the compression is carried too far.

This fact should never be overlooked. Therefore the activities which are nearly critical should be taken into account while determining corrective measures. Then the costs of all possible corrective measures are to be forecast so that the alternative proposals can be compared with one another, to determine the optimum overall solution. In some cases the delayed completion date may come out to be a more economical solution.

Replanning phase of the cycle can only take place after the processes of execution, measurement, feedback and re-evaluation. Therefore effectiveness of control mechanism is dependent upon the speed and accuracy with which the feedback data is collected, transmitted and analysed. The continuous cycling of information, specially in large projects, involves considerable amount of repetetive analysis of the network. This process may consume so long time that control mechanism becomes ineffective. In such cases, the use of computers enables a greater speed of feedback and analysis, and therefore, more frequent cycling of control information than is manually possible.

CHAPTER VII

CONCLUSION

As the result of the previous chapters, it can be concluded that the planning of construction works is a must from both economical and juridical viewpoints. The degree of effectiveness in planning depends on many factors. If a contractor or owner want to enjoy the benefits of planning, attention must be paid to following points:

a. Organization

A capable organization is the first and the most important condition, which must be fulfilled for effective planning. A firm's organization is the arrangement of its interdependent parts, each of which has a function of its own and a relationship to the whole.

Authority and duty of each interdependent part of the organization should be clearly defined with its responsibility. This point is of extreme importance especially from the planning unit's angle. Because some managers still have the impression that the planners like to hold the authority but to reject the responsibility. The function of planning unit is to evauate the facts and forecasts and then to propose alternative ways of action, each being associated with probable benefits and shortcomings. In other words the planning unit prepares the basis of decision for the manager. It is the project manager who has the authority to select any of the proposed alternatives or any other solution.

Therefore, he himself, carries the responsibility of the decision made.

The functional chart of a construction organization is given in figure 44 in a compact form[19].

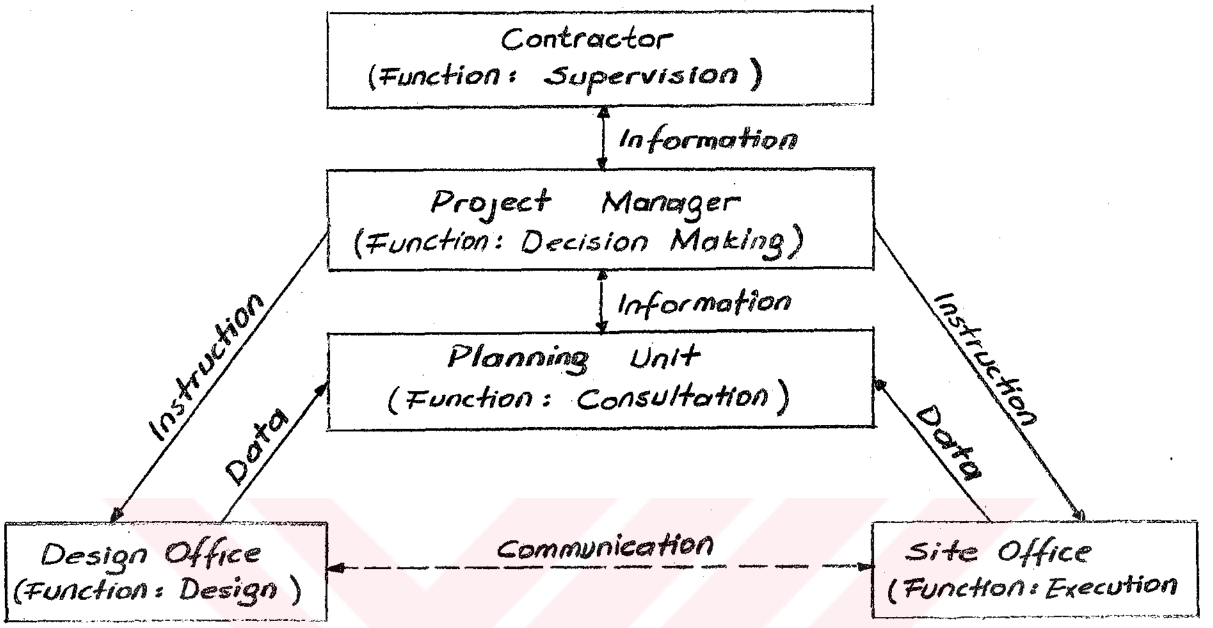


Figure 44. Functional chart for a construction organization.

b. Information Flow

The rapid flow of information within an organization is an important factor which increases the efficiency of management and thus the organization. Because if the project manager gets informed about the prevailing conditions as they arise, his decisions will be more accurate. Also, the necessary measures for the probable problems can be taken before they occur; and errors or inaccuries in the original plan can be corrected in a short time. Therefore, it may be stated that information is the blood of an organization and only by its regular flow the organization can be kept alive.

c. Data

It is evident that plans become more realistic, if duration and cost estimates of the project activities and even the establishment of relationships between them are based on reliable data.

Data collection in construction industry is more difficult than in any other sector, because it has some special features that are not encountered in others. Among these the wide range of operations and processes, and continuously changing conditions are the most important ones. For instance, construction of buildings, bridges, highways, airports, pipelines, dams tunnels etc. are all included in construction industry, although each of them requires different construction methods, equipments and labor skills. Since all construction firms are, more or less, specialized on a certain type of work, each firm should keep his own records of past experience, continuously and systematically. On these records activities and working conditions should be clearly indicated as well as the capacity used, duration and cost of activities.

The systematic handling of data and the working out of characteristic figures require the establishment of data banks which will help the planners in obtaining data for each type of work that they are not familiar with.

d. Planning Method

The advantages and disadvantages of three groups of planning methods are analyzed in Chapter III. Under the light of the discussions made in that chapter, it can be concluded that network based methods have, in general, less shortcomings than bar charts and cyclogrammes, but they offer more advantages. Although bar charts and cyclogrammes can be used efficiently within the limited fields indicated in Chapter III, network based techniques are applicable to any type of work.

Network based planning methods should be considered in two categories: probabilistic and deterministic methods. Since construction costs and performance times can be estimated with sufficient accuracy, employment of deterministic techniques are more appropriate. In cases where some uncertainties are involved in time (and cost) estimates, there arises a tendency to use a probabilistic approach, like PERT. But it should be remembered that PERT is based on various assumptions; many of which are easily questionable. These assumptions may be considered on two separate levels:

i) Activities

PERT handles uncertainty by assuming that the probable durations of an activity are beta-distributed. The three time estimates (see Chapter IV) are then used to determine the end points (t_a and t_b) and the mode of this distribution (t_m), although these three points do not define a unique beta distribution. The expected mean time (t_e) and standard deviation (σ_{te}) are determined by the following assumptions:

$$t_e = \frac{t_a + 4t_m + t_b}{6}$$

$$\sigma_{te} = \frac{1}{6}(t_b - t_a)$$

Possible errors introducted to overall PERT computations, due to the assumptions above, are computed as[35]:

- Worst absolute errors due to the assumption of beta-distribution only

in the mean time : 25 - 33%

in the standard deviation: 17%

- Worst absolute errors due to standard deviation assumption and the approximation of the mean time only

in the mean time : 33%

in the standard deviation: 17%

The are also some errors due to the inaccuracy of optimistic, pessimistic and most likely time estimates, even if the above assumptions hold correct.

ii) Network

Significant errors may be introduced into the calculation of expected network mean time (project duration) and standard deviation, even if the mean time, standard deviation and beta distribution of individual activities are correct. In the case studies carried out by K.R.MacCrimmon and C.A.,Ryvavec[35], the errors in the PERT- calculated mean time and standard deviation were found to be 10-30 per cent.

If there is only one path through a network that is significantly longer than any other path, then the PERT procedure for calculating the project mean time and standard deviation will give approximately correct results, since individual beta-distributions will sum up to an approximate normal distribution. However, if there are a large number of parallel paths having approximately the same length, errors will be introduced in the PERT-calculated project mean and standard deviation.

Considering the brief explanation above together with the fact that PERT requires extra computational effort and hence additional cost, it can be concluded that deterministic planning methods are more suitable for construction management.

d. Use of Computer

The mathematical structures of network based methods make them suitable for computer processing. The use of computers in planning process increases the speed of information flow, and thereby provides a chance to managers to make quick decisions in periodically exact times. The speed of computer is also invaluable in project control phase.

The advantages of computer use should be considered together with some other factors making the manual computations preferable. First of all, computer processing is not available yet to all potential users. For instance, there are 110 computer centers in Turkey[36], and among these 41 centers are available for hiring machine time; but only 21 of them (2 in Adana, 7 in Ankara, 9 in İstanbul, and 3 in İzmir) are suitable for the processing of the available programs PCS and BKN. As pointed out before, the special BKN programs are in ALGOL language, but there is no computer system processing in ALGOL in Turkey.

The planner should select the most suitable program among the available ones. The detailed descriptions (Appendix B) and the comparison of PCS and BKN (Chapter V) are given in this study to englighten the potential users. The following figures may also help them in making the selection:

The computer (IBM 360-40) time needed to produce a schedule report and a bar chart out of the network model of Yeşilköy Airfield Infrastructure Project, which consists of 305 activities and 754 relationships, is 17 minutes by BKN and 22 minutes by PCS. The number of input cards needed for producing the same reports were 1384 and 911 for BKN and PCS respectively.

LIST OF REFERENCES

1. Master Plan Report for Extension of Yeşilköy International Airport, Paris, the Paris Airport Authority, 1961.

2. Yeşilköy Airfield Infrastructure- General and Special Administrative Specifications, İstanbul, Aeroport de Paris.

3. Yeşilköy Hava Alanı Alt Yapı İnşaatı - Aylık İzleme Raporları, İstanbul, Aeroport de Paris.

4. F.Oulés, Economic Planning and Democracy, Penguin Books, 1966.

5. First Five Year Development Plan, Ankara, State Planning Organization.

6. Dr.D.Sorguç, İnşaat Sektöründe İstihdam İmkânlarının ve Optimum Tekno-Ekonomik Stratejinin Araştırılması, Ankara, TÜBİTAK Proje No: MAG -ÖE.3, 1971.

7. O.Sungur, Yeşilköy Uluslararası Hava Meydanı Tevsii Projesi Ekonomik Fizibilite Raporu, Ankara, Bayındırlık Bakanlığı Başmüşavirlik Fizibilite Koordinasyon Grubu.

8. N.Berberoğlu, The Feasibility Report of Bursa Airport, M.S. Thesis - METU, 1970.

9. Feasibility Studies, Ekonomic and Technical Soundness Analysis, Capital Projects, Washington, Department of State Agency for International Development.

10. İktisadî Rapor 1968, Ankara, Türkiye Ticaret Odaları, Sanayi Odaları ve Ticaret Borsaları Birliği, 1968.

11. Dr.D.Sorguç, Struktur und Model eines Wohnungsbau-programmes in den Entwicklungsländern, München, 1967.

12. D.Arditti, Prefabrication of Dwellings - Feasibility in Developing Countries on a System - Analysis of Costs with Special Emphasis on Turkey, Ankara, M.S.Thesis - METU, 1968.

13. Bayındırlık İşleri Genel Şartnamesi, Ankara, Bayındırlık Bakanlığı, Karayolları Genel Müdürlüğü, 1964.

14. İkinci Beş Yıllık Kalkınma Plânı - 1969 Yılı Programı, Ankara, Başbakanlık Devlet Plânlama Teşkilâtı, 1969.

15. W.Clark, The Gantt Chart, London, Sir Isaac Pitman and Sons Ltd. 1957.

16. J.Nezval, Grundlagen der Fliessfertigung in der Bauproduktion, Berlin, Veb Verlag für Bauwesen, 1960.

17. P.G.Gill, Systems Management Techniques for Builders and Contractors, London, McGraw Hill Book Co., 1968.

18. Prof.G.Burkhardt, Numerische Ablaufplannung einer Baustelle, 2. Auflage, Berlin, Bauverlag Wiesbaden, 1968.

19. Dr.D.Sorguç, Lectures on Construction Planning, Division of Construction Engineering Studies and the Strategy of Construction - CE Dept.METU, 1970-1972.

20. J.M.Antill and R.W.Woodhed, Critical Path Methods in Construction Practice, London, John Wiley and Sons Inc., 1965.

21. R.D. Archibald and R.L.Villoria, Network Based Management Systems, New York, Wiley, 1967.

22. R.L.Martino, Project Management and Control - Finding the Critical Path, New York, AMA, 1964.

23. R.L.Martino, Project Management and Control - Applied Operational Planning, New York, AMA, 1964.

24. R.L.Martino, Project Management and Control - Allocating and Scheduling Resources, New York, AMA, 1964.

25. H.S.Woodgate, Planning By Network, London, Business Publications Ltd., 1964.

26. R.Pilcher, Principles of Construction Management, London, McGraw Hill, 1966.

27. G.Turner and K.Elliot, Project Planning and Control in the Construction Industry, London, Cassel Ltd., 1964.

28. L.N.Morris, Critical Path - Construction and Analysis, London, Pergamon Press, 1966.

29. R.W.Miller, Schedule, Cost and Profit Control with PERT, London, McGraw Hill Book Co., 1963.

30. R.L.Ackoff, The Evaluation of Management Systems, Ottawa, Canadian Operations Research Society - Volume 8, No.1, March 1970.

31. H.F.Lande, How to Use the Computer in Business Planning, Prentice-Hall Inc., 1969.

32. Dr.Ş.Uzsoy, Elektronik Hesaplayıcılar ve Mühendislik, Ankara, Türkiye Mühendislik Haberleri - Cilt No.:16, Sayı: 186, Ekim 1970.

33. Project Control System / 360 (360 A - CP - 06x) Program Description and Operations Manual, New York, IBM Corporation - Technical Publications Dept.

34. L.C.Miller, Successful Management for Contractors, London, McGraw Hill Book Co., 1962.

35. K.R.McCrimmon and C.A.Ryvavec, An Analytical Study of PERT Assumptions (Managerial Economics), London, Pan Books Ltd., 1969.

36. Dr.Ş.Uzsoy, Türkiye Elektronik Bilgi İşleme Merkezleri Kılavuzu, Ankara, TÜBİTAK, Proje No.:MAG-ÖE-8, Kasım 1971.

APPENDIX A

THE ACTIVITY LIST

OF

YEŞİLKÖY AIRFIELD INFRASTRUCTURE PROJECT

Code	Description	Duration (days) PCS	BKN
0001	Project Start	0.0	0
	1. EARTH WORK		
	a. Earth Moving		
0100	On the Area to be Paved in North and East	9.0	9
0101	Outside the Area to be Paved in North and East	21.0	21
0102	On the Fuel Farm Area	7.0	7
	b. Borrowing and Filling the Selected Material		
0110	Outside the Fuel Farm Area	20.0	20
0111	On the Fuel Farm Area	6.0	6
	2. LEAN CONCRETING		
0201	From PTW No.1 (24+60) to end of Link No.6	13.5	14
0203	PTW No.2 (Fuel Farm Area)	1.4	2
0205	Link No.10	5.0	5
0206	Link No.11	4.1	4
0207	FTO No.4	6.5	7
0208	FTO No.5	6.5	7
0209	PTW No.1 (Fuel Farm Area)	5.0	5
0210	Link No.7 (Fuel Farm Area)	5.0	5
	3. PAVEMENT QUALITY CONCRETING		
0300	Runway Strip No.6 (04+36 - 19+50)	6.3	6
0301	Runway Strip No.6 (19+50 - 34+36)	6.6	7

0303	Link No.1 South-West Strip	0.7	1
0304	(Zone 1) Link No.1	2.1	2
0305	(Zone 1) Runway	2.0	2
0306	(Zone 1) FTO No.2	2.0	2
0308	(Zone 2) FTO No.2	3.3	3
0309	(Zone 2) Runway	0.8	1
0310	(Zone 2) FTO No.3	2.0	2
0312	(Zone 3) FTO No.3	3.3	3
0313	(Zone 3) Runway	0.8	1
0314	(Zone 3) FTO No.4	3.3	3
0315	(Zone 3) PTW No.1	4.3	4
0316	(Zone 4) FTO No.4	2.0	2
0317	(Zone 4) Runway	0.8	1
0318	(Zone 4) FTO No.5	3.3	3
0319	(Zone 4) PTW No.1	1.8	2
0320	(Zone 5) FTO No.5	2.0	2
0321	(Zone 5) Runway	1.8	2
0322	(Zone 5) Link No.6	2.1	2
0323	(Zone 5) PTW No.1	1.6	2
0327	(Zone 6) Link No.7 (Fuel Farm Area)	2.1	2
0328	(Zone 6) PTW No.2	2.0	2
0329	(Zone 7) Link No.7 (Fuel Farm Area)	2.1	2
0330	(Zone 7) PTW No.1	4.3	4
0331	(Zone 7) Link No.10	2.1	2
0332	(Zone 7) PTW No.2	4.0	4
0333	(Zone 8) Link No.10	2.1	2
0334	(Zone 8) PTW No.1	1.8	2
0335	(Zone 8) Link No.11	2.1	2
0336	(Zone 8) PTW No.2	1.8	2
0337	Link No.11 North Strip	1.4	2
0338	PTW No.1 East Strip (between Links No.11 and 6)	1.8	2
0339	Link No.6 East Strip and North-East Strip	2.0	2
0340	PTW No.2 East Strip (Zone 6)	1.4	2
0343	PTW No.2 East Strip (Zone 7)	4.0	4
0344	PTW No.2 East Strip (Zone 8)	1.9	2

0345	FTO No.2 Interior Strip	1.9	2
0346	FTO No.3 Interior Strip	1.9	2
0347	FTO No.4 Interior Strip	1.9	2
0348	FTO No.5 Interior Strip	1.9	2
0349	Link No.7 Interior Strip (Fuel F.Area)	0.7	1
0350	Link No.10 Interior Strip	0.7	1
0351	Link No.11 Interior Strip	0.7	1
0352	PTW No.1 Interior Strip (Zone 3)	4.3	4
0353	PTW No.1 Interior Strip (Zone 4)	1.8	2
0354	PTW No.1 Interior Strip (Zone 5)	1.7	2
0355	PTW No.2 Interior Strip (Zone 6)	1.4	2
0356	PTW No.2 Interior Strip (Zone 7)	4.0	4
0357	PTW No.2 Interior Strip (Zone 8)	1.8	2
0358	PTW No.1 West Strip (Fuel F.Area)	0.5	1
0359	PTW No.1 East Strip (Fuel F.Area)	0.5	1
0360	PTW No.1 Interior Strip (Fuel F.Area)	0.5	1
0361	PTW No.2 West Strip (Fuel F.Area)	0.7	1
0362	PTW No.2 East Strip (Fuel F.Area)	0.7	1
0363	PTW No.2 Interior Strip (Fuel F.Area)	0.7	1
0364	Runway Strip No.3 (34+36 - 04+36)	13.0	13
0365	Link No.6 Interior Strip	2.0	2
0366	Runway Strip No.2 (04+36 - 13+00)	3.9	4
0367	Runway Strip No.2 (13+00 - 25+30)	5.3	5
0368	Runway Strip No.2 (25+30 - 34+36)	3.9	4
0369	Runway Strip No.5	13.0	13
0370	Runway Strip No.4	13.0	13
	4. SHOULDER STABILIZATION		
0400	Runway West Side (04+36 - 19+50)	11.1	11
0401	Runway West Side (19+50 - 34+36)	12.4	13
0402	Link No.8 Both Sides	4.7	5
0403	Link No.1 South-West Side	1.2	1
0404	(Zone 1) Link No.1	3.2	3
0405	(Zone 1) Runway	5.6	6
0406	(Zone 1) FTO No.2	3.1	3
0407	(Zone 1) PTW No.1	4.3	4
0408	(Zone 2) FTO No.2	4.8	5

0409	(Zone 2) Runway	1.8	2
0410	(Zone 2) FTO No.3	3.1	3
0411	(Zone 2) PTW No.1	2.5	3
0412	(Zone 3) FTO No.3	4.8	5
0413	(Zone 3) Runway	0.9	1
0414	(Zone 3) FTO No.4	4.8	5
0415	(Zone 3) PTW No.1	6.7	7
0416	(Zone 4) FTO No.4	3.1	3
0417	(Zone 4) Runway	1.0	1
0418	(Zone 4) FTO No.5	4.8	5
0419	(Zone 4) PTW No.1	2.5	3
0420	(Zone 5) FTO No.5	3.1	3
0421	(Zone 5) Runway	6.2	6
0422	(Zone 5) Link No.6	3.1	3
0423	(Zone 5) PTW No.1	2.8	3
0424	PTW No.1 East Side and Link No.9 South Side	6.3	6
0425	(Zone 6) Link No.9	1.4	2
0426	(Zone 6) PTW No.1	2.2	2
0427	(Zone 6) Link No.7 (Fuel F.Area)	1.5	2
0428	(Zone 6) PTW No.2	1.7	2
0429	(Zone 7) Link No.7 (Fuel F.Area)	1.5	2
0430	(Zone 7) PTW No.1	6.5	7
0431	(Zone 7) Link No.10	1.5	2
0432	(Zone 7) PTW No.2	6.5	7
0433	(Zone 8) Link No.10	2.0	2
0435	(Zone 8) Link No.11	1.5	2
0436	(Zone 8) PTW No.2	2.0	2
0437	Link No.11 North Side	1.4	2
0438	PTW No.1 East Side (between Links No.11 and 6)	2.4	2
0439	Link No.6 North and North-East Sides	3.4	3
0440	PTW No.2 East Side (10+80 - Fuel Farm Area)	1.8	2
0441	PTW No.2 East Side (Fuel F.Area)	0.9	1
0442	PTW No.2 East Side (Fuel F.Area - 28+23)	10.0	10

	5. FORMING ASPHALTIC CONCRETE LAYER ON SHOULDERS		
0500	Runway West Side (04+36 - 19+50)	7.3	7
0501	Runway West Side (19+50 - 34+36)	7.7	8
0502	Link No.8 Both Sides	3.8	4
0503	Link No.1 South-West Side	1.1	1
0504	(Zone 1) Link No.1	1.9	2
0505	(Zone 1) Runway	3.7	4
0506	(Zone 1) FTO No.2	2.1	2
0507	(Zone 1) PTW No.1	2.8	3
0508	(Zone 2) FTO No.2	2.9	3
0509	(Zone 2) Runway	1.1	1
0510	(Zone 2) FTO No.3	2.1	2
0511	(Zone 2) PTW No.1	1.6	2
0512	(Zone 3) FTO No.3	3.0	3
0513	(Zone 3) Runway	0.6	1
0514	(Zone 3) FTO No.4	3.0	3
0515	(Zone 3) PTW No.1	4.4	4
0516	(Zone 4) FTO No.4	2.1	2
0517	(Zone 4) Runway	1.0	1
0518	(Zone 4) FTO No.5	2.9	3
0519	(Zone 4) PTW No.1	2.4	2
0520	(Zone 5) FTO No.5	2.1	2
0521	(Zone 5) Runway	4.1	4
0522	(Zone 5) Link No.6	1.8	2
0523	(Zone 5) PTW No.1	1.8	2
0524	PTW No.1 East Side and Link No.9 South Side	4.3	4
0525	(Zone 6) Link No.9	1.0	1
0526	(Zone 6) PTW No.1	1.5	2
0527	(Zone 6) Link No.7 (Fuel F.Area)	1.1	1
0528	(Zone 6) PTW No.2	1.1	1
0529	(Zone 7) Link No.7 (Fuel F.Area)	1.1	1
0530	(Zone 7) PTW No.1	3.4	4
0531	(Zone 7) Link No.10	1.1	1
0532	(Zone 7) PTW No.2	3.4	4
0533	(Zone 8) Link No.10	1.1	1

0534	(Zone 8) PTW No.1	1.1	1
0535	(Zone 8) Link No.11	1.1	1
0536	(Zone 8) PTW No.2	1.1	1
0537	Link No.11 North Side	1.1	1
0538	PTW No.1 East Side (between Links No.11 and 6)	1.5	2
0539	Link No.6 North and North-East Sides	1.9	2
0540	PTW No.2 East Side (10+80 - Fuel Farm Area)	1.7	2
0541	PTW No.2 East Side (Fuel F.Area)	0.5	1
0542	PTW No.2 East Side (Fuel F.Area - 28+23)	6.9	7
	6. CONSTRUCTING DRAINAGE STRUCTURES		
0600	Runway West Side (04+36 - 19+50)	1.0	1
0601	Runway West Side (19+50 - 34+36)	7.0	7
0602	Link No.8 Both Sides	1.0	1
0605	(Zone 1) Runway	1.0	1
0608	(Zone 2) FTO No.2	3.0	3
0609	(Zone 2) Runway	2.0	2
0610	(Zone 2) FTO No.3	1.0	1
0611	(Zone 2) PTW No.1	1.0	1
0612	(Zone 3) FTO No.3	2.0	2
0613	(Zone 3) Runway	3.0	3
0614	(Zone 3) FTO No.4	4.0	4
0615	(Zone 3) PTW No.1	7.0	7
0616	(Zone 4) FTO No.4	3.0	3
0617	(Zone 4) Runway	2.0	2
0618	(Zone 4) FTO No.5	3.0	3
0619	(Zone 4) PTW No.1	3.0	3
0620	(Zone 5) FTO No.5	3.0	3
0621	(Zone 5) Runway	7.0	7
0622	(Zone 5) Link No.6	3.0	3
0623	(Zone 5) PTW No.1	3.0	3
0624	PTW No.1 East Side and Link No.9 South Strip	8.0	8
0627	(Zone 6) Link No.7 (Fuel F.Area)	3.0	3
0628	(Zone 6) PTW No.2	3.0	3

0629	(Zone 7) Link No.7 (Fuel F.Area)	1.0	1
0630	(Zone 7) PTW No.1	7.0	7
0631	(Zone 7) Link No.10	3.0	3
0632	(Zone 7) PTW No.2	7.0	7
0633	(Zone 8) Link No.10	3.0	3
0634	(Zone 8) PTW No.1	2.0	2
0635	(Zone 8) Link No.11	3.0	3
0636	(Zone 8) PTW No.2	2.0	2
0637	Link No.11 North Side	3.0	3
0638	PTW No.1 East Side (between Links No.11 and 6)	2.0	2
0639	Link No.6 North and North-East Sides	4.0	4
0640	PTW No.2 East Side (10+80 - Fuel Farm Area)	2.0	2
0641	PTW No.2 East Side (Fuel F.Area)	2.0	2
0642	PTW No.2 East Side (Fuel F.Area - 28+23)	9.0	9
	7. LAYING PVC CABLE PASSES UNDER SHOULDERS		
0700	Runway West Side (04+36 - 19+50)	9.6	10
0701	Runway West Side (19+50 - 34+36)	10.6	11
0702	Link No.8 Both Sides	4.0	4
0703	Link No.1 South-West Side	1.0	1
0704	(Zone 1) Link No.1	2.6	3
0705	(Zone 1) Runway	4.8	5
0706	(Zone 1) FTO No.2	2.7	3
0707	(Zone 1) PTW No.1	3.7	4
0708	(Zone 2) FTO No.2	4.1	4
0709	(Zone 2) Runway	1.4	1
0710	(Zone 2) FTO No.3	2.7	3
0711	(Zone 2) PTW No.1	2.1	2
0712	(Zone 3) FTO No.3	4.1	4
0713	(Zone 3) Runway	0.5	1
0714	(Zone 3) FTO No.4	4.1	4
0715	(Zone 3) PTW No.1	5.7	6
0716	(Zone 4) FTO No.4	2.7	3
0717	(Zone 4) Runway	1.4	1

0718	(Zone 4) FTO No.5	4.1	4
0719	(Zone 4) PTW No.1	2.1	2
0720	(Zone 5) FTO No.5	2.7	3
0721	(Zone 5) Runway	5.4	5
0722	(Zone 5) Link No.6	2.7	3
0723	(Zone 5) PTW No.1	2.5	3
0724	PTW No.1 East Side and Link No.9 South Side	5.3	5
0725	(Zone 6) Link No.9	1.2	1
0726	(Zone 6) PTW No.1	1.9	2
0727	(Zone 6) Link No.7 (Fuel F.Area)	1.2	1
0728	(Zone 6) PTW No.2	1.4	1
0729	(Zone 7) Link No.7 (Fuel F.Area)	1.2	1
0730	(Zone 7) PTW No.1	5.5	6
0731	(Zone 7) Link No.10	1.2	1
0732	(Zone 7) PTW No.2	1.7	6
0733	(Zone 8) Link No.10	1.2	1
0734	(Zone 8) PTW No.1	1.7	2
0735	(Zone 8) Link No.11	1.2	1
0736	(Zone 8) PTW No.2	1.7	2
0737	Link No.11 North Side	1.2	1
0738	PTW No.1 East Side (between Links No.11 and 6)	2.0	2
0739	Link No.6 North and North-East Sides	2.9	3
0740	PTW No.2 East Side (10+80 - Fuel Farm Area)	1.5	2
0741	PTW No.2 East Side (Fuel F.Area)	0.8	1
0742	PTW No.2 East Side (Fuel F.Area - 25+23)	8.8	9
	8. LAYING MULTICELL CABLE PASSES UNDER SHOULDERS		
0800	Runway West Side (04+36 - 19+50)	6.4	6
0801	Runway West Side (19+50 - 34+36)	7.1	7
0802	Link No.8 Both Sides	2.7	3
0803	Link No.1 South West Side	0.7	1
0804	(Zone 1) Link No.1	2.0	2
0805	(Zone 1) Runway	3.2	3

0806	(Zone 1) FTO No.2	1.8	2
0807	(Zone 1) PTW No.1	2.4	2
0808	(Zone 2) FTO No.2	2.8	3
0809	(Zone 2) Runway	1.0	1
0810	(Zone 2) FTO No.3	1.8	2
0811	(Zone 2) PTW No.1	1.4	1
0812	(Zone 3) FTO No.3	2.8	3
0813	(Zone 3) Runway	0.7	1
0814	(Zone 3) FTO No.4	2.8	3
0815	(Zone 3) PTW No.1	3.8	4
0816	(Zone 4) FTO No.4	1.8	2
0817	(Zone 4) Runway	1.0	1
0818	(Zone 4) FTO No.5	2.8	3
0819	(Zone 4) PTW No.1	1.4	1
0820	(Zone 5) FTO No.5	1.8	2
0821	(Zone 5) Runway	3.5	4
0822	(Zone 5) Link No.6	1.8	2
0823	(Zone 5) PTW No.1	1.6	2
0824	PTW No.1 East Side and Link No.9 South Side	3.5	4
0825	(Zone 6) Link No.9	0.8	1
0826	(Zone 6) PTW No.1	1.3	1
0827	(Zone 6) Link No.7 (Fuel F.Area)	0.9	1
0828	(Zone 6) PTW No.2	1.0	1
0829	(Zone 7) Link No.7 (Fuel F.Area)	0.9	1
0830	(Zone 7) PTW No.1	3.7	4
0831	(Zone 7) Link No.10	0.9	1
0832	(Zone 7) PTW No.2	3.7	4
0833	(Zone 8) Link No.10	0.9	1
0834	(Zone 8) PTW No.1	1.2	1
0835	(Zone 8) Link No.11	0.9	1
0836	(Zone 8) PTW No.2	1.2	1
0837	Link No.11 North Side	0.8	1
0838	PTW No.1 East Side (between Links No.11 and 6)	1.4	1
0839	Link No.6 North and North East Sides	1.9	2
0840	PTW No.2 East Side (10+80 - Fuel Farm Area)	1.0	1

0841	PTW No.2 East Side (Fuel F.Area)	0.5	1
0842	PTW No.2 East Side (Fuel F.Area - 28+23)	5.8	6
	9. TOP SOILING		
0900	Runway West Side (04+36 - 19+50)	15.0	15
0901	Runway West Side (19+50 - 34+36)	16.0	16
0902	Area between the Links No.1 and 8	3.0	3
0903	Link No.8 South-East Side	2.0	2
0904	PTW No.1 East Side and Link No.9 South Side	3.0	3
0905	PTW No.2 East Side and Link No.11 North Side	16.0	16
0906	PTW No.1 East Side and Link No.6 North and North-East Sides	14.0	14
0907	Zone 1	11.0	11
0908	Zone 2	6.0	6
0909	Zone 3	12.0	12
0910	Zone 4	5.0	5
0911	Zone 5	10.0	10
0912	Zone 5	4.0	4
0913	Zone 7	10.0	10
0914	Zone 8	3.0	3

APPENDIX B

DESCRIPTIONS OF COMPUTER PROGRAMS FOR NETWORK COMPUTATIONS

1. PROJECT CONTROL SYSTEM (PCS)

The Project Control System (PCS) is designed to perform basic network computations discussed Chapter V and produce reports for a project whose network model has been established. PCS is prepared to process precedence networks which are difficult to analyze manually. However if the network is an arrow diagram, the system automatically converts it into a precedence diagram during generation and update runs.

The requirements, capabilities and special features of the system will be discussed under the titles "Preparation of Input", and "Output Reports".

PREPARATION OF INPUT

All input data must be submitted to PCS in form of card images. There are twelve different types of cards that may be submitted. These cards are divided into four general categories: activity (work item) property cards, network cards, output report cards and run cards.

a. Activity (Work Item) Property Cards

These cards are the input cards on which the user specifies:

- what activities are to be included in the network,
- the properties of each activity.

There are five different types of cards in this category: activity (work item) cards, milestone cards, progress reporting cards, schedule cards and resource cards.

i) Activity (Work Item) Cards

These cards are used to delete, change or add an activity to a network. Up to 5000 different activities can be contained within one network. The format of this type is:

Column 1. The identification code "G" must be entered.

Columns 2-5. The numeric network identification code.

Column 6. A valid activity modification code:

blank The activity represented by this card is to be added

C The fields on disk corresponding to those on this card are to be completely replaced

D The activity represented by this card is to be deleted.

Columns 7-16. If the network is a precedence network, the activity identification code must be entered in cc 7-16. This code may be alphameric.

If the network is an arrow diagram, the code of tail event of the related activity must be entered in cc 7-10, columns 11-12 must be left blank, and the code of its head event must be entered in cc 13-16. These event codes may also be alphameric.

Columns 18-61. A description of activity may be entered.

Columns 63-66. The estimated duration of activity is entered in the form of XXX.X where decimal point is implied.

Column 67. The starting day of the work week of activity may be entered:

blank or 1	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday
6	Saturday
7	Sunday

Column 68. The number of working days in a week is entered. If none is entered, the system assumes a five-day work week.

Column 69. The calender type to be associated with the activity may be entered. The valid codes are:

blank	The holiday calender. No work will be scheduled for this activity on any holiday
1	The special calender. No work will be scheduled for this activity on any holiday or special nonwork day.
2	The standard calender. Work will be scheduled on all acceptable work week days (see Chapter V Part 3).

Column 70. The time unit, in which the duration of activity is expressed, is entered. The allowable time unit entries are:

blank	Days
1	Hours
2	Half days

3 One-shift days

4 Two-shift days

5 Three-shift days

6 Weeks

Columns 71-80. A revised work item code may be entered.

ii) Milestone Cards

Milestone cards are used to specify network milestones. The user is allowed to identify up to 480 activities in his network as milestones. The card format is:

Column 1. The idendification code "L".

Column 2-5. The numeric network identification code.

Column 6. A valid modification code:

blank Add a new milestone to the network

C Change the milestone description of a milestone already in the network

D Delete the milestone from the network

Columns 7-16. Work item identification code is entered as explained for work item cards.

Column 18. The milestone position code:

1 The start of the work item is considered to be the milestone.

blank The end of the work item is considered to be the milestone.

Columns 20-63. The description of the milestone.

iii) Progress Reporting Cards are used to specify the actual start date, actual completion date, remaining duration, percent completed during this period or percent completed to date, actual cost of this period or actual cost to date of individual activities in the network. The card format is:

Column 1. The identification code "J".

Columns 2-5. The numeric network identification code.

Column 6. Enter the letter C to specify that only the cost information is entered. Leave cc 6 blank to indicate that only time, or both time and cost information, are entered.

Columns 7-16. The activity identification code.

Columns 18-24. The actual start day of the work item is entered in the form DDMMMYY where:

DD - A two-digit number representing the day of the month

MMM- The first three letters of the month

YY - The last two digits of the year.

Columns 26-32. The actual completion date of the work item in the form DDMMMYY.

Columns 34-37. The remaining duration entered in time units with an implied decimal (XXX.X).

Column 39. The time unit conversion, which enables PCS to convert the value of remaining duration to "day-values", is entered as one of the following:

blank	days
1	hours
2	half days
3	one-shift days
4	two-shift days
5	three-shift days
6	weeks

Columns 41-45. Percent completed this period entered with an implied decimal point (X.XXXX).

Columns 47-51. Percent completed to date entered with an implied decimal point (X.XXXX).

Columns 66-72. The actual cost of the reporting period is entered in whole dollars.

Columns 74-80. The actual cost to date is entered in whole dollars.

iv) Schedule (Fixed Date) Cards

The schedule card is optional input for either a network generation or an update run. The user may use schedule cards to specify, change, or delete the scheduled start date, scheduled completion date and organization codes of individual activities in the network. The format is:

Column 1. The identification code "I".

Columns 2-5. The numeric network identification code.

Column 6. The schedule card modification code:

blank All fields on disk corresponding to those in the card are replaced.

C Only those fields that are punched replace their corresponding on disk.

Columns 7-16. The activity identification code.

Column 18. The type of scheduled start date desired for the activity. The number of the scheduled date type is the entry to be used.

Type 1 These dates have no effect on the system

Type 2 This represents the earliest date desired for PCS to schedule the start or the completion of the activity.

Type 3 This represents the date desired for PCS to schedule the start or the completion of the activity, regardless of the early or late start or completion dates the system computes.

Type 4 This fixes the late start or late completion of an activity.

Type 5 This sets the late completion time of the activity equal to its computed early completion time.

Columns 20-26. The scheduled start date in the form DDMMMYY.

Column 28. The type of completion date desired for the activity. The valid entries are the same of those given for cc 18.

Columns 30-36. The scheduled completion date in the form DDMMMYY.

Columns 38-41, 43-46, 48-51, 53-56. These columns represent 4 different organization-code fields. These codes have no impact on network calculations, but can be used to provide selective output reporting.

v) Resource Cards

The resource card is used to relate up to 4 resources for any activity in the network as well as the estimated cost in whole dollars for the activity. The format used is:

Column 1. The identification code "K".

Columns 2-5. The numeric network identification code.

Column 6. The modification code:

blank   If any reseource information for this activity is entered for the first time

c   To be used to change existing resource information on file.

Columns 7-16. The activity identification code

Columns 19-22, 29-32, 39-42, 49-52. A different resource code that is to be associated with the activity may be entered in each of these groups of columns.

Columns 23, 33, 43, 53. A resource code flag is entered:

blank   The units of resources used by this activity are to be considered a daily rate.

1   The units of resource used is a total, or constant value.

Columns 24-27, 34-37, 44-47, 54-57. The units of resource required is entered in the XXX.X form (decimal implied) if the related flag is blank and in XXXX form otherwise.

Columns 61-67. The total estimated cost of the activity in whole dollars.

b. Network Cards

The network cards are the input cards on which the user specifies data concerned with various properties of the network as a whole; that is relationships, time delays, calculation dates, calender, resources, and rescource descriptions.

Within the general category of network cards, there are five different types of cards: the network title card, preceding work item cards, calender cards, resource description cards and resource grouping card.

i) Network Title Card

The network title card is used to identify the network and to specify the calculation dates for the network. The format is:

Column 1. The identification code "B".

Columns 2-5. The numeric network identification code.

Column 6. This column must be left blank on a generation run. There must be a "C" for any other run type.

Columns 8-14. The project start (base) date is entered in the form DDMMMYY. This date should remain constant throughout the life of the network.

Columns 16-22. The data date which should not be earlier than the project base date is entered in the form DDMMMYY.

Columns 24-67. The network title.

Columns 69-75. The date of the computer run or any other desired date in DDMMMYY form.

Column 77. The user may enter a number in this column to indicate the sequence of run that may be made during the same day.

ii) Preceding Work Item Cards

Preceding work item cards are used to specify the relation-ships that exist between the various activities in the network, and to specify the time delay the user wants associated with each such relationship. These cards are not required for arrow diagrams.The card format of this type is:

Column 1. The identification code "H".

Columns 2-5. The numeric network identification code.

Column 6. The preceding activity modification code:

blank Add a relationship(s).

c Change the type or value of the time delay that exists on disk for a particular relationship(s).

D Delete an existing relationship(s) from the file.

Columns 7-16. The activity identification code.

Columns 18-27, 38-47, 58-67. The identification codes of preceding activities of the common activity are entered in these groups of columns.

Columns 29, 49, 69. The relationship the user wants established between the common activity and its predecessors are specified:

S Start to start relationship

F Completion to completion relationship

blank Completion to start relationship

Columns 30, 50, 70. The type of time delay the user wants associated with the relationship specified in the preceding column is entered in cc 30, 50 or 70 -which ever is appropriate:

Enter "P" to indicate a time delay is expressed as percentage.

Enter blank, 1, 2, 3, 4, 5 or 6 -which ever identifies the applicable time unit- to indicate that the delay is expressed in this time unit (see Activity Cards)

Columns 32-36, 52-56, 72-76. The amount of time delay which is desired to be associated with the related relationship is entered. For a percentage the format is X.XXXX, for time units the format is XXX.X, with the decimal point implied in both cases.

iii) Calender Cards

Calender cards are used to specify days, that are to be deleted from or restored to, the special nonwork day and/or the holiday calender associated with the network. The format of this type is:

Column 1. The identification code "C".

Columns 2-5. The numeric network identification code.

Column 6. The calender card modification code:

blank — Any calender dates appearing in cc 10-80 are to be added to the set of either holidays or special nonwork days

D — Any calender date appearing in cc 10-80 are to be removed from the set of either holidays or special nonwork days.

Column 8. The two possible entries are:

1 — Indicates that the dates in cc 10-80 relate to the set of holidays

2 — Indicates that the dates in cc 10-80 relate to the set of special nonwork days.

Columns 10-16, 18-24, 26-32, 34-40, 42-48, 50-56, 58-64, 66-72, 74-80. A day that is to be deleted from or restored to the calender specified in cc 8 may be entered in each of these groups of columns in the form DDMMMYY.

iv) Resource Description Cards

These cards are used to associate a code with and to provide a description of, the resources that are to be assigned to activities in the network, or to disassociate a code from a resource to which it was previously assigned. The format is :

Column 1. The idendification code "D".

Column 6. The resource description card modification code:

blank Add a resource code(s) and description(s)

D Delete the resource code(s) present in the card.

Columns 8-11, 30-33, 52-55. A different numeric resource code can be entered in each set of columns.

Columns 13-27, 35-49, 57-71. The descriptions of the resources whose codes are given in preceding columns.

v) Resource Grouping Cards

Resource grouping cards are used to add resources or delete them from resource groups. A maximum of 19 resource groups can be added to a network. The format of this type is:

Column 1. The identification code "E".

Column 6. A valid resource grouping card modification code:

blank Add a resource group to the network and/or add resources to a group.

D To delete an entire resource group (leave cc 30-33 blank) or to remove selected resources from a group (enter the resource codes into cc 30-78)

Columns 8-9. The numeric resource group code.

Columns 14-28. A description of the resource group.

Columns 30-33, 35-38, 40-43, 45-48, 50-53, 55-58, 60-63, 65-68, 70-73, 75-78. Resource codes, identifying resources the user wants to add or delete from this resource group.

c. Output Report Cards

The output report cards are the input cards on which the user specifies what output reports he wants the system to generate. There is only one type of output report card which is the "output request card".

i) Output Request Card

It is used to specify which output reports are wanted to be generated and to control the extend and scope of each such report. The card format of output request card is:

Column 1. The card identification code "F".

Columns 2-5. The network identification code.

Columns 11-17. Lower span date specifying the beginning date of the time period to be included in the report.

Columns 19-25. Upper span date specifying the ending date of the time period to be included in the report.

Columns 44-45. Resource Grouping Code. This field permits the user to restrict printing to work items using a resource belonging to a particular group code.

Columns 47-50. Resource Code. This field allows the user to restrict printing to:

- Activities using the resource specified, if no resource group code is specified in cc 44-45.

- Activities using this particular resource as well as activities using resources belonging to the resource grouping code specified in cc 44-45.

Column 52. If the user does not want work items having zero duration to be printed on reports specified on this card, he enters the letter "N" in cc 52, otherwise he leaves it blank.

Columns 53-80. Report Requests. There are two columns (in some cases only one) to specify a request for each type of report. A report is requested by punching a valid numeric code (N) into one of these columns . The valid numeric codes for each type of report are given in parentheses below. Punching the code (N) in an odd-numbered column will cause all dates to be printed as calender dates in the form DDMMMYY, where punching it in an even-numbered column will cause all dates to be printed as project days (number of days elapsed from the project start date) in the form XXX.X. The columns assigned and the valid numeric codes for each report are:

cc 53-54. Summary bar chart (4, 5, 6 or 7)

cc 55-56 Milestone (3, 4, 5, 6, 7 or 8)

cc 57-58 Work status card (any number)

cc 59-60 Work status and progress report (1, 2, 3, 4, 5, 6, 7 or 8)

cc 61-62 Schedule report (1, 2, 3, 4, 5, 6, 7 or 8)

cc 63-64 Bar chart (1, 2, 3, 4, 5, 6, 7 or 8) cc 65-66 Resource assignment report (1, 2, 3, 4, 5, 6 or 7)

cc 67-68 Resource utilization report (4, 5, 6 or 7)

cc 69-70 Lump sum cost report (1, 2, 3, 4, 5, 6 or 7)

cc 71 Monthly cost report (5 or 7)

cc 73-74 Precedence report (any number)

cc 75 Calender report (any number)

cc 77 Master file (any number)

cc 78 Back up master file (z)

The meanings of values that (N) can assume are:

1. Organization code 1 sequence
2. Organization code 2 sequence
3. Work item sequence
4. Early start sequence
5. Early finish sequence
6. Late start sequence
7. Late finish sequence
8. Start float sequence (see Chapter V Part 3)

c. Run Card

The run card is the input card on which the user specifies the kind of run desired. There is only one type of run card:

i) Processing Control Card

This card is used to specify the type of run wanted and to indicate whether the network submitted is a precedence or an arrow diagram. The card format is:

Column 1. The identification code "A".

Columns 2-5. The network identification code.

Column 7. The type of run desired:

G - network generation run

U - update run

Z - maintenance run

R - output report run

Columns 9-11. This field is for the type of network in use:

blank A precedence diagram

CPM An arrow diagram

Columns 13-14. If the user wants the contents of input deck to be printed out, he should leave these columns blank, otherwise he should punch "NO".

Column 20. This column is used to indicate to the program whether or not the results of a PCS run are to be stored into PCS Permanent Storage.

Columns 22-24. The number of hours in a day is entered in these columns in XX.X form, where decimal point is implied. If no value is entered, PCS assumes an 8.0 hours-day.

There are two other types of card which are used in submitting the input card deck:

i) Group Header Card

Column	Information
1	Card identification code (B,C,D,E,F,G,H,I, J,K or L)
2-5	Must be blank
6	An asterisk (*)
7-80	Must be blank

OUTPUT REPORTS

I. Reports Used in Yeşilköy Airfield Infrastructure Project

PCS can produce 14 different reports, only four of them which were used in planning the Yeşilköy Project will be described here:

a. Schedule Report

The schedule report gives the following information for each activity (see Appendices C.1a and C.1.b):

i) Description. This is the work item identification code and description as it appeared on the work item card (see "Activity Card").

ii) Total duration. The total duration (XXX.X) is the duration converted into tenths of a day which appeared on work item card (see "Activity Cards").

iii) Calender indicators. They are printed under the column marked with "CAL".

First indicator - number of days in the work week
Second indicator- start day of work week
Third indicator - calender used:

blank:	No work on holidays
1	No work on both holidays and special nonwork days.
2	Work on all holidays and special nonwork days.

Fourth indicator- time unit in which the duration was specified on the work item card (see "Activity Cards").

iv) Early and late start and completion dates. These dates are printed as either calender dates or project day as indicated in the request.

v) Start float and finish float. The floats are printed in tenths of days (see Chapter V-Part 3).

b. Precedence Report:

The precedence report gives the following information for all work items in the network (see Appendix C 1.e)

i) Description of the work item.

ii) Preceding work item. All of an activity's predecessors are given by their activity codes.

iii) Relationship between activity and its predecessors. A code under the column "R" indicates the relationship:

blank	End to start
S	Start to start
F	End to end

iv) Time delay is printed under the column marked with "LAG VALUE". If this value is a percentage (P) is printed in the column "F". Otherwise the value is printed in tenths of days.

v) Preceding work item start date is printed in the column "PWI START DATE". This is the early start date of the preceding activity.

vi) Elapsed time. This is the length of time between the start and finish of the activity, reported in tenths of days.

vii) PWI finish date. The late completion date of PWI is printed.

viii) Float. This is the PWI start float in tenths of days.

c. Calender Report

Calender report gives the calender which PCS uses in calculating the network (see Appendix C.1.c) using the following format:

Both the project day number and the calender date are printed.

Holidays are indicated by printing H to the left of the day number. Special nonwork days are indicated by printing NW to the right of the day number. A day that is both a holiday and a special nonwork day will have on H to the left and an NW to the right.

d. Bar Chart

The bar chart indicates the days on which actual work is scheduled to be performed on selected work items (see Appendix C.1.d).

The beginning date (Monday) of every work week within the span of the report is printed across the top of the page. Alloted to each week are seven columns (Monday through Sunday) the first of which is marked by (I) unless replaced by one of the bar chart report codes given below.

If the project day option is used, project day numbers where day number 1.0 is equivalent to project base date, appear across the top of the page. The report is divided in ten-day increments indicated by (I), unless replaced by one of the allowable report codes given below.

ii) End of File Card

Column	Information
1-5	Must be blank
6	An asterisk (*)
7-80	Must be blank

The various bar chart report codes are as follows:

*	Duration
x	Critical duration
-	Start float
N	Negative start float

INPUT CARD DECK

	N.G.	U.	M.	O.R.
DOS Job control cards	R	R	R	R
Processing control card (A)	R	R	R	R
Network title card (B)	R	R	R	R
Group header cards	R	R	R	R
Calendar cards (C)	O	O	O	O
Resource description cards (D)	O	O	O	O
Resource grouping cards (E)	O	O	O	O
Output request cards (F)	O	O	O	R
Work item cards (G)	R	O	X	X
Preceding work item cards (H)	R (Precedence only)	O	X	X
Schedule cards (I)	O	O	X	X
Progress reporting (J)	X	O	R	X
Resource cards (K)	O	O	X	X
Milestone cards (L)	O	O	X	X
End-of-file card (* cc 6)	R	R	R	R

where: R = required O = optional X = may not be included
N.G.= Network Generation U.= Update M.= Maintenance
O.R.= Output Report

II. Other PCS Output Reports

a. Work Status and Progress Report

This report supplies the following information to the user of the system:

i) The identification codes and the descriptions of activities; predecessors of these activities and their earliest start dates if the relationship is "start to start" or their lates completion dates if the relationship is either "end to start" or "end to end",

ii) The original duration of the activity and the time unit in which the duration was specified,

iii) The number of days in the work week of the activity,

iv) If the execution of the activity is started, its remaining duration and completed percentage,

v) The expected start date of the activity,

vi) The latest permissable completion date of the activity.

b. Resource Assignment Report

Resource assignment report lists the daily requirement of each activity using the specified resource (see "Output Request Card"), as well as total daily requirements. A separate resource assignment report may be printed for each selected resource.

This report is always printed for a period 7 weeks. The starting date for this period is governed by the lower span date (see "Output Request Card"). If lower span date is not specified, project start date is taken as the starting date of the period.

c. Resource Utilization Report

This report gives the weekly requirements for a selected resource together with cumulative requirement from the project start date in a graphical form. If the working days option is used in requesting the report (see "Output Request Card") resource requirements are plotted for 10-day periods instead of weekly periods.

The system, itself, selects the scales to be used in preparing this report depending upon the highest periodic and cumulative amounts.

d. Lump Sum Cost Report

This report gives the estimated and actual cost of each activity as specified by the user. The activity's early start date, remaining duration, percent completed, late finish date and start float are also printed in the report. This report may be used for filing purposes.

e. Monthly Cost Report

Monthly cost report gives actual and estimated monthly expenditures for project activities, as well as the total monthly expenditure. Depending upon the user's request, the system may take either the early or the late finish of activities as basis in locating the expenditures in time.

f. Milestone Report

This report contains a list of network milestones, together with their scheduled dates and floats.

The other PCS output reports which are rarely used are:

g. Summary Bar Chart

h. Master File List - gives all the input data for filing purposes.

i. Backup Master File - card images of master file to be used to free the disk for other uses between the network generation runs.

j. Network Status Cards - card images to be used as input for special ("user written installation") programs.

2. BAUKASTENNETZ (BKN)

The BKN system is developed by Prof. Georg Burkhart from the Institute of Construction Science in Technical University of Munchen between the years 1963-67 for analysis of activity-on-node networks. The system is composed of a main program which is described below in detail, and additional programs whose brief descriptions are given.

I. Main BKN Program

PREPARATION OF INPUT

The input data required by BKN primarily consists of data concerning:

- Individual activities that make up the network,
- The interrelationships between these activities.

This information is supplied to the system in form of card images only.

The input card types are:

i) Activity Description Cards

The user introduces the identification codes and the descriptions of activities by this type of cards in the following format:

Columns 2-10. The numeric activity identification code.

Columns 14-43. The description of the activity.

These cards should be sorted according to the sequence in which the activities are desired to appear on output reports.

ii) Relation Cards

By the use of these cards, the user supplies the information about the relationships existing between the project activities as well as the activity durations. A new card is required for each relationship. The number of relation cards submitted to the system must not exceed 4199, since this is the maximum number that BKN can process. The format of this card type is:

Columns 2-10. The numeric code of preceding activity

Columns12-20. The numeric code of the activity

Columns 27-30. The duration of the activity whose code is punched in cc 12-20, in whole days.

Columns 35-38. The time delay between the activity and its predecessor in whole days.

Column 40. The type of relationship between the activity and its predecessor. The allowable entries to this field are

0 End to start with no time delay

1 End to start with some time delay

2 Start to start

3 A combination of start to start and end to end

4 End to end

iii) Calender Cards

This type of input cards are optional; when they are submitted, the output reports are prepared in terms of calender dates, otherwise the results of computations are printed out in working days.

Calender cards are used to specify the days on which the user wants work to be scheduled. The format of this type is:

Columns 1-2. The number representing the month of the year.

Columns 4-5. The last two digits of the year

Columns 7-8, 10-11, 13-14, 16-17, 19-20, 22-23, 25-26, 28-29, 31-32, 34-35, 37-38, 40-41, 43-44, 46-47, 49-50, 52-53, 55-56, 58-59, 61-62, 64-65, 67-68, 70-71, 73-74, 76-77. The numbers representing the days of the month specified in cc 1-2, on which work will be scheduled.

Columns 79-80. A number indicating the sequence of the card within the calender card deck.

Calender cards should be submitted to the system in chronological sequence, and the number of working days should not exceed 1399 days.

iv) Exogene (Fixed) Date Cards

This type of cards in BKN corresponds to "schedule cards" of PCS and they are used to fix either the start or the completion of an activity on a desired date. The position of such a card within the input card deck indicates whether it shows a fixed start or a fixed end. The format is:

Columns 2-10. The numeric activity identification code.

Columns 17-20. The exogene date assigned to the activity whose code is entered in cc 2-10, in terms of working days elapsed from the project start.

v) Scaling Cards

Scaling cards are used to specify the number of working days to be plotted per 100 printing positions for bar chart. The format is:

Column 10. The entry to this field is 0

Columns 18-20. The number of working days to be plotted for each 100 printing positions.

There are some other card types which are optionally used:

i) If the user punches -3 in cc 9-10 of a card, cc 14-63 of this card may be used in introducing some title.

ii) A -2 in cc 9-10 causes a line to be left blank in print outs.

iii) A -1 in cc 9-10 causes a page to be left blank in computer print outs in relation to the place of this card in the input deck.

INPUT CARD DECK

```
// JOB BKN
// OPTION LINK
INCLUDE
   OBJECT DECK OF BKN PROGRAM
/*
// EXEC LNKEDT
// EXEC
   RALATION CARDS
-1 (in cc 9-10)
   EXOGENE DATE CARDS FOR FIXED STARTS
-1 (in cc 9-10)
   EXOGENE DATE CARDS FOR FIXED ENDS
-1 (in cc 9-10)
   CALENDER CARDS
-1 (in cc 1-2)
 0 (in cc 10)   1 (in cc 20)
blank card
   ACTIVITY DESCRIPTION CARDS FOR SCHEDULE REPORT
-1 (in cc 9-10)
 0 (in cc 10)   1 (in cc 20)
   SCALING CARD
blank card
   ACTIVITY DESCRIPTION CARDS FOR BAR CHART
-1 (in cc 9-10)
/*
/&
```

OUTPUT REPORTS

a. Schedule Report

The schedule report gives the following information for activities contained in the network (see Appendices C.2.a and C.2.c)

- The numeric identification code and the description of an activity is printed in columns "JOB-J" and "JOB-DESCRIPTION" respectively.

- The precedessors of the activity are given under the title "JOB-I".

- The type of relationships specified between the activities and their predecessors are given in column "TYP" and the related time delay in column "T.D." in whole days.

- The duration of activities are printed in whole days under "D-J" column.

- Then the earliest start, earliest end, latest start and latest end times for all activities (J) are printed under related columns either in terms of calender dates or working days.

- The computed total and free float values for each activity (J) are given under columns named "GF-J" and "FF-J" respectively.

The order of appearance of activities in schedule report is identical to their sequence within the first deck of activity description cards.

If the user submits a deck of calender cards the system prints out the schedule report in terms of calender dates, otherwise in working days.

b. Bar Chart

BKN gives the results of network computations in form of a bar chart also (see Appendix C,2.f). The bar chart of BKN provides the user with information about activity code, description and duration beside which activity's duration is plotted, according to the scale specified in scaling card, from its early start to its early end. The earliest start and earliest end times are printed in terms of calender dates or working days. The sequence of activities in bar chart is identical to the second deck of activity description cards.

c. Calender Report

The calender report gives the calender which is used by BKN in network computations as given in Appendix C.2.e.

d. Critical Path Report

This report (see Appendices c.2.b and c.2.d) lists the identification codes of critical activities. Special remarks are made for neutral and negative critical activities.

II. Additional BKN Programs

a. BKN-BAR

This program supplies a bar chart which is printed according to early positions of activities. The start and end points of bars are marked with starting and completion dates of the related activities.

The user is permitted to specify the spacing between the bars and the time scale.

b. BKN-BLOCK

In some cases, there may be definite periods within the project duration in which certain project activities cannot be carried out. This causes difficulty in the preparation of work schedules. BKN-BLOCK is designed to solve this problem taking such activities, which are specified in input, into account in preparing the job schedule.

Activities which cannot be carried out in those periods are divided into three groups in accordance with their nature:

i) arbitrarily divisible (intermittent) activities which can proceed piecewise at irregular periods of time,

ii) indivisible (continuous) activities which have to be worked without interruption until finished,

iii) limitedly divisable activities.

The program schedules the first group of activities such that the execution is stopped when blockade is reached, then re-started after the blockade.

The second group of activities are scheduled to start after blockade when any part of the them fall into blockade.

When a part of an activity of the third group falls into blockade; if the duration of this part is smaller than a specified minimum value, activity will be compressed, if the duration of the part outside the blockade is smaller than the given minimum amount, the activity is treated like an indivisible one. Beside the two cases above an activity is scheduled like a divisible activity.

c. BKN-CUT

This program is very helpful when some activities come out to have negative total float values due to fixed dates. If the user gives a list of activities on the negative total float path showing their priority in compression process, BKN-CUT performs the necessary compressions until negative total floats are eliminated. If the compression of activities in the list does not suffice, it prints "local critical path" showing the activities to be further shortened.

d. BKN-PERM

This program is used to find out, by permutations, the operational sequencing of activities according to given priorities after the causal network is established. The computer prints the result of each permutation and enables the decision maker to select the most suitable one.

e. BKN-CONTROL

BKN-CONTROL program produces a job schedule report and a bar chart which show the projection of work status at the control date according to the fixed project end date. The program requires input containing control time, completed activities, the time needed for the completion of activities which are started, but not completed yet, and expected future changes in the network together with the data of the original network.

f. BKN-MOD

This special program is used with disc to restore the whole network as a result of network modifications and control computations. Following changes in the structure of a network may be done by this program:

i) deleting activities from the network,

ii) deleting relationships from the network,

iii) changing durations of activities,

iv) changing type of relationship and/or associated time delay,

v) adding activities to the network,

vi) adding relationships to the network.

g. BKN-POT

BKN-POT is used to determine resource requirements according to early start of activities. Upto 11 different resource groups can be specified. This program requires voluminous input data for each resource group to compute the necessary amount required in function of each activity. In case of excavation equipment, for example, available types of equipment with their capacity (volume, HP, etc.) and weight must be provided for the related activity and the volume of work or transportation distance (km). The output report gives the total capacity required (volume, HP, etc.) for each activity. It also gives, in separate lists, the capacity of each equipment together with the time period (from .... to ....) in which it is needed. At the end of group lists "maximum capacity" and the value of resource area (capacity x duration) are printed for resource leveling purposes.

h. BKN-COST

There are two special BKN programmes to be used to handle the cost aspect of a project.

i) Cost Planning - This program produces a report of cumulative costs in a tabular form which is based on the early start of activities. This report can be prepared according to working days at project start, or monthly, from any project control date to end date of the project. The program requires the activity costs in addition to input data related to network.

ii) Payment Plan - If the planner specifies the amount of contractor's receipt upto the control date, the second program computes the monthly payments to be made from this date on. This program produces another report indicating the cost overrun and underrun together with their causes for each project activity. The data needed for this purpose are composed of:

- total receipts of the contractor,

- finished quantity, contractor's claim on finished quantity, remained quantity and contractor's claim on remained quantity for each project activity,

- changes in activity volume of work and its unit price.

APPENDIX C

OUTPUT REPORTS

OF

COMPUTER PROGRAMS

IBM PROJECT CONTROL SYSTEM

RUN DATE 1 * * S C H E D U L E R E P O R T * * DATA DATE 1

RUN SEQUENCE 0 NETWORK ID 1111 YESILKOY AIRFIELD INFRASTRUCTURE PROJECT FROM 1 TO 414

SEQUENCE E S PAGE 1

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0001	PROJECT START	0.0	71	1.0	1.0	0.0	1.0	1.0	0.0
0100	EARTH MOVING-UNDER AREA TO BE PAVED IN N&E	9.0	61	1.0	10.0	8.0	10.9	20.9	8.0
0110	BORROW & FILL SELECTED MTL.-OUT.FUEL F.AREA	20.0	61	1.0	1.0	0.0	23.9	23.9	0.0
0207	L.C.-FTO NO.4	6.5	61	1.0	1.0	0.0	8.4	8.4	0.0
0303	P.Q.C.-LINK NO.1 SOUTH-WEST STRIP	0.7	611	1.0	2.2	1.2	1.6	2.8	1.2
0602	DRAINAGE-LINK NO.8 BOTH SIDES	1.0	61	1.0	167.2	136.2	1.9	168.1	136.2
0304	P.Q.C.-(ZONE 1) LINK NO.1	2.1	611	1.8	3.0	1.2	3.8	6.0	1.2
0624	DRAINAGE-PTW NO.1 EAST & LINK NO.9 SOUTH	8.0	61	2.0	168.2	136.2	10.9	177.1	136.2
0305	P.Q.C.-(ZONE 1) RUNWAY	2.0	611	5.0	6.3	1.3	6.9	8.2	1.3
0306	P.Q.C.-(ZONE 1) FTO NO.2	2.0	611	7.1	8.4	1.3	9.0	10.3	1.3
0208	L.C.-FTO NO.5	6.5	61	8.5	8.5	0.0	15.9	15.9	0.0
0308	P.Q.C.-(ZONE 2) FTO NO.2	3.3	611	9.2	10.5	1.3	13.4	14.7	1.3
0803	MULT.CAB.P.-LINK NO.1 SOUTH WEST SIDE	0.7	61	9.7	178.9	139.2	10.3	180.5	139.2
0403	SH.ST.-LINK NO.1 SOUTH-WEST SIDE	1.2	71	10.4	182.1	164.7	11.5	183.2	164.7
0802	MULT.CAB.P.-LINK NO.8 BOTH SIDES	2.7	61	10.4	180.6	139.2	14.0	183.2	139.2
0101	EARTH MOVING-OUT.THE AREA TO BE PAVED IN N&E	21.0	61	12.0	219.2	170.2	37.9	246.1	170.2
0605	DRAINAGE-(ZONE 1) RUNWAY	1.0	61	12.0	177.2	136.2	12.9	178.1	136.2
0703	PVC CAB.P.-LINK NO.1 SOUTH-WEST SIDE	1.0	61	12.0	191.4	148.4	12.9	192.3	148.4
0503	SH.ASP.C.-LINK NO.1 SOUTH-WEST SIDE	1.1	61	13.0	219.6	169.6	14.0	220.6	169.6
0608	DRAINAGE-(ZONE 2) FTO NO.2	3.0	61	13.0	178.2	136.2	15.9	182.1	136.2
0309	P.Q.C.-(ZONE 2) RUNWAY	0.8	611	13.5	14.8	1.3	14.2	15.5	1.3

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0402	SH.ST.-LINK NO.8 BOTH SIDES	4.7	71	14.1	183.3	162.2	18.7	187.9	162.2
0824	MULT.CAB.P.-PTW NO.1 EAST & LINK NO.9 SOUTH	3.5	61	14.1	183.5	139.4	17.5	187.9	139.4
0310	P.Q.C.-(ZONE 2) FTO NO.3	2.0	611	14.4	15.7	1.3	16.3	17.6	1.3
0201	L.C.-FROM PTW NO.1(24+60) TO END OF LIN.NO.6	13.5	61	16.0	16.0	0.0	34.4	34.4	0.0
0609	DRAINAGE-(ZONE 2) RUNWAY	2.0	61	16.0	182.2	136.2	17.9	184.1	136.2
0312	P.Q.C.-(ZONE 3) FTO NO.3	3.3	611	16.5	17.8	1.3	20.7	22.0	1.3
0807	MULT.CAB.P.-(ZONE 1) PTW NO.1	2.4	61	17.6	190.9	142.3	20.9	194.2	142.3
0424	SH.ST.-PTW NO.1 EAST SIDE & LINK NO.9 SOUTH	6.3	71	18.8	188.0	162.2	25.0	194.2	162.2
0610	DRAINAGE-(ZONE 2) FTO NO.3	1.0	61	19.0	184.2	136.2	19.9	185.1	136.2
0702	PVC CAB.P.-LINK NO.8 BOTH SIDES	4.0	61	19.0	192.4	143.4	22.9	~~197.3~~	143.4
0612	DRAINAGE-(ZONE 3) FTO NO.3	2.0	61	20.0	185.2	136.2	21.9	188.1	136.2
0313	P.Q.C.-(ZONE 3) RUNWAY	0.8	611	20.8	22.1	1.3	21.5	22.8	1.3
0804	MULT.CAB.P.-(ZONE 1) LINK NO.1	2.0	61	21.0	195.6	143.6	22.9	197.5	143.6
0314	P.Q.C.-(ZONE 3) FTO NO.4	3.3	611	21.6	22.9	1.3	24.8	27.1	1.3
0613	DRAINAGE-(ZONE 3) RUNWAY	3.0	61	22.0	188.2	136.2	24.9	191.1	136.2
0502	SH.ASP.C.-LINK NO.8 BOTH SIDES	3.8	61	23.0	220.7	161.7	27.7	225.4	161.7
0805	MULT.CAB.P.-(ZONE 1) RUNWAY	3.2	61	23.0	197.6	143.6	27.1	201.7	143.6
0902	LAY TOP SOIL-BETWEEN LINKS NO.1&8	3.0	61	23.8	259.2	191.4	27.7	262.1	191.4
0407	SH.ST.-(ZONE 1) PTW NO.1	6.3	71	25.1	194.3	162.2	31.3	198.5	162.2
0316	P.Q.C.-(ZONE 4) FTO NO.4	2.0	511	26.0	27.3	1.3	27.9	31.2	1.3
0614	DRAINAGE-(ZONE 3) FTO NO.4	4.0	61	26.0	191.2	136.2	31.9	196.1	136.2
0724	PVC CAB.P.-PTW NO.1 EAST & LINK NO.9 SOUTH	5.3	61	26.0	197.4	141.4	34.2	203.6	141.4
0806	MULT.CAB.P.-(ZONE 1) FTO NO.2	1.8	61	27.2	204.6	146.4	28.9	208.3	146.4

SEQUENCE E S PAGE 3

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0903	LAY TOP SOIL-LINK NO.8 SOUTH-EAST	2.0	61	27.8	262.2	191.4	31.7	265.1	191.4
0317	P.Q.C.-(ZONE 4) RUNWAY	0.8	611	28.1	31.4	1.3	28.8	33.1	1.3
0318	P.Q.C.-(ZONE 4) FTO NO.5	3.3	611	28.9	33.2	1.3	35.1	36.4	1.3
0808	MULT.CAB.P.-(ZONE 2) FTO NO.2	2.8	61	31.0	208.7	146.7	34.7	211.4	146.7
0404	SH.ST.-(ZONE 1) LINK NO.1	3.2	71	31.4	198.6	162.2	34.5	201.7	162.2
0616	DRAINAGE-(ZONE 4) FTO NO.4	3.0	61	33.0	196.2	136.2	35.9	199.1	136.2
0524	SH.ASP.C.-PTW NO.1 EAST & LINK NO.9 SOUTH	4.3	61	34.3	225.5	158.2	38.5	230.7	158.2
0707	PVC CAB.P.-(ZONE 1) PTW NO.1	3.7	61	34.3	203.7	141.4	37.9	209.3	141.4
0206	L.C.-LINK NO.11	4.1	61	34.5	184.8	125.3	38.5	189.8	125.3
0405	SH.ST.-(ZONE 1) RUNWAY	5.6	71	34.6	201.8	162.2	40.1	208.3	162.2
0809	MULT.CAB.P.-(ZONE 2) RUNWAY	1.0	61	34.8	215.6	148.8	35.7	216.5	148.8
0320	P.Q.C.-(ZONE 5) FTO NO.5	2.0	611	35.3	36.6	1.3	37.2	38.5	1.3
0904	LAY TOP SOIL-PTW NO.1 EAST & LINK NO.9 SOUTH	3.0	61	35.6	265.2	188.6	38.5	268.1	188.6
0810	MULT.CAB.P.-(ZONE 2) FTO NO.3	1.8	61	35.8	216.6	148.8	37.5	218.3	148.8
0617	DRAINAGE-(ZONE 4) RUNWAY	2.0	61	36.0	199.2	136.2	37.9	202.1	136.2
0321	P.Q.C.-(ZONE 5) RUNWAY	1.8	611	37.4	38.7	1.3	40.1	41.4	1.3
0812	MULT.CAB.P.-(ZONE 3) FTO NO.3	2.8	61	37.6	218.4	148.8	41.3	222.1	148.8
0102	EARTH MOVING-FUEL FARM AREA	7.0	61	38.0	246.2	170.2	45.9	254.1	170.2
0618	DRAINAGE-(ZONE 4) FTO NO.5	3.0	61	38.0	202.2	136.2	41.9	206.1	136.2
0704	PVC CAB.P.-(ZONE 1) LINK NO.1	2.6	61	38.0	209.4	141.4	41.5	211.9	141.4
0205	L.C.-LINK NO.10	5.0	61	38.6	189.9	125.3	44.5	195.8	125.3
0507	SH.ASP.C.-(ZONE 1) PTW NO.1	2.8	61	38.6	230.8	158.2	42.3	234.5	158.2
0406	SH.ST.-(ZONE 1) FTO NO.2	3.1	71	40.2	208.4	162.2	43.2	211.4	162.2

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0907	LAY TOP SOIL-ZONE 1	11.0	61	41.2	268.2	187.0	54.1	281.1	187.0
0813	MULT.CAB.P.-(ZONE 3) RUNWAY	0.7	61	41.4	224.4	151.0	42.0	225.0	151.0
0322	P.Q.C.-(ZONE 5) LINK NO.6	2.1	611	41.5	41.5	0.0	43.5	43.5	0.0
0705	PVC CAB.P.-(ZONE 1) RUNWAY	4.8	61	41.6	212.0	141.4	47.3	218.7	141.4
0620	DRAINAGE-(ZONE 5) FTO NO.5	3.0	61	42.0	206.2	136.2	44.9	210.1	136.2
0814	MULT.CAB.P.-(ZONE 3) FTO NO.4	2.8	61	42.1	225.1	151.0	44.8	227.8	151.0
0504	SH.ASP.C.-(ZONE 1) LINK NO.1	1.9	61	42.4	234.6	158.2	44.2	237.4	158.2
0408	SH.ST.-(ZONE 2) FTO NO.2	4.8	71	43.3	211.5	162.2	48.0	217.2	162.2
0323	P.Q.C.-(ZONE 5) PTW NO.1	1.6	611	43.6	43.6	0.0	45.1	45.1	0.0
0816	MULT.CAB.P.-(ZONE 4) FTO NO.4	1.8	61	44.9	230.2	152.3	47.6	232.9	152.3
0621	DRAINAGE-(ZONE 5) RUNWAY	7.0	61	45.0	210.2	136.2	52.9	219.1	136.2
0319	P.Q.C.-(ZONE 4) PTW NO.1	1.8	611	45.2	45.2	0.0	47.9	47.9	0.0
0111	BORROW & FILL SELECTED MTL.-FUEL FARM AREA	6.0	61	47.0	254.2	170.2	52.9	261.1	170.2
0505	SH.ASP.C.-(ZONE 1) RUNWAY	3.7	61	47.4	237.5	156.1	51.0	243.1	156.1
0706	PVC CAB.P.-(ZONE 1) FTO NO.2	2.7	61	47.4	218.8	141.4	50.0	222.4	141.4
0817	MULT.CAB.P.-(ZONE 4) RUNWAY	1.0	61	47.7	233.0	152.3	48.6	233.9	152.3
0315	P.Q.C.-(ZONE 3) PTW NO.1	4.3	611	48.0	48.0	0.0	52.2	52.2	0.0
0409	SH.ST.-(ZONE 2) RUNWAY	1.8	71	48.1	217.3	162.2	49.8	219.0	162.2
0818	MULT.CAB.P.-(ZONE 4) FTO NO.5	2.8	61	48.7	234.0	152.3	51.4	237.7	152.3
0410	SH.ST.-(ZONE 2) FTO NO.3	3.1	71	49.9	219.1	162.2	52.9	222.1	162.2
0708	PVC CAB.P.-(ZONE 2) FTO NO.2	4.1	61	50.1	222.5	141.4	55.1	226.5	141.4
0506	SH.ASP.C.-(ZONE 1) FTO NO.2	2.1	61	51.1	243.2	156.1	54.1	245.2	156.1
0820	MULT.CAB.P.-(ZONE 5) FTO NO.5	1.8	61	51.5	240.4	153.9	54.2	243.1	153.9

WI	DESCRIPTION	TOT. DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0346	P.Q.C.-FTO NO.3 INTERIOR STRIP	1.9	611	52.3	52.3	0.0	55.1	55.1	0.0
0412	SH.ST.-(ZONE 3) FTO NO.3	4.8	71	53.0	222.2	162.2	57.7	226.9	162.2
0210	L.C.-LINK NO.7 (FUEL FARM AREA)	5.0	61	54.0	261.2	170.2	58.9	267.1	170.2
0622	DRAINAGE-(ZONE 5) LINK NO.6	3.0	61	54.0	219.2	136.2	56.9	223.1	136.2
0821	MULT.CAB.P.-(ZONE 5) RUNWAY	3.5	61	54.3	243.2	153.9	57.7	246.6	153.9
0508	SH.ASP.C.-(ZONE 2) FTO NO.2	2.9	61	55.2	245.3	155.1	58.0	248.1	155.1
0709	PVC CAB.P.-(ZONE 2) RUNWAY	1.4	61	55.2	226.6	141.4	56.5	227.9	141.4
0347	P.Q.C.-FTO NO.4 INTERIOR STRIP	1.9	611	55.4	55.4	0.0	57.2	57.2	0.0
0710	PVC CAB.P.-(ZONE 2) FTO NO.3	2.7	61	56.6	229.0	141.4	59.2	232.6	141.4
0623	DRAINAGE-(ZONE 5) PTW NO.1	3.0	61	57.0	223.2	136.2	59.9	226.1	136.2
0348	P.Q.C.-FTO NO.5 INTERIOR STRIP	1.9	611	57.5	57.5	0.0	59.3	59.3	0.0
0413	SH.ST.-(ZONE 3) RUNWAY	0.9	71	57.8	227.0	162.2	58.6	227.8	162.2
0822	MULT.CAB.P.-(ZONE 5) LINK NO.6	1.8	61	57.8	251.1	157.3	59.5	252.8	157.3
0509	SH.ASP.C.-(ZONE 2) RUNWAY	1.1	61	58.1	248.2	155.1	59.1	250.2	155.1
0414	SH.ST.-(ZONE 3) FTO.NO.4	4.8	71	58.7	227.9	162.2	63.4	233.6	162.2
0203	L.C.-PTW NO.2 (FUEL FARM AREA)	1.4	61	59.0	267.2	170.2	61.3	268.5	170.2
0510	SH.ASP.C.-(ZONE 2) FTO NO.3	2.1	61	59.3	250.3	155.0	62.3	252.3	155.0
0712	PVC CAB.P.-(ZONE 3) FTO NO.3	4.1	61	59.3	232.7	141.4	64.3	237.7	141.4
0367	P.Q.C.-RUNWAY STRIP NO.2 (13+00-25+30)	5.3	611	59.4	59.4	0.0	65.6	65.6	0.0
0619	DRAINAGE-(ZONE 4) PTW NO.1	3.0	61	61.0	226.2	136.2	63.9	230.1	136.2
0823	MULT.CAB.P.-(ZONE 5) PTW NO.1	1.6	61	61.0	253.5	157.5	62.5	255.0	157.5
0209	L.C.-PTW NO.1 (FUEL FARM AREA)	5.0	61	61.4	268.6	170.2	66.3	274.5	170.2
0416	SH.ST.-(ZONE 4) FTO NO.4	3.1	71	63.5	233.7	162.2	66.5	236.7	162.2

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0615	DRAINAGE-(ZONE 3) PTW NO.1	7.0	61	64.0	230.2	136.2	71.9	240.1	136.2
0819	MULT.CAB.P.-(ZONE 4) PTW NO.1	1.4	61	64.0	255.1	156.1	65.3	257.4	156.1
0512	SH.ASP.C.-(ZONE 3) FTO NO.3	3.0	61	64.4	252.4	153.0	68.3	255.3	153.0
0713	PVC CAB.P.-(ZONE 3) RUNWAY	0.5	61	64.4	237.8	141.4	64.8	238.2	141.4
0714	PVC CAB.P.-(ZONE 3) FTO NO.4	4.1	61	64.9	238.3	141.4	69.9	244.3	141.4
0345	P.Q.C.-FTO NO.2 INTERIOR STRIP	1.9	611	65.7	65.7	0.0	68.5	68.5	0.0
0417	SH.ST.-(ZONE 4) RUNWAY	1.0	71	66.6	236.8	162.2	67.5	237.7	162.2
0418	SH.ST.-(ZONE 4) FTO NO.5	4.8	71	67.6	237.8	162.2	72.3	243.5	162.2
0513	SH.ASP.C.-(ZONE 3) RUNWAY	0.6	61	68.4	255.4	153.0	68.9	255.9	153.0
0330	P.Q.C.-(ZONE 7) PTW NO.1	4.3	611	68.8	68.8	0.0	73.0	73.0	0.0
0514	SH.ASP.C.-(ZONE 3) FTO NO.4	3.0	61	70.0	257.0	152.0	72.9	259.9	152.0
0716	PVC CAB.P.-(ZONE 4) FTO NO.4	2.7	61	70.0	244.4	141.4	72.6	247.0	141.4
0611	DRAINAGE-(ZONE 2) PTW NO.1	1.0	61	72.0	240.2	136.2	72.9	241.1	136.2
0815	MULT.CAB.P.-(ZONE 3) PTW NO.1	3.8	61	72.0	257.5	150.5	76.7	261.2	150.5
0420	SH.ST.-(ZONE 5) FTO NO.5	3.1	71	72.4	243.6	162.2	75.4	246.6	162.2
0717	PVC CAB.P.-(ZONE 4) RUNWAY	1.4	61	72.7	247.1	141.4	75.0	248.4	141.4
0516	SH.ASP.C.-(ZONE 4) FTO NO.4	2.1	61	73.0	260.0	152.0	76.0	262.0	152.0
0630	DRAINAGE-(ZONE 7) PTW NO.1	7.0	61	73.0	241.2	136.2	80.9	250.1	136.2
0334	P.Q.C.-(ZONE 8) PTW NO.1	1.8	611	73.2	73.2	0.0	75.9	75.9	0.0
0718	PVC CAB.P.-(ZONE 4) FTO NO.5	4.1	61	75.1	248.5	141.4	79.1	253.5	141.4
0421	SH.ST.-(ZONE 5) RUNWAY	6.2	71	75.5	246.7	162.2	81.6	252.8	162.2
0517	SH.ASP.C.-(ZONE 4) RUNWAY	1.0	61	76.1	262.1	152.0	77.0	264.0	152.0
0811	MULT.CAB.P.-(ZONE 2) PTW NO.1	1.4	61	76.8	264.9	153.1	78.1	266.2	153.1

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0518	SH.ASP.C.-(ZONE 4) FTO NO.5	2.9	61	79.2	264.1	149.9	83.0	266.9	149.9
0720	PVC CAB.P.-(ZONE 5) FTO NO.5	2.7	61	79.2	253.6	141.4	82.8	257.2	141.4
0422	SH.ST.-(ZONE 5) LINK NO.6	3.1	71	81.7	252.9	162.2	84.7	255.9	162.2
0634	DRAINAGE-(ZONE 8) PTW NO.1	2.0	61	82.0	250.2	136.2	83.9	252.1	136.2
0830	MULT.CAB.P.-(ZONE 7) PTW NO.1	3.7	61	82.0	266.3	150.3	85.6	269.9	150.3
0721	PVC CAB.P.-(ZONE 5) RUNWAY	5.4	61	82.9	257.3	141.4	89.2	262.6	141.4
0520	SH.ASP.C.-(ZONE 5) FTO NO.5	2.1	61	83.1	267.0	149.9	85.1	269.0	149.9
0635	DRAINAGE-(ZONE 8) LINK NO.11	3.0	61	84.0	252.2	136.2	86.9	255.1	136.2
0423	SH.ST.-(ZONE 5) PTW NO.1	2.8	71	84.8	256.0	162.2	87.5	258.7	162.2
0834	MULT.CAB.P.-(ZONE 8) PTW NO.1	1.2	61	85.7	274.7	154.0	86.8	~~275.8~~	154.0
0636	DRAINAGE-(ZONE 8) PTW NO.2	2.0	61	87.0	255.2	136.2	89.9	258.1	136.2
0419	SH.ST.-(ZONE 4) PTW NO.1	2.5	71	87.6	258.8	162.2	90.0	261.2	162.2
0521	SH.ASP.C.-(ZONE 5) RUNWAY	4.1	61	89.3	269.1	146.8	94.3	274.1	146.8
0722	PVC CAB.P.-(ZONE 5) LINK NO.6	2.7	61	89.3	262.7	141.4	91.9	266.3	141.4
0633	DRAINAGE-(ZONE 8) LINK NO.10	3.0	61	90.0	258.2	136.2	92.9	261.1	136.2
0415	SH.ST.-(ZONE 3) PTW NO.1	6.7	71	90.1	261.3	162.2	97.7	267.9	162.2
0723	PVC CAB.P.-(ZONE 5) PTW NO.1	2.5	61	92.0	266.4	141.4	96.4	268.8	141.4
0631	DRAINAGE-(ZONE 7) LINK NO.10	3.0	61	94.0	261.2	136.2	97.9	265.1	136.2
0522	SH.ASP.C.-(ZONE 5) LINK NO.6	1.8	61	94.4	274.2	146.8	97.1	275.9	146.8
0719	PVC CAB.P.-(ZONE 4) PTW NO.1	2.1	61	96.5	268.9	141.4	98.5	271.9	141.4
0523	SH.ASP.C.-(ZONE 5) PTW NO.1	1.8	61	97.2	276.0	146.8	98.9	278.7	146.8
0411	SH.ST.-(ZONE 2) PTW NO.1	2.5	71	97.8	268.0	162.2	100.2	270.4	162.2
0632	DRAINAGE-(ZONE 7) PTW NO.2	7.0	61	98.0	265.2	136.2	105.9	273.1	136.2

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0715	PVC CAB.P.-(ZONE 3) PTW NO.1	5.7	61	98.6	272.0	141.4	105.2	278.6	141.4
0519	SH.ASP.C.-(ZONE 4) PTW NO.1	2.4	61	99.0	278.8	146.8	101.3	281.1	146.8
0430	SH.ST.-(ZONE 7) PTW NO.1	6.5	71	100.3	270.5	162.2	106.7	276.9	162.2
0515	SH.ASP.C.-(ZONE 3) PTW NO.1	4.4	61	105.3	281.2	143.9	110.6	286.5	143.9
0711	PVC CAB.P.-(ZONE 2) PTW NO.1	2.1	61	105.3	278.7	141.4	107.3	280.7	141.4
0908	LAY TOP SOIL-ZONE 2	6.0	61	105.3	281.2	143.9	112.2	288.1	143.9
0629	DRAINAGE-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.0	61	106.0	273.2	136.2	106.9	274.1	136.2
0434	SH.ST.-(ZONE 8) PTW NO.1	2.0	71	106.8	277.0	162.2	108.7	278.9	162.2
0628	DRAINAGE-(ZONE 6) PTW NO.2	3.0	61	107.0	274.2	136.2	110.9	278.1	136.2
0730	PVC CAB.P.-(ZONE 7) PTW NO.1	5.5	61	107.4	280.8	141.4	113.8	287.2	141.4
0511	SH.ASP.C.-(ZONE 2) PTW NO.1	1.6	61	110.7	286.6	143.9	112.2	288.1	143.9
0627	DRAINAGE-(ZONE 6) LINK NO.7 (FUEL F.AREA)	3.0	61	111.0	278.2	136.2	113.9	281.1	136.2
0909	LAY TOP SOIL-ZONE 3	12.0	61	112.3	288.2	143.9	126.2	302.1	143.9
0530	SH.ASP.C.-(ZONE 7) PTW NO.1	3.4	61	113.9	299.5	151.6	118.2	302.8	151.6
0734	PVC CAB.P.-(ZONE 8) PTW NO.1	1.7	61	113.9	287.3	141.4	115.5	288.9	141.4
0640	DRAINAGE-PTW NO.2 EAST (10+80-FUEL F.AREA)	2.0	61	114.0	281.2	136.2	115.9	283.1	136.2
0641	DRAINAGE-PTW NO.2 EAST (FUEL FARM AREA)	2.0	61	117.0	283.2	136.2	118.9	286.1	136.2
0534	SH.ASP.C.-(ZONE 8) PTW NO.1	1.1	61	118.3	302.9	151.6	119.3	303.9	151.6
0642	DRAINAGE-PTW NO.2 EAST (FUEL F.AREA-28+23)	9.0	61	119.0	286.2	136.2	128.9	296.1	136.2
0910	LAY TOP SOIL-ZONE 4	5.0	61	126.3	302.2	143.9	135.2	308.1	143.9
0637	DRAINAGE-LINK NO.11 NORTH SIDE	3.0	61	133.0	309.2	147.2	135.9	313.1	147.2
0911	LAY TOP SOIL-ZONE 5	10.0	61	135.3	308.2	143.9	147.2	320.1	143.9
0638	DRAINAGE-PTW NO.1 EAST SIDE (BTW.L.NO.11&6)	2.0	61	136.0	313.2	147.2	138.9	315.1	147.2

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0639	DRAINAGE-LINK NO.6 NORTH & NORTH-EAST SIDES	4.0	61	139.0	315.2	147.2	142.9	320.1	147.2
0601	DRAINAGE-RUNWAY WEST SIDE (19+50-34+36)	7.0	61	143.0	344.4	167.4	150.9	352.3	167.4
0600	DRAINAGE-RUNWAY WEST SIDE (04+36-19+50)	1.0	61	152.0	372.8	184.8	152.9	373.7	184.8
0335	P.Q.C.-(ZONE 8) LINK NO.11	2.1	611	198.0	198.0	0.0	201.0	201.0	0.0
0336	P.Q.C.-(ZONE 8) PTW NO.2	1.8	611	201.1	201.1	0.0	202.8	202.8	0.0
0333	P.Q.C.-(ZONE 8) LINK NO.10	2.1	611	202.9	202.9	0.0	204.9	204.9	0.0
0331	P.Q.C.-(ZONE 7) LINK NO.10	2.1	611	206.0	206.1	0.1	209.0	209.1	0.1
0332	P.Q.C.-(ZONE 7) PTW NO.2	4.0	611	209.1	209.2	0.1	215.0	215.1	0.1
0835	MULT.CAB.P.-(ZONE 8) LINK NO.11	0.9	61	209.1	275.9	54.8	209.9	276.7	54.8
0435	SH.ST.-(ZONE 8) LINK NO.11	1.5	71	210.0	279.0	66.0	211.4	280.4	66.0
0836	MULT.CAB.P.-(ZONE 8) PTW NO.2	1.2	61	210.9	276.8	53.9	212.0	278.9	53.9
0735	PVC CAB.P.-(ZONE 8) LINK NO.11	1.2	61	211.5	289.0	63.5	212.6	290.1	63.5
0436	SH.ST.-(ZONE 8) PTW NO.2	2.0	71	212.1	280.5	65.4	215.0	282.4	65.4
0535	SH.ASP.C.-(ZONE 8) LINK NO.11	1.1	61	212.7	304.0	75.3	215.7	306.0	75.3
0833	MULT.CAB.P.-(ZONE 8) LINK NO.10	0.9	61	215.0	279.0	53.0	215.8	279.8	53.0
0736	PVC CAB.P.-(ZONE 8) PTW NO.2	1.7	61	215.1	290.2	63.1	216.7	292.8	63.1
0328	P.Q.C.-(ZONE 6) PTW NO.2	2.0	611	215.2	215.3	0.1	217.1	217.2	0.1
0433	SH.ST.-(ZONE 8) LINK NO.10	1.5	71	215.9	282.5	64.6	217.3	283.9	64.6
0536	SH.ASP.C.-(ZONE 8) PTW NO.2	1.1	61	216.8	306.1	74.3	217.8	307.1	74.3
0831	MULT.CAB.P.-(ZONE 7) LINK NO.10	0.9	61	217.1	279.9	51.8	217.9	280.7	51.8
0340	P.Q.C.-PTW NO.2 EAST STRIP (ZONE 6)	1.4	611	217.3	217.4	0.1	218.6	218.7	0.1
0733	PVC CAB.P.-(ZONE 8) LINK NO.10	1.2	61	217.4	292.9	62.5	218.5	294.0	62.5
0431	SH.ST.-(ZONE 7) LINK NO.10	1.5	71	218.0	284.0	64.0	219.4	285.4	64.0

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0533	SH.ASP.C.-(ZONE 8) LINK NO.10	1.1	61	218.6	307.2	73.6	219.6	308.2	73.6
0343	P.Q.C.-PTW NO.2 EAST STRIP (ZONE 7)	4.0	611	218.8	218.9	0.1	223.7	223.8	0.1
0731	PVC CAB.P.-(ZONE 7) LINK NO.10	1.2	61	219.5	294.1	61.6	220.6	295.2	61.6
0531	SH.ASP.C.-(ZONE 7) LINK NO.10	1.1	61	220.7	308.3	72.6	222.7	309.3	72.6
0832	MULT.CAB.P.-(ZONE 7) PTW NO.2	3.7	61	223.1	280.8	47.7	226.7	285.4	47.7
0344	P.Q.C.-PTW NO.2 EAST STRIP (ZONE 8)	1.9	611	223.8	223.9	0.1	225.6	225.7	0.1
0337	P.Q.C.-LINK NO.11 NORTH STRIP	1.4	611	225.7	225.8	0.1	227.0	227.1	0.1
0432	SH.ST.-(ZONE 7) PTW NO.2	6.5	71	226.8	285.5	56.7	234.2	291.9	56.7
0338	P.Q.C.-PTW NO.1 EAST STPIP (BTW LIN.NO.11&6)	1.8	611	227.1	227.2	0.1	229.8	229.9	0.1
0339	P.Q.C.-LINK NO.6 NORTH & NORTH-EAST STRIP	2.0	611	229.9	230.0	0.1	232.8	232.9	0.1
0301	P.Q.C.-RUNWAY STRIP NO.6 (19+50-34+36)	6.6	611	232.9	233.0	0.1	241.4	241.5	0.1
0732	PVC CAB.P.-(ZONE 7) PTW NO.2	5.5	61	234.3	295.3	51.0	241.7	301.7	51.0
0300	P.Q.C.-RUNWAY STRIP NO.6 (04+36-19+50)	6.3	611	241.5	241.6	0.1	248.7	248.8	0.1
0532	SH.ASP.C.-(ZONE 7) PTW NO.2	3.4	61	241.8	309.4	57.6	246.1	313.7	57.6
0370	P.Q.C.-RUNWAY STRIP NO.4	13.0	611	248.8	248.9	0.1	264.7	264.8	0.1
0365	P.Q.C.-LINK NO.6 INTERIOR STRIP	2.0	611	264.9	265.0	0.1	266.8	266.9	0.1
0354	P.Q.C.-PTW NO.1 INTERIOR STRIP (ZONE 5)	1.7	611	266.9	267.0	0.1	268.5	268.6	0.1
0351	P.Q.C.-LINK NO.11 INTERIOR STRIP	0.7	611	268.6	268.7	0.1	269.2	269.3	0.1
0357	P.Q.C.-PTW NO.2 INTERIOR STRIP (ZONE 8)	1.8	611	269.3	269.4	0.1	272.0	272.1	0.1
0356	P.Q.C.-PTW NO.2 INTERIOR STRIP (ZONE 7)	4.0	611	272.1	272.2	0.1	276.0	276.1	0.1
0362	P.Q.C.-PTW NO.2 EAST STRIP (FUEL F.AREA)	0.7	611	276.1	276.2	0.1	276.7	276.8	0.1
0361	P.Q.C.-PTW NO.2 WEST STRIP (FUEL F.AREA)	0.7	611	276.8	276.9	0.1	278.4	278.5	0.1
0329	P.Q.C.-(ZONE 7) LINK NO.7 (FUEL FARM AREA)	2.1	611	278.6	278.7	0.1	280.6	280.7	0.1

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WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0359	P.Q.C.-PTW NO.1 EAST STRIP (FUEL F.AREA)	0.5	611	280.7	281.6	0.9	281.1	282.0	0.9
0358	P.Q.C.-PTW NO.1 WEST STRIP (FUEL F.AREA)	0.5	611	281.2	282.1	0.9	281.6	282.5	0.9
0327	P.Q.C.-(ZONE 6) LINK NO.7 (FUEL FARM AREA)	2.1	611	281.8	282.7	0.9	283.8	285.7	0.9
0352	P.Q.C.-PTW NO.1 INTERIOR STRIP (ZONE 3)	4.3	611	285.0	359.4	63.4	289.2	364.6	63.4
0829	MULT.CAB.P.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	0.9	61	288.7	288.8	0.1	289.5	289.6	0.1
0353	P.Q.C.-PTW NO.1 INTERIOR STRIP (ZONE 4)	1.8	611	289.3	364.7	63.4	292.0	366.4	63.4
0429	SH.ST.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.5	71	289.6	292.0	2.4	291.0	293.4	2.4
0826	MULT.CAB.P.-(ZONE 6) PTW NO.1	1.3	61	289.6	289.7	0.1	290.8	290.9	0.1
0825	MULT.CAB.P.-(ZONE 6) LINK NO.9	0.8	61	290.9	292.0	0.1	292.6	292.7	0.1
0426	SH.ST.-(ZONE 6) PTW NO.1	2.2	71	291.1	293.5	2.4	293.2	295.6	2.4
0729	PVC CAB.P.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.2	61	292.0	301.8	8.8	293.1	302.9	8.8
0350	P.Q.C.-LINK NO.10 INTERIOR STRIP	0.7	611	292.2	366.6	63.4	292.8	367.2	63.4
0828	MULT.CAB.P.-(ZONE 6) PTW NO.2	1.0	61	292.7	292.8	0.1	293.6	293.7	0.1
0355	P.Q.C.-PTW NO.2 INTERIOR STRIP (ZONE 6)	1.4	611	292.9	367.3	63.4	294.2	369.6	63.4
0529	SH.ASP.C.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.1	61	293.2	313.8	17.6	294.2	314.8	17.6
0425	SH.ST.-(ZONE 6) LINK NO.9	1.4	71	293.3	295.7	2.4	294.6	297.0	2.4
0726	PVC CAB.P.-(ZONE 6) PTW NO.1	1.9	61	293.3	303.0	8.7	295.1	304.8	8.7
0827	MULT.CAB.P.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	0.9	61	293.7	293.8	0.1	294.5	294.6	0.1
0363	P.Q.C.-PTW NO.2 INTERIOR STRIP (FUEL F.AREA)	0.7	611	294.3	369.7	63.4	294.9	370.3	63.4
0840	MULT.CAB.P.-PTW NO.2 EAST(10+80-FUEL F.AREA)	1.0	61	294.6	294.7	0.1	295.5	295.6	0.1
0428	SH.ST.-(ZONE 6) PTW NO.2	1.7	71	294.7	297.1	2.4	296.3	298.7	2.4
0349	P.Q.C.-LINK NO.7 INTERIOR STRIP(FUEL F.AREA)	0.7	611	295.1	370.5	63.4	295.7	371.1	63.4
0526	SH.ASP.C.-(ZONE 6) PTW NO.1	1.5	61	295.2	314.9	16.7	296.6	316.3	16.7

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0725	PVC CAB.P.-(ZONE 6) LINK NO.9	1.2	61	295.2	304.9	8.7	296.3	307.0	8.7
0841	MULT.CAB.P.-PTW NO.2 EAST (FUEL FARM AREA)	0.5	61	295.6	295.7	0.1	296.0	296.1	0.1
0360	P.Q.C.-PTW NO.1 INTERIOR STRIP (FUEL F.AREA)	0.5	611	295.9	371.3	63.4	296.3	371.7	63.4
0842	MULT.CAB.P.-PTW NO.2 EAST(FUEL F.AREA-28+23)	5.8	61	296.1	296.2	0.1	302.8	302.9	0.1
0427	SH.ST.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	1.5	71	296.4	298.8	2.4	297.8	300.2	2.4
0728	PVC CAB.P.-(ZONE 6) PTW NO.2	1.4	61	296.4	307.1	8.7	297.7	308.4	8.7
0366	P.Q.C.-RUNWAY STRIP NO.2 (04+36-13+00)	3.9	611	296.6	372.0	63.4	301.4	376.8	63.4
0525	SH.ASP.C.-(ZONE 6) LINK NO.9	1.0	61	296.7	316.4	16.7	297.6	317.3	16.7
0528	SH.ASP.C.-(ZONE 6) PTW NO.2	1.1	61	297.8	317.4	16.6	299.8	318.4	16.6
0440	SH.ST.-PTW NO.2 EAST (10+80-FUEL F.AREA)	1.8	71	297.9	300.3	2.4	299.6	302.0	2.4
0727	PVC CAB.P.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	1.2	61	297.9	308.5	8.6	300.0	309.6	8.6
0441	SH.ST.-PTW NO.2 EAST (FUEL FARM AREA)	0.9	71	299.7	302.1	2.4	300.5	302.9	2.4
0527	SH.ASP.C.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	1.1	61	300.1	318.5	16.4	301.1	320.5	16.4
0740	PVC CAB.P.-PTW NO.2 EAST (10+80-FUEL F.AREA)	1.5	61	300.1	309.7	8.6	301.5	311.1	8.6
0540	SH.ASP.C.-PTW NO.2 EAST (10+80-FUEL F.AREA)	1.7	61	301.6	320.6	16.0	303.2	322.2	16.0
0741	PVC CAB.P.-PTW NO.2 EAST(FUEL FARM AREA)	0.8	61	301.6	311.2	8.6	302.3	311.9	8.6
0368	P.Q.C.-RUNWAY STRIP NO.2 (25+30-34+36)	3.9	611	301.7	377.1	63.4	306.5	380.9	63.4
0442	SH.ST.-PTW NO.2 EAST (FUEL F.AREA-28+23)	10.0	71	302.9	303.0	0.1	312.8	312.9	0.1
0837	MULT.CAB.P.-LINK NO.11 NORTH SIDE	0.8	61	302.9	321.9	16.0	303.6	322.6	16.0
0541	SH.ASP.C.-PTW NO.2 EAST (FUEL FARM AREA)	0.5	61	303.3	322.3	16.0	303.7	322.7	16.0
0838	MULT.CAB.P.-PTW NO.1 EAST (BTW.LINK.NO.11&6)	1.4	61	303.7	322.7	16.0	306.0	324.0	16.0
0839	MULT.CAB.P.-LINK NO.6 NORTH & NORTH-EAST	1.9	61	306.1	324.1	16.0	307.9	325.9	16.0
0369	P.Q.C.-RUNWAY STRIP NO.5	13.0	611	306.7	381.1	63.4	321.6	399.0	63.4

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0801	MULT.CAB.P.-RUNWAY WEST SIDE (19+50-34+36)	7.1	61	308.0	352.4	37.4	316.0	360.4	37.4
0437	SH.ST.-LINK NO 11 NORTH SIDE	1.4	71	312.9	323.2	10.3	314.2	324.5	10.3
0742	PVC CAB.P.-PTW NO.2 EAST(FUEL F.AREA-28+23)	8.8	61	313.0	313.0	0.0	322.7	322.7	0.0
0438	SH.ST.-PTW NO.1 EAST SIDE (BTW LINK.NO.11&6)	2.4	71	314.3	324.6	10.3	316.6	326.9	10.3
0800	MULT.CAB.P.-RUNWAY WEST SIDE (04+36-19+50)	6.4	61	316.1	373.8	48.7	323.4	381.1	48.7
0439	SH.ST.-LINK NO.6 NORTH & NORTH-EAST SIDES	3.4	71	316.7	327.0	10.3	320.0	330.3	10.3
0401	SH.ST.-RUNWAY WEST SIDE (19+50-34+36)	12.4	71	320.1	360.5	39.4	332.4	372.8	39.4
0906	LAY TOP SOIL-PTW NO.1 EAST & LIN.6 N.& N-E	14.0	61	320.2	320.2	0.0	337.1	337.1	0.0
0364	P.Q.C.-RUNWAY STRIP NO.3 (34+36-04+36)	13.0	611	321.8	399.2	63.4	337.7	414.1	63.4
0542	SH.ASP.C.-PTW NO.2 EAST (FUEL F.AREA-28+23)	6.9	61	322.8	322.8	0.0	330.6	330.6	0.0
0737	PVC CAB.P.-LINK NO.11 NORTH SIDE	1.2	61	322.8	327.2	3.4	323.9	328.3	3.4
0738	PVC CAB.P.-PTW NO.1 EAST (BTW.LINKS NO.11&6)	2.0	61	324.0	328.4	3.4	325.9	330.3	3.4
0739	PVC CAB.P.-LINK NO.6 NORTH & NORTH-EAST	2.9	61	327.0	330.4	3.4	329.8	335.2	3.4
0537	SH.ASP.C.-LINK NO.11 NORTH SIDE	1.1	61	330.7	330.7	0.0	331.7	331.7	0.0
0538	SH.ASP.C.-PTW NO.1 EAST SIDE (BTW.L.NO.11&6)	1.5	61	331.8	331.8	0.0	335.2	335.2	0.0
0400	SH.ST.-RUNWAY WEST SIDE (04+36-19+50)	11.1	71	332.5	381.2	47.7	344.5	392.2	47.7
0701	PVC CAB.P.-RUNWAY WEST SIDE (19+50-34+36)	10.6	61	332.5	372.9	33.4	346.0	385.4	33.4
0539	SH.ASP.C.-LINK NO.6 NORTH & NORTH-EAST SIDES	1.9	61	335.3	335.3	0.0	337.1	337.1	0.0
0914	LAY TOP SOIL-ZONE 8	3.0	61	337.2	337.2	0.0	341.1	341.1	0.0
0913	LAY TOP SOIL-ZONE 7	10.0	61	341.2	341.2	0.0	352.1	352.1	0.0
0501	SH.ASP.C.-RUNWAY WEST SIDE (19+50+34+36)	7.7	61	346.1	385.5	33.4	355.7	397.1	33.4
0700	PVC CAB.P.-RUNWAY WEST SIDE (04+36-19+50)	9.6	61	346.1	392.3	39.2	357.6	405.8	39.2
0912	LAY TOP SOIL-ZONE 6	4.0	61	352.2	352.2	0.0	357.1	357.1	0.0

SEQUENCE E S

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0905	LAY TOP SOIL-PTW NO.2 EAST & LIN.NO.11 NORTH	16.0	61	357.2	357.2	0.0	376.1	376.1	0.0
0500	SH.ASP.C.-RUNWAY WEST SIDE (04+36-19+50)	7.3	61	357.7	405.9	39.2	365.9	414.1	39.2
0901	LAY.TOP SOIL-RUNWAY WEST SIDE (19+50-34+36)	16.0	61	376.2	376.2	0.0	397.1	397.1	0.0
0900	LAY.TOP SOIL-RUNWAY WEST SIDE (04+36-19+50)	15.0	61	397.2	397.2	0.0	414.1	414.1	0.0
1000	PROJECT END	0.0	71	414.1	414.1	0.0	414.1	414.1	0.0

PROJECT BASE DATE 1.0 PROJECT DURATION 413.2 PROJECT COMPLETION DATE 414.1

IBM PROJECT CONTROL SYSTEM

RUN DATE 1 * * S C H E D U L E R E P O R T * * DATA DATE 1

RUN SEQUENCE 0 NETWORK ID 1111 YESILKOY AIRFIELD INFRASTRUCTURE PROJECT FROM 1 TO 450

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WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY		FINISH LATE	FIN FLOAT
0001	PROJECT START	0.0	71	1.0	1.0	0.0	1.0		1.0	0.0
0100	EARTH MOVING-UNDER AREA TO BE PAVED IN N&E	9.0	61	1.0	1.0	0.0	10.9		10.9	0.0
0110	BORROW & FILL SELECTED MTL.-OUT.FUEL F.AREA	20.0	61	1.0	1.0	0.0	23.9	S4	23.9	0.0
0207	L.C.-FTO NO.4	6.5	61	1.0	1.0	0.0	8.4		8.4	0.0
0303	P.Q.C.-LINK NO.1 SOUTH-WEST STRIP	0.7	611	1.0	2.2	1.2	1.6		2.8	1.2
0602	DRAINAGE-LINK NO.8 BOTH SIDES	1.0	61	1.0	3.0	2.0	1.9		3.9	2.0
0304	P.Q.C.-(ZONE 1) LINK NO.1	2.1	611	1.8	3.0	1.2	3.8		6.0	1.2
0624	DRAINAGE-PTW NO.1 EAST & LINK NO.9 SOUTH	8.0	61	2.0	5.0	2.0	10.9		13.9	2.0
0305	P.Q.C.-(ZONE 1) RUNWAY	2.0	611	5.0	6.3	1.3	6.9		8.2	1.3
0306	P.Q.C.-(ZONE 1) FTO NO.2	2.0	611	7.1	8.4	1.3	9.0		10.3	1.3
0208	L.C.-FTO NO.5	6.5	61	8.5	8.5	0.0	15.9		15.9	0.0
0308	P.Q.C.-(ZONE 2) FTO NO.2	3.3	611	9.2	10.5	1.3	13.4		14.7	1.3
0803	MULT.CAB.P.-LINK NO.1 SOUTH WEST SIDE	0.7	61	9.7	215.6	167.9	10.3		216.2	167.9
0802	MULT.CAB.P.-LINK NO.8 BOTH SIDES	2.7	61	10.4	216.3	167.9	14.0		218.9	167.9
0101	EARTH MOVING-OUT.THE AREA TO BE PAVED IN N&E	21.0	61	12.0	12.0	0.0	37.9	S4	37.9	0.0
0605	DRAINAGE-(ZONE 1) RUNWAY	1.0	61	12.0	14.0	2.0	12.9		14.9	2.0
0608	DRAINAGE-(ZONE 2) FTO NO.2	3.0	61	13.0	15.0	2.0	15.9		17.9	2.0
0309	P.Q.C.-(ZONE 2) RUNWAY	0.8	611	13.5	14.8	1.3	14.2		15.5	1.3
0824	MULT.CAB.P.-PTW NO.1 EAST & LINK NO.9 SOUTH	3.5	61	14.1	219.0	167.9	17.5		223.4	167.9
0310	P.Q.C.-(ZONE 2) FTO NO.3	2.0	611	14.4	15.7	1.3	16.3		17.6	1.3
0201	L.C.-FROM PTW NO.1(24+60) TO END OF LIN.NO.6	13.5	61	16.0	16.0	0.0	34.4		34.4	0.0

SEQUENCE E S

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0609	DRAINAGE-(ZONE 2) RUNWAY	2.0	61	16.0	19.0	2.0	17.9	20.9	2.0
0312	P.Q.C.-(ZONE 3) FTO NO.3	3.3	611	16.5	17.8	1.3	20.7	22.0	1.3
0807	MULT.CAB.P.-(ZONE 1) PTW NO.1	2.4	61	17.6	223.5	167.9	20.9	225.8	167.9
0610	DRAINAGE-(ZONE 2) FTO NO.3	1.0	61	19.0	21.0	2.0	19.9	21.9	2.0
0612	DRAINAGE-(ZONE 3) FTO NO.3	2.0	61	20.0	22.0	2.0	21.9	23.9	2.0
0313	P.Q.C.-(ZONE 3) RUNWAY	0.8	611	20.8	22.1	1.3	21.5	22.8	1.3
0804	MULT.CAB.P.-(ZONE 1) LINK NO.1	2.0	61	21.0	225.9	167.9	22.9	227.8	167.9
0314	P.Q.C.-(ZONE 3) FTO NO.4	3.3	611	21.6	22.9	1.3	24.8	27.1	1.3
0613	DRAINAGE-(ZONE 3) RUNWAY	3.0	61	22.0	24.0	2.0	24.9	27.9	2.0
0805	MULT.CAB.P.-(ZONE 1) RUNWAY	3.2	61	23.0	227.9	167.9	27.1	233.0	167.9
0316	P.Q.C.-(ZONE 4) FTO NO.4	2.0	611	26.0	27.3	1.3	27.9	31.2	1.3
0614	DRAINAGE-(ZONE 3) FTO NO.4	4.0	61	26.0	28.0	2.0	31.9	34.9	2.0
0806	MULT.CAB.P.-(ZONE 1) FTO NO.2	1.8	61	27.2	233.1	167.9	28.9	234.8	167.9
0317	P.Q.C.-(ZONE 4) RUNWAY	0.8	611	28.1	31.4	1.3	28.8	33.1	1.3
0318	P.Q.C.-(ZONE 4) FTO NO.5	3.3	611	28.9	33.2	1.3	35.1	36.4	1.3
0808	MULT.CAB.P.-(ZONE 2) FTO NO.2	2.8	61	31.0	234.9	167.9	34.7	238.6	167.9
0616	DRAINAGE-(ZONE 4) FTO NO.4	3.0	61	33.0	35.0	2.0	35.9	37.9	2.0
0206	L.C.-LINK NO.11	4.1	61	34.5	35.9	1.4	38.5	40.9	1.4
0809	MULT.CAB.P.-(ZONE 2) RUNWAY	1.0	61	34.8	238.7	167.9	35.7	240.6	167.9
0320	P.Q.C.-(ZONE 5) FTO NO.5	2.0	611	35.3	36.6	1.3	37.2	38.5	1.3
0810	MULT.CAB.P.-(ZONE 2) FTO NO.3	1.8	61	35.8	240.7	167.9	37.5	243.4	167.9
0617	DRAINAGE-(ZONE 4) RUNWAY	2.0	61	36.0	38.0	2.0	37.9	40.9	2.0
0321	P.Q.C.-(ZONE 5) RUNWAY	1.8	611	37.4	38.7	1.3	40.1	41.4	1.3

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0812	MULT.CAB.P.-(ZONE 3) FTO NO.3	2.8	61	37.6	243.5	167.9	41.3	246.2	167.9
0102	EARTH MOVING-FUEL FARM AREA	7.0	61	38.0	209.0	141.0	45.9 S4	217.9	141.0
0618	DRAINAGE-(ZONE 4) FTO NO.5	3.0	61	38.0	41.0	2.0	41.9	43.9	2.0
0205	L.C.-LINK NO.10	5.0	61	38.6	41.0	1.4	44.5 S4	45.9	1.4
0813	MULT.CAB.P.-(ZONE 3) RUNWAY	0.7	61	41.4	246.3	167.9	42.0	246.9	167.9
0322	P.Q.C.-(ZONE 5) LINK NO.6	2.1	611	41.5	41.5	0.0	43.5	43.5	0.0
0620	DRAINAGE-(ZONE 5) FTO NO.5	3.0	61	42.0	44.0	2.0	44.9	47.9	2.0
0814	MULT.CAB.P.-(ZONE 3) FTO NO.4	2.8	61	42.1	247.0	157.9	44.8	250.7	167.9
0323	P.Q.C.-(ZONE 5) PTW NO.1	1.6	611	43.6	43.6	0.0	45.1	45.1	0.0
0816	MULT.CAB.P.-(ZONE 4) FTO NO.4	1.8	61	44.9	250.8	167.9	47.6	252.5	167.9
0621	DRAINAGE-(ZONE 5) RUNWAY	7.0	61	45.0	48.0	2.0	52.9	55.9	2.0
0319	P.Q.C.-(ZONE 4) PTW NO.1	1.8	611	45.2	45.2	0.0	47.9	47.9	0.0
0111	BORROW & FILL SELECTED MTL.-FUEL FARM AREA	6.0	61	47.0	218.0	141.0	52.9 S4	224.9	141.0
0817	MULT.CAB.P.-(ZONE 4) RUNWAY	1.0	61	47.7	252.6	167.9	48.6	253.5	167.9
0315	P.Q.C.-(ZONE 3) PTW NO.1	4.3	611	48.0	48.0	0.0	52.2	52.2	0.0
0818	MULT.CAB.P.-(ZONE 4) FTO NO.5	2.8	61	48.7	253.6	167.9	51.4	257.3	167.9
0820	MULT.CAB.P.-(ZONE 5) FTO NO.5	1.8	61	51.5	257.4	167.9	54.2	259.1	167.9
0346	P.Q.C.-FTO NO.3 INTERIOR STRIP	1.9	611	52.3	52.3	0.0	55.1	55.1	0.0
0210	L.C.-LINK NO.7 (FUEL FARM AREA)	5.0	61	54.0	225.6	141.6	58.9	232.5	141.6
0622	DRAINAGE-(ZONE 5) LINK NO.6	3.0	61	54.0	56.0	2.0	56.9	58.9	2.0
0821	MULT.CAB.P.-(ZONE 5) RUNWAY	3.5	61	54.3	259.2	167.9	57.7	262.6	167.9
0347	P.Q.C.-FTO NO.4 INTERIOR STRIP	1.9	611	55.4	55.4	0.0	57.2	57.2	0.0
0623	DRAINAGE-(ZONE 5) PTW NO.1	3.0	61	57.0	59.0	2.0	59.9	62.9	2.0

SEQUENCE E S

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WI	DESCRIPTION	TOT. DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0348	P.Q.C.--FTO NO.5 INTERIOR STRIP	1.9	611	57.5	57.5	0.0	59.3	59.3	0.0
0822	MULT.CAB.P.-(ZONE 5) LINK NO.6	1.8	61	57.8	262.7	167.9	59.5	265.4	167.9
0203	L.C.--PTW NO.2 (FUEL FARM AREA)	1.6	61	59.0	232.6	141.6	61.3	233.9	141.6
0367	P.Q.C.--RUNWAY STRIP NO.2 (15+00-25+30)	5.3	611	59.4	59.4	0.0	65.6	65.6	0.0
0619	DRAINAGE-(ZONE 4) PTW NO.1	3.0	61	61.0	63.0	2.0	63.9	65.9	2.0
0823	MULT.CAB.P.-(ZONE 5) PTW NO.1	1.6	61	61.0	265.5	167.5	62.5	267.0	167.5
0209	L.C.--PTW NO.1 (FUEL FARM AREA)	5.0	61	61.4	234.0	141.6	66.3 S4	240.9	141.6
0615	DRAINAGE-(ZONE 3) PTW NO.1	7.0	61	64.0	66.0	2.0	71.9	73.9	2.0
0819	MULT.CAB.P.-(ZONE 4) PTW NO.1	1.4	61	64.0	267.1	166.1	65.3	268.4	166.1
0345	P.Q.C.--FTO NO.2 INTERIOR STRIP	1.9	611	65.7	65.7	0.0	68.5	68.5	0.0
0330	P.Q.C.-(ZONE 7) PTW NO.1	4.3	611	68.8	68.8	0.0	73.0	73.0	0.0
0611	DRAINAGE-(ZONE 2) PTW NO.1	1.0	61	72.0	75.0	2.0	72.9 S4	75.9	2.0
0815	MULT.CAB.P.-(ZONE 3) PTW NO.1	3.8	61	72.0	268.5	160.5	76.7	273.2	160.5
0334	P.Q.C.-(ZONE 8) PTW NO.1	1.8	611	73.2	73.2	0.0	75.9	75.9	0.0
0811	MULT.CAB.P.-(ZONE 2) PTW NO.1	1.4	61	76.8	273.3	160.5	78.1	274.6	160.5
0335	P.Q.C.-(ZONE 8) LINK NO.11	2.1	611	198.0	198.0	0.0	201.0	201.0	0.0
0630	DRAINAGE-(ZONE 7) PTW NO.1	7.0	61	198.0 S2	233.5	27.5	206.9	243.4	27.5
0336	P.Q.C.-(ZONE 8) PTW NO.2	1.8	611	201.1	201.1	0.0	202.8	202.8	0.0
0333	P.Q.C.-(ZONE 8) LINK NO.10	2.1	611	202.9	202.9	0.0	204.9	204.9	0.0
0331	P.Q.C.-(ZONE 7) LINK NO.10	2.1	611	206.0	206.1	0.1	209.0	209.1	0.1
0634	DRAINAGE-(ZONE 8) PTW NO.1	2.0	61	208.0	243.5	27.5	209.9	245.4	27.5
0830	MULT.CAB.P.-(ZONE 7) PTW NO.1	3.7	61	208.0	274.7	54.7	211.6	279.3	54.7
0332	P.Q.C.-(ZONE 7) PTW NO.2	4.0	611	209.1	209.2	0.1	215.0	215.1	0.1

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0635	DRAINAGE-(ZONE 8) LINK NO.11	3.0	61	210.0	245.5	27.5	212.9	248.4	27.5
0834	MULT.CAB.P.-(ZONE 8) PTW NO.1	1.2	61	211.7	279.4	54.7	212.8	280.5	54.7
0636	DRAINAGE-(ZONE 8) PTW NO.2	2.0	61	215.0	248.5	27.5	216.9	251.4	27.5
0835	MULT.CAB.P.-(ZONE 8) LINK NO.11	0.9	61	215.0	280.6	54.6	215.8	281.4	54.6
0328	P.Q.C.-(ZONE 6) PTW NO.2	2.0	611	215.2	215.3	0.1	217.1	217.2	0.1
0633	DRAINAGE-(ZONE 8) LINK NO.10	3.0	61	217.0	251.5	27.5	219.9	254.4	27.5
0836	MULT.CAB.P.-(ZONE 8) PTW NO.2	1.2	61	217.0	281.5	53.5	218.1	282.6	53.5
0340	P.Q.C.-PTW NO.2 EAST STRIP (ZONE 6)	1.4	611	217.3	217.4	0.1	218.6	218.7	0.1
0403	SH.ST.-LINK NO.1 SOUTH-WEST SIDE	1.2	71	218.0 S2	218.1	0.1	219.1	219.2	0.1
0343	P.Q.C.-PTW NO.2 EAST STRIP (ZONE 7)	4.0	611	218.8	218.9	0.1	223.7	223.8	0.1
0402	SH.ST.-LINK NO.8 BOTH SIDES	4.7	71	219.2	219.3	0.1	223.8	223.9	0.1
0703	PVC CAB.P.-LINK NO.1 SOUTH-WEST SIDE	1.0	61	219.2	227.4	7.2	220.1	229.3	7.2
0631	DRAINAGE-(ZONE 7) LINK NO.10	3.0	61	220.0	254.5	27.5	223.9	258.4	27.5
0833	MULT.CAB.P.-(ZONE 8) LINK NO.10	0.9	61	220.0	282.7	51.7	220.8	283.5	51.7
0503	SH.ASP.C.-LINK NO.1 SOUTH-WEST SIDE	1.1	61	220.2	255.6	28.4	222.2	257.6	28.4
0344	P.Q.C.-PTW NO.2 EAST STRIP (ZONE 8)	1.9	611	223.8	223.9	0.1	225.6	225.7	0.1
0424	SH.ST.-PTW NO.1 EAST SIDE & LINK NO.9 SOUTH	6.3	71	223.9	224.0	0.1	230.1	230.2	0.1
0702	PVC CAB.P.-LINK NO.8 BOTH SIDES	4.0	61	223.9	229.4	4.5	227.8	234.3	4.5
0632	DRAINAGE-(ZONE 7) PTW NO.2	7.0	61	224.0	258.5	27.5	232.9	266.4	27.5
0831	MULT.CAB.P.-(ZONE 7) LINK NO.10	0.9	61	224.0	283.6	49.6	224.8	285.4	49.6
0337	P.Q.C.-LINK NO.11 NORTH STRIP	1.4	611	225.7	225.8	0.1	227.0	227.1	0.1
0338	P.Q.C.-PTW NO.1 EAST STPIP (BTW LIN.NO.11&6)	1.8	611	227.1	227.2	0.1	229.8	229.9	0.1
0502	SH.ASP.C.-LINK NO.8 BOTH SIDES	3.8	61	227.9	257.7	22.8	233.6	261.4	22.8

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0902	LAY TOP SOIL-BETWEEN LINKS NO.1&8	3.0	61	229.7	293.2	52.5	233.6	296.1	52.5
0339	P.Q.C.-LINK NO.6 NORTH & NORTH-EAST STRIP	2.0	611	229.9	230.0	0.1	232.8	232.9	0.1
0407	SH.ST.-(ZONE 1) PTW NO.1	4.3	71	230.2	230.3	0.1	235.4	235.5	0.1
0724	PVC CAB.P.-PTW NO.1 EAST & LINK NO.9 SOUTH	5.3	61	230.2	234.4	3.2	237.4	241.6	3.2
0301	P.Q.C.-RUNWAY STRIP NO.6 (19+50-34+36)	6.6	611	232.9	233.0	0.1	241.4	241.5	0.1
0629	DRAINAGE-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.0	61	233.0	266.5	27.5	233.9	267.4	27.5
0832	MULT.CAB.P.-(ZONE 7) PTW NO.2	3.7	61	233.0	285.5	43.5	237.6	289.1	43.5
0903	LAY TOP SOIL-LINK NO.8 SOUTH-EAST	2.0	61	233.7	296.2	52.5	236.6	299.1	52.5
0628	DRAINAGE-(ZONE 6) PTW NO.2	3.0	61	234.0	267.5	27.5	237.9	271.4	27.5
0404	SH.ST.-(ZONE 1) LINK NO.1	3.2	71	235.5	235.6	0.1	238.6	238.7	0.1
0524	SH.ASP.C.-PTW NO.1 EAST & LINK NO.9 SOUTH	4.3	61	237.5	261.5	20.0	243.7	266.7	20.0
0707	PVC CAB.P.-(ZONE 1) PTW NO.1	3.7	61	237.5	241.7	3.2	243.1	246.3	3.2
0627	DRAINAGE-(ZONE 6) LINK NO.7 (FUEL F.AREA)	3.0	61	238.0	271.5	27.5	241.9	274.4	27.5
0405	SH.ST.-(ZONE 1) RUNWAY	5.6	71	238.7	238.8	0.1	245.2	245.3	0.1
0904	LAY TOP SOIL-PTW NO.1 EAST & LINK NO.9 SOUTH	3.0	61	238.8	299.2	50.4	243.7	302.1	50.4
0300	P.Q.C.-RUNWAY STRIP NO.6 (04+36-19+50)	6.3	611	241.5	241.6	0.1	248.7	248.8	0.1
0640	DRAINAGE-PTW NO.2 EAST (10+80-FUEL F.AREA)	2.0	61	243.0	274.5	27.5	244.9	276.4	27.5
0704	PVC CAB.P.-(ZONE 1) LINK NO.1	2.6	61	243.2	246.4	3.2	245.7	248.9	3.2
0507	SH.ASP.C.-(ZONE 1) PTW NO.1	2.8	61	243.8	266.8	20.0	246.5	269.5	20.0
0641	DRAINAGE-PTW NO.2 EAST (FUEL FARM AREA)	2.0	61	245.0	276.5	27.5	246.9	279.4	27.5
0406	SH.ST.-(ZONE 1) FTO NO.2	3.1	71	245.3	245.4	0.1	248.3	248.4	0.1
0907	LAY TOP SOIL-ZONE 1	11.0	61	245.4	302.2	48.8	258.3	315.1	48.8
0705	PVC CAB.P.-(ZONE 1) RUNWAY	4.8	61	245.8	250.0	3.2	251.5	254.7	3.2

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0504	SH.ASP.C.-(ZONE 1) LINK NO.1	1.9	61	246.6	269.6	20.0	248.4	272.4	20.0
0642	DRAINAGE-PTW NO.2 EAST (FUEL F.AREA-28+23)	9.0	61	247.0	279.5	27.5	257.9	289.4	27.5
0408	SH.ST.-(ZONE 2) FTO NO.2	4.8	71	248.4	248.5	0.1	253.1	253.2	0.1
0370	P.Q.C.-RUNWAY STRIP NO.4	13.0	611	248.8	248.9	0.1	264.7	264.8	0.1
0505	SH.ASP.C.-(ZONE 1) RUNWAY	3.7	61	251.6	272.5	17.9	255.2	276.1	17.9
0706	PVC CAB.P.-(ZONE 1) FTO NO.2	2.7	61	251.6	254.8	3.2	254.2	258.4	3.2
0409	SH.ST.-(ZONE 2) RUNWAY	1.8	71	253.2	253.3	0.1	254.9	255.0	0.1
0708	PVC CAB.P.-(ZONE 2) FTO NO.2	4.1	61	254.3	258.5	3.2	259.3	262.5	3.2
0410	SH.ST.-(ZONE 2) FTO NO.3	3.1	71	255.0	255.1	0.1	258.0	258.1	0.1
0506	SH.ASP.C.-(ZONE 1) FTO NO.2	2.1	61	255.3	276.2	17.9	258.3	279.2	17.9
0637	DRAINAGE-LINK NO.11 NORTH SIDE	3.0	61	258.0	289.5	27.5	260.9	293.4	27.5
0412	SH.ST.-(ZONE 3) FTO NO.3	4.8	71	258.1	258.2	0.1	262.8	262.9	0.1
0508	SH.ASP.C.-(ZONE 2) FTO NO.2	2.9	61	259.4	279.3	16.9	262.2	282.1	16.9
0709	PVC CAB.P.-(ZONE 2) RUNWAY	1.4	61	259.4	262.6	3.2	260.7	264.9	3.2
0710	PVC CAB.P.-(ZONE 2) FTO NO.3	2.7	61	260.8	265.0	3.2	264.4	267.6	3.2
0638	DRAINAGE-PTW NO.1 EAST SIDE (BTW.L.NO.11&6)	2.0	61	261.0	293.5	27.5	262.9	295.4	27.5
0509	SH.ASP.C.-(ZONE 2) RUNWAY	1.1	61	262.3	282.2	16.9	264.3	283.2	16.9
0413	SH.ST.-(ZONE 3) RUNWAY	0.9	71	262.9	263.0	0.1	263.7	263.8	0.1
0414	SH.ST.-(ZONE 3) FTO.NO.4	4.8	71	263.8	263.9	0.1	268.5	268.6	0.1
0639	DRAINAGE-LINK NO.6 NORTH & NORTH-EAST SIDES	4.0	61	264.0	295.5	27.5	267.9	300.4	27.5
0510	SH.ASP.C.-(ZONE 2) FTO NO.3	2.1	61	264.5	283.3	16.8	266.5	286.3	16.8
0712	PVC CAB.P.-(ZONE 3) FTO NO.3	4.1	61	264.5	267.7	3.2	268.5	272.7	3.2
0365	P.Q.C.-LINK NO.6 INTERIOR STRIP	2.0	611	264.9	265.0	0.1	266.8	266.9	0.1

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0354	P.Q.C.-PTW NO.1 INTERIOR STRIP (ZONE 5)	1.7	611	266.9	267.0	0.1	268.5	268.6	0.1
0601	DRAINAGE-RUNWAY WEST SIDE (19+50-34+36)	7.0	61	268.0	300.5	27.5	275.9	308.4	27.5
0351	P.Q.C.-LINK NO.11 INTERIOR STRIP	0.7	611	268.6	268.7	0.1	269.2	269.3	0.1
0416	SH.ST.-(ZONE 4) FTO NO.4	3.1	71	268.6	268.7	0.1	271.6	271.7	0.1
0512	SH.ASP.C.-(ZONE 3) FTO NO.3	3.0	61	268.6	286.4	14.8	272.5	289.3	14.8
0713	PVC CAB.P.-(ZONE 3) RUNWAY	0.5	61	268.6	272.8	3.2	269.0	273.2	3.2
0714	PVC CAB.P.-(ZONE 3) FTO NO.4	4.1	61	269.1	273.3	3.2	274.1	278.3	3.2
0357	P.Q.C.-PTW NO.2 INTERIOR STRIP (ZONE 8)	1.8	611	269.3	269.4	0.1	272.0	272.1	0.1
0417	SH.ST.-(ZONE 4) RUNWAY	1.0	71	271.7	271.8	0.1	272.6	272.7	0.1
0356	P.Q.C.-PTW NO.2 INTERIOR STRIP (ZONE 7)	4.0	611	272.1	272.2	0.1	276.0	276.1	0.1
0513	SH.ASP.C.-(ZONE 3) RUNWAY	0.6	61	272.6	289.4	14.8	273.1	289.9	14.8
0418	SH.ST.-(ZONE 4) FTO NO.5	4.8	71	272.7	272.8	0.1	277.4	277.5	0.1
0514	SH.ASP.C.-(ZONE 3) FTO NO.4	3.0	61	274.2	290.0	13.8	278.1	293.9	13.8
0716	PVC CAB.P.-(ZONE 4) FTO NO.4	2.7	61	274.2	278.4	3.2	276.8	281.0	3.2
0600	DRAINAGE-RUNWAY WEST SIDE (04+36-19+50)	1.0	61	276.0	315.6	33.6	276.9	316.5	33.6
0362	P.Q.C.-PTW NO.2 EAST STRIP (FUEL F.AREA)	0.7	611	276.1	276.2	0.1	276.7	276.8	0.1
0361	P.Q.C.-PTW NO.2 WEST STRIP (FUEL F.AREA)	0.7	611	276.8	276.9	0.1	278.4	278.5	0.1
0717	PVC CAB.P.-(ZONE 4) RUNWAY	1.4	61	276.9	281.1	3.2	279.2	282.4	3.2
0420	SH.ST.-(ZONE 5) FTO NO.5	3.1	71	277.5	277.6	0.1	280.5	280.6	0.1
0516	SH.ASP.C.-(ZONE 4) FTO NO.4	2.1	61	278.2	294.0	13.8	280.2	296.0	13.8
0329	P.Q.C.-(ZONE 7) LINK NO.7 (FUEL FARM AREA)	2.1	611	278.6	278.7	0.1	280.6	280.7	0.1
0718	PVC CAB.P.-(ZONE 4) FTO NO.5	4.1	61	279.3	282.5	3.2	283.3	287.5	3.2
0517	SH.ASP.C.-(ZONE 4) RUNWAY	1.0	61	280.3	296.1	13.8	281.2	297.0	13.8

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0421	SH.ST.-(ZONE 5) RUNWAY	6.2	71	280.6	280.7	0.1	286.7	286.8	0.1
0359	P.Q.C.-PTW NO.1 EAST STRIP (FUEL F.AREA)	0.5	611	280.7	280.8	0.1	281.1	281.2	0.1
0358	P.Q.C.-PTW NO.1 WEST STRIP (FUEL F.AREA)	0.5	611	281.2	281.3	0.1	281.6	281.7	0.1
0327	P.Q.C.-(ZONE 6) LINK NO.7 (FUEL FARM AREA)	2.1	611	281.8	281.9	0.1	283.8	283.9	0.1
0518	SH.ASP.C.-(ZONE 4) FTO NO.5	2.9	61	283.4	297.1	11.7	287.2	300.9	11.7
0720	PVC CAB.P.-(ZONE 5) FTO NO.5	2.7	61	283.4	287.5	3.2	287.0	290.2	3.2
0352	P.Q.C.-PTW NO.1 INTERIOR STRIP (ZONE 3)	4.3	611	285.0	285.2	0.2	289.2	289.4	0.2
0422	SH.ST.-(ZONE 5) LINK NO.6	3.1	71	286.8	286.9	0.1	289.8	289.9	0.1
0721	PVC CAB.P.-(ZONE 5) RUNWAY	5.4	61	287.1	290.3	3.2	293.4	296.6	3.2
0520	SH.ASP.C.-(ZONE 5) FTO NO.5	2.1	61	287.3	301.0	11.7	289.3	303.0	11.7
0829	MULT.CAB.P.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	0.9	61	288.7	289.2	0.5	289.5	290.0	0.5
0353	P.Q.C.-PTW NO.1 INTERIOR STRIP (ZONE 4)	1.8	611	289.3	289.5	0.2	292.0	292.2	0.2
0826	MULT.CAB.P.-(ZONE 6) PTW NO.1	1.3	61	289.6	290.1	0.5	290.8	292.3	0.5
0423	SH.ST.-(ZONE 5) PTW NO.1	2.8	71	289.9	290.0	0.1	292.6	292.7	0.1
0825	MULT.CAB.P.-(ZONE 6) LINK NO.9	0.8	61	290.9	292.4	0.5	292.6	293.1	0.5
0350	P.Q.C.-LINK NO.10 INTERIOR STRIP	0.7	611	292.2	292.4	0.2	292.8	293.0	0.2
0419	SH.ST.-(ZONE 4) PTW NO.1	2.5	71	292.7	292.8	0.1	295.1	295.2	0.1
0828	MULT.CAB.P.-(ZONE 6) PTW NO.2	1.0	61	292.7	293.2	0.5	293.6	294.1	0.5
0355	P.Q.C.-PTW NO.2 INTERIOR STRIP (ZONE 6)	1.4	611	292.9	293.1	0.2	294.2	294.4	0.2
0521	SH.ASP.C.-(ZONE 5) RUNWAY	4.1	61	293.5	303.1	8.6	297.5	308.1	8.6
0722	PVC CAB.P.-(ZONE 5) LINK NO.6	2.7	61	293.5	296.7	3.2	296.1	300.3	3.2
0827	MULT.CAB.P.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	0.9	61	293.7	294.2	0.5	294.5	295.0	0.5
0363	P.Q.C.-PTW NO.2 INTERIOR STRIP (FUEL F.AREA)	0.7	611	294.3	294.5	0.2	294.9	295.1	0.2

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0840	MULT.CAB.P.-PTW NO.2 EAST(10+80-FUEL F.AREA)	1.0	61	294.6	295.1	0.5	295.5	296.0	0.5
0349	P.Q.C.-LINK NO.7 INTERIOR STRIP(FUEL F.AREA)	0.7	611	295.1	295.3	0.2	295.7	295.9	0.2
0415	SH.ST.-(ZONE 3) PTW NO.1	6.7	71	295.2	295.3	0.1	301.8	301.9	0.1
0841	MULT.CAB.P.-PTW NO.2 EAST (FUEL FARM AREA)	0.5	61	295.6	296.1	0.5	296.0	296.5	0.5
0360	P.Q.C.-PTW NO.1 INTERIOR STRIP (FUEL F.AREA)	0.5	611	295.9	296.1	0.2	296.3	296.5	0.2
0842	MULT.CAB.P.-PTW NO.2 EAST(FUEL F.AREA-28+23)	5.8	61	296.1	296.6	0.5	302.8	303.3	0.5
0723	PVC CAB.P.-(ZONE 5) PTW NO.1	2.5	61	296.2	300.4	3.2	299.6	302.8	3.2
0366	P.Q.C.-RUNWAY STRIP NO.2 (04+36-13+00)	3.9	611	296.6	296.8	0.2	301.4	301.6	0.2
0522	SH.ASP.C.-(ZONE 5) LINK NO.6	1.8	61	297.6	308.2	8.6	300.3	309.9	8.6
0719	PVC CAB.P.-(ZONE 4) PTW NO.1	2.1	61	299.7	302.9	3.2	301.7	304.9	3.2
0523	SH.ASP.C.-(ZONE 5) PTW NO.1	1.8	61	300.4	310.0	8.6	302.1	311.7	8.6
0368	P.Q.C.-RUNWAY STRIP NO.2 (25+30-34+36)	3.9	611	301.7	301.9	0.2	306.5	306.7	0.2
0411	SH.ST.-(ZONE 2) PTW NO.1	2.5	71	301.9	302.0	0.1	304.3	304.4	0.1
0715	PVC CAB.P.-(ZONE 3) PTW NO.1	5.7	61	301.9	306.0	3.1	308.5	311.6	3.1
0519	SH.ASP.C.-(ZONE 4) PTW NO.1	2.4	61	302.2	311.8	8.6	304.5	315.1	8.6
0837	MULT.CAB.P.-LINK NO.11 NORTH SIDE	0.8	61	302.9	303.4	0.5	303.6	304.1	0.5
0838	MULT.CAB.P.-PTW NO.1 EAST (BTW.LINK.NO.11&6)	1.4	61	303.7	304.2	0.5	306.0	306.5	0.5
0430	SH.ST.-(ZONE 7) PTW NO.1	6.5	71	304.4	304.5	0.1	310.8	310.9	0.1
0839	MULT.CAB.P.-LINK NO.6 NORTH & NORTH-EAST	1.9	61	306.1	306.5	0.5	307.9	308.4	0.5
0369	P.Q.C.-RUNWAY STRIP NO.5	13.0	611	306.7	306.9	0.2	321.6	321.8	0.2
0801	MULT.CAB.P.-RUNWAY WEST SIDE (19+50-34+36)	7.1	61	308.0	308.5	0.5	316.0	316.5	0.5
0515	SH.ASP.C.-(ZONE 3) PTW NO.1	4.4	61	308.6	315.2	5.6	313.9	320.5	5.6
0711	PVC CAB.P.-(ZONE 2) PTW NO.1	2.1	61	308.6	311.7	3.1	310.6	314.7	3.1

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY		FINISH LATE	FIN FLOAT
0908	LAY TOP SOIL-ZONE 2	6.0	61	308.6	315.2	5.6	315.5		322.1	5.6
0434	SH.ST.-(ZONE 8) PTW NO.1	2.0	71	310.9	311.0	0.1	312.8		312.9	0.1
0730	PVC CAB.P.-(ZONE 7) PTW NO.1	5.5	61	310.9	314.8	2.9	317.3		321.2	2.9
0435	SH.ST.-(ZONE 8) LINK NO.11	1.5	71	312.9	313.0	0.1	314.3		314.4	0.1
0511	SH.ASP.C.-(ZONE 2) PTW NO.1	1.6	61	314.0	320.6	5.6	315.5		322.1	5.6
0436	SH.ST.-(ZONE 8) PTW NO.2	2.0	71	314.4	314.5	0.1	316.3		316.4	0.1
0909	LAY TOP SOIL-ZONE 3	12.0	61	315.6	322.2	5.6	329.5		337.1	5.6
0800	MULT.CAB.P.-RUNWAY WEST SIDE (04+36-19+50)	6.4	61	316.1	316.6	0.5	323.4	S4	323.9	0.5
0433	SH.ST.-(ZONE 8) LINK NO.10	1.5	71	316.4	316.5	0.1	317.8		317.9	0.1
0530	SH.ASP.C.-(ZONE 7) PTW NO.1	3.4	61	317.4	332.5	13.1	321.7		337.8	13.1
0734	PVC CAB.P.-(ZONE 8) PTW NO.1	1.7	61	317.4	321.3	2.9	320.0		322.9	2.9
0431	SH.ST.-(ZONE 7) LINK NO.10	1.5	71	317.9	318.0	0.1	319.3		319.4	0.1
0432	SH.ST.-(ZONE 7) PTW NO.2	6.5	71	319.4	319.5	0.1	325.8		325.9	0.1
0735	PVC CAB.P.-(ZONE 8) LINK NO.11	1.2	61	320.1	323.0	2.9	321.2		324.1	2.9
0736	PVC CAB.P.-(ZONE 8) PTW NO.2	1.7	61	321.3	324.2	2.9	322.9		325.8	2.9
0364	P.Q.C.-RUNWAY STRIP NO.3 (34+36-04+36)	13.0	611	321.8	322.0	0.2	337.7	S4	337.9	0.2
0534	SH.ASP.C.-(ZONE 8) PTW NO.1	1.1	61	321.8	337.9	13.1	322.8		338.9	13.1
0535	SH.ASP.C.-(ZONE 8) LINK NO.11	1.1	61	322.9	339.0	13.1	323.9		341.0	13.1
0733	PVC CAB.P.-(ZONE 8) LINK NO.10	1.2	61	323.0	325.9	2.9	324.1		328.0	2.9
0536	SH.ASP.C.-(ZONE 8) PTW NO.2	1.1	61	324.0	341.1	13.1	325.0		342.1	13.1
0731	PVC CAB.P.-(ZONE 7) LINK NO.10	1.2	61	324.2	328.1	2.9	325.3		329.2	2.9
0533	SH.ASP.C.-(ZONE 8) LINK NO.10	1.1	61	325.1	342.2	13.1	327.1		343.2	13.1
0429	SH.ST.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.5	71	325.9	326.0	0.1	327.3		327.4	0.1

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0732	PVC CAB.P.-(ZONE 7) PTW NO.2	5.5	61	325.9	329.3	2.4	332.3	336.7	2.4
0531	SH.ASP.C.-(ZONE 7) LINK NO.10	1.1	61	327.2	343.3	13.1	328.2	344.3	13.1
0426	SH.ST.-(ZONE 6) PTW NO.1	2.2	71	327.4	327.5	0.1	329.5	329.6	0.1
0425	SH.ST.-(ZONE 6) LINK NO.9	1.4	71	329.6	329.7	0.1	330.9	331.0	0.1
0910	LAY TOP SOIL-ZONE 4	5.0	61	329.6	337.2	5.6	336.5	343.1	5.6
0428	SH.ST.-(ZONE 6) PTW NO.2	1.7	71	331.0	331.1	0.1	332.6	332.7	0.1
0532	SH.ASP.C.-(ZONE 7) PTW NO.2	3.4	61	332.4	344.4	9.0	337.7	348.7	9.0
0729	PVC CAB.P.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.2	61	332.4	336.8	2.4	335.5	337.9	2.4
0427	SH.ST.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	1.5	71	332.7	332.8	0.1	335.1	335.2	0.1
0440	SH.ST.-PTW NO.2 EAST (10+80-FUEL F.AREA)	1.8	71	335.2	335.3	0.1	336.9	337.0	0.1
0726	PVC CAB.P.-(ZONE 6) PTW NO.1	1.9	61	335.6	338.0	2.4	337.4	339.8	2.4
0911	LAY TOP SOIL-ZONE 5	10.0	61	336.6	343.2	5.6	348.5	355.1	5.6
0441	SH.ST.-PTW NO.2 EAST (FUEL FARM AREA)	0.9	71	337.0	337.1	0.1	337.8	337.9	0.1
0725	PVC CAB.P.-(ZONE 6) LINK NO.9	1.2	61	337.5	339.9	2.4	338.6	342.0	2.4
0529	SH.ASP.C.-(ZONE 7) LINK NO.7 (FUEL F.AREA)	1.1	61	337.8	348.8	9.0	338.8	349.8	9.0
0442	SH.ST.-PTW NO.2 EAST (FUEL F.AREA-28+23)	10.0	71	337.9	338.0	0.1	347.8	347.9	0.1
0728	PVC CAB.P.-(ZONE 6) PTW NO.2	1.4	61	338.7	342.1	2.4	341.0	343.4	2.4
0526	SH.ASP.C.-(ZONE 6) PTW NO.1	1.5	61	338.9	349.9	9.0	341.3	351.3	9.0
0727	PVC CAB.P.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	1.2	61	341.1	343.5	2.4	342.2	344.6	2.4
0525	SH.ASP.C.-(ZONE 6) LINK NO.9	1.0	61	341.4	351.4	9.0	342.3	352.3	9.0
0740	PVC CAB.P.-PTW NO.2 EAST (10+80-FUEL F.AREA)	1.5	61	342.3	344.7	2.4	343.7	346.1	2.4
0528	SH.ASP.C.-(ZONE 6) PTW NO.2	1.1	61	342.4	352.4	9.0	343.4	353.4	9.0
0527	SH.ASP.C.-(ZONE 6) LINK NO.7 (FUEL F.AREA)	1.1	61	343.5	353.5	9.0	344.5	355.5	9.0

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0741	PVC CAB.P.-PTW NO.2 EAST(FUEL FARM AREA)	0.8	61	343.8	346.2	2.4	344.5	346.9	2.4
0540	SH.ASP.C.-PTW NO.2 EAST (10+80-FUEL F.AREA)	1.7	61	344.6	355.6	9.0	346.2	357.2	9.0
0541	SH.ASP.C.-PTW NO.2 EAST (FUEL FARM AREA)	0.5	61	346.3	357.3	9.0	346.7	357.7	9.0
0437	SH.ST.-LINK NO 11 NORTH SIDE	1.4	71	347.9	350.2	2.3	349.2	351.5	2.3
0742	PVC CAB.P.-PTW NO.2 EAST(FUEL F.AREA-28+23)	8.8	61	348.0	348.0	0.0	357.7	357.7	0.0
0438	SH.ST.-PTW NO.1 EAST SIDE (BTW LINK.NO.11&6)	2.4	71	349.3	351.6	2.3	351.6	353.9	2.3
0439	SH.ST.-LINK NO.6 NORTH & NORTH-EAST SIDES	3.4	71	351.7	354.0	2.3	355.0	357.3	2.3
0401	SH.ST.-RUNWAY WEST SIDE (19+50-34+36)	12.4	71	355.1	357.4	2.3	367.4	369.7	2.3
0906	LAY TOP SOIL-PTW NO.1 EAST & LIN.6 N.& N-E	14.0	61	355.2	355.2	0.0	371.1	371.1	0.0
0542	SH.ASP.C.-PTW NO.2 EAST (FUEL F.AREA-28+23)	6.9	61	357.8	357.8	0.0	365.6	365.6	0.0
0737	PVC CAB.P.-LINK NO.11 NORTH SIDE	1.2	61	357.8	362.2	3.4	358.9	363.3	3.4
0738	PVC CAB.P.-PTW NO.1 EAST (BTW.LINKS NO.11&6)	2.0	61	359.0	363.4	3.4	360.9	365.3	3.4
0739	PVC CAB.P.-LINK NO.6 NORTH & NORTH-EAST	2.9	61	362.0	365.4	3.4	364.8	369.2	3.4
0537	SH.ASP.C.-LINK NO.11 NORTH SIDE	1.1	61	365.7	365.7	0.0	366.7	366.7	0.0
0538	SH.ASP.C.-PTW NO.1 EAST SIDE (BTW.L.NO.11&6)	1.5	61	366.8	366.8	0.0	369.2	369.2	0.0
0400	SH.ST.-RUNWAY WEST SIDE (04+36-19+50)	11.1	71	367.5	370.3	2.8	378.5	381.3	2.8
0701	PVC CAB.P.-RUNWAY WEST SIDE (19+50-34+36)	10.6	61	367.5	369.8	1.3	380.0	381.3	1.3
0539	SH.ASP.C.-LINK NO.6 NORTH & NORTH-EAST SIDES	1.9	61	369.3	369.3	0.0	371.1	371.1	0.0
0914	LAY TOP SOIL-ZONE 8	3.0	61	371.2	371.2	0.0	374.1	374.1	0.0
0913	LAY TOP SOIL-ZONE 7	10.0	61	374.2	374.2	0.0	386.1	386.1	0.0
0501	SH.ASP.C.-RUNWAY WEST SIDE (19+50+34+36)	7.7	61	380.1	384.0	2.9	388.7	392.6	2.9
0700	PVC CAB.P.-RUNWAY WEST SIDE (04+36-19+50)	9.6	61	380.1	381.4	1.3	391.6 S4	392.9	1.3
0912	LAY TOP SOIL-ZONE 6	4.0	61	386.2	386.2	0.0	391.1	391.1	0.0

WI	DESCRIPTION	TOT DURAT	CAL	START EARLY	START LATE	START FLOAT	FINISH EARLY	FINISH LATE	FIN FLOAT
0905	LAY TOP SOIL-PTW NO.2 EAST & LIN.NO.11 NORTH	16.0	61	391.2	391.2	0.0	412.1	412.1	0.0
0500	SH.ASP.C.-RUNWAY WEST SIDE (04+36-19+50)	7.3	61	391.7	392.7	1.0	401.9 S4	402.9	1.0
0900	LAY.TOP SOIL-RUNWAY WEST SIDE (04+36-19+50)	15.0	61	412.2	412.2	0.0	432.1	432.1	0.0
0901	LAY.TOP SOIL-RUNWAY WEST SIDE (19+50-34+36)	16.0	61	432.2	432.2	0.0	450.1	450.1	0.0
1000	PROJECT END	0.0	71	450.1	450.1	0.0	450.1	450.1	0.0

PROJECT BASE DATE 1.0 PROJECT DURATION 449.2 PROJECT COMPLETION DATE 450.1

IBM
PROJECT CONTROL SYSTEM

CALENDAR REPORT

YESILKOY AIRFIELD INFRASTRUCTURE PROJECT (1111)

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
-3 27SEP70	-2 28SEP70	-1 29SEP70	0 30SEP70	1 1OCT70	2 2OCT70	3 3OCT70
4 4OCT70	5 5OCT70	6 6OCT70	7 7OCT70	8 8OCT70	9 9OCT70	10 10OCT70
11 11OCT70	12 12OCT70	13 13OCT70	14 14OCT70	15 15OCT70	16 16OCT70	17 17OCT70
18 18OCT70	19 19OCT70	20 20OCT70	21 21OCT70	22 22OCT70	23 23OCT70	24 24OCT70
25 25OCT70	26 26OCT70	27 27OCT70	28 28OCT70	H 29 29OCT70	H 30 30OCT70	31 31OCT70
32 1NOV70	33 2NOV70	34 3NOV70	35 4NOV70	36 5NOV70	37 6NOV70	38 7NOV70
39 8NOV70	40 9NOV70	41 10NOV70	42 11NOV70	43 12NOV70	44 13NOV70	45 14NOV70
46 15NOV70	47 16NOV70	48 17NOV70	49 18NOV70	50 19NOV70	51 20NOV70	52 21NOV70
53 22NOV70	54 23NOV70	55 24NOV70	56 25NOV70	57 26NOV70	58 27NOV70	59 28NOV70
60 29NOV70	61 30NOV70	62 1DEC70	63 2DEC70	64 3DEC70	65 4DEC70	66 5DEC70
67 6DEC70	68 7DEC70	69 8DEC70	70 9DEC70	71 10DEC70	72 11DEC70	73 12DEC70
74 13DEC70	75 14DEC70	76 NW 15DEC70	77 NW 16DEC70	78 NW 17DEC70	79 NW 18DEC70	80 NW 19DEC70
81 NW 20DEC70	82 NW 21DEC70	83 NW 22DEC70	84 NW 23DEC70	85 NW 24DEC70	86 NW 25DEC70	87 NW 26DEC70
88 NW 27DEC70	89 NW 28DEC70	90 NW 29DEC70	91 NW 30DEC70	92 NW 31DEC70	H 93 NW 1JAN71	94 NW 2JAN71

95 NW 3JAN71	96 NW 4JAN71	97 NW 5JAN71	98 NW 6JAN71	99 NW 7JAN71	100 NW 8JAN71	101 NW 9JAN71
102 NW 10JAN71	103 NW 11JAN71	104 NW 12JAN71	105 NW 13JAN71	106 NW 14JAN71	107 NW 15JAN71	108 NW 16JAN71
109 NW 17JAN71	110 NW 18JAN71	111 NW 19JAN71	112 NW 20JAN71	113 NW 21JAN71	114 NW 22JAN71	115 NW 23JAN71
116 NW 24JAN71	117 NW 25JAN71	118 NW 26JAN71	119 NW 27JAN71	120 NW 28JAN71	121 NW 29JAN71	122 NW 30JAN71
123 NW 31JAN71	124 NW 1FEB71	125 NW 2FEB71	126 NW 3FEB71	127 NW 4FEB71	128 NW 5FEB71	H 129 NW 6FEB71
130 NW 7FEB71	H 131 NW 8FEB71	H 132 NW 9FEB71	133 NW 10FEB71	134 NW 11FEB71	135 NW 12FEB71	136 NW 13FEB71
137 NW 14FEB71	138 NW 15FEB71	139 NW 16FEB71	140 NW 17FEB71	141 NW 18FEB71	142 NW 19FEB71	143 NW 20FEB71
144 NW 21FEB71	145 NW 22FEB71	146 NW 23FEB71	147 NW 24FEB71	148 NW 25FEB71	149 NW 26FEB71	150 NW 27FEB71
151 NW 28FEB71	152 NW 1MAR71	153 NW 2MAR71	154 NW 3MAR71	155 NW 4MAR71	156 NW 5MAR71	157 NW 6MAR71
158 NW 7MAR71	159 NW 8MAR71	160 NW 9MAR71	161 NW 10MAR71	162 NW 11MAR71	163 NW 12MAR71	164 NW 13MAR71
165 NW 14MAR71	166 NW 15MAR71	167 NW 16MAR71	168 NW 17MAR71	169 NW 18MAR71	170 NW 19MAR71	171 NW 20MAR71
172 NW 21MAR71	173 NW 22MAR71	174 NW 23MAR71	175 NW 24MAR71	176 NW 25MAR71	177 NW 26MAR71	178 NW 27MAR71
179 NW 28MAR71	180 NW 29MAR71	181 NW 30MAR71	182 NW 31MAR71	183 NW 1APR71	184 NW 2APR71	185 NW 3APR71
186 NW 4APR71	187 NW 5APR71	188 NW 6APR71	189 NW 7APR71	190 NW 8APR71	191 NW 9APR71	192 NW 10APR71
193 NW 11APR71	194 NW 12APR71	195 NW 13APR71	196 NW 14APR71	197 NW 15APR71	198 16APR71	199 17APR71
200 18APR71	201 19APR71	202 20APR71	203 21APR71	204 22APR71	H 205 23APR71	206 24APR71
207 25APR71	208 26APR71	209 27APR71	210 28APR71	211 29APR71	212 30APR71	H 213 1MAY71
214 2MAY71	215 3MAY71	216 4MAY71	217 5MAY71	218 6MAY71	219 7MAY71	220 8MAY71

221 9MAY71	222 10MAY71	223 11MAY71	224 12MAY71	225 13MAY71	226 14MAY71	227 15MAY71
228 16MAY71	229 17MAY71	230 18MAY71	H 231 19MAY71	232 20MAY71	233 21MAY71	234 22MAY71
235 23MAY71	236 24MAY71	237 25MAY71	238 26MAY71	H 239 27MAY71	240 28MAY71	241 29MAY71
242 30MAY71	243 31MAY71	244 1JUN71	245 2JUN71	246 3JUN71	247 4JUN71	248 5JUN71
249 6JUN71	250 7JUN71	251 8JUN71	252 9JUN71	253 10JUN71	254 11JUN71	255 12JUN71
256 13JUN71	257 14JUN71	258 15JUN71	259 16JUN71	260 17JUN71	261 18JUN71	262 19JUN71
263 20JUN71	264 21JUN71	265 22JUN71	266 23JUN71	267 24JUN71	268 25JUN71	269 26JUN71
270 27JUN71	271 28JUN71	272 29JUN71	273 30JUN71	274 1JUL71	275 2JUL71	276 3JUL71
277 4JUL71	278 5JUL71	279 6JUL71	280 7JUL71	281 8JUL71	282 9JUL71	283 10JUL71
284 11JUL71	285 12JUL71	286 13JUL71	287 14JUL71	288 15JUL71	289 16JUL71	290 17JUL71
291 18JUL71	292 19JUL71	293 20JUL71	294 21JUL71	295 22JUL71	296 23JUL71	297 24JUL71
298 25JUL71	299 26JUL71	300 27JUL71	301 28JUL71	302 29JUL71	303 30JUL71	304 31JUL71
305 1AUG71	306 2AUG71	307 3AUG71	308 4AUG71	309 5AUG71	310 6AUG71	311 7AUG71
312 8AUG71	313 9AUG71	314 10AUG71	315 11AUG71	316 12AUG71	317 13AUG71	318 14AUG71
319 15AUG71	320 16AUG71	321 17AUG71	322 18AUG71	323 19AUG71	324 20AUG71	325 21AUG71
326 22AUG71	327 23AUG71	328 24AUG71	329 25AUG71	330 26AUG71	331 27AUG71	332 28AUG71
333 29AUG71	H 334 30AUG71	335 31AUG71	336 1SEP71	337 2SEP71	338 3SEP71	339 4SEP71
340 5SEP71	341 6SEP71	342 7SEP71	343 8SEP71	344 9SEP71	345 10SEP71	346 11SEP71

347 12SEP71	348 13SEP71	349 14SEP71	350 15SEP71	351 16SEP71	352 17SEP71	353 18SEP71
354 19SEP71	355 20SEP71	356 21SEP71	357 22SEP71	358 23SEP71	359 24SEP71	360 25SEP71
361 26SEP71	362 27SEP71	363 28SEP71	364 29SEP71	365 30SEP71	366 1OCT71	367 2OCT71
368 3OCT71	369 4OCT71	370 5OCT71	371 6OCT71	372 7OCT71	373 8OCT71	374 9OCT71
375 10OCT71	376 11OCT71	377 12OCT71	378 13OCT71	379 14OCT71	380 15OCT71	381 16OCT71
382 17OCT71	383 18OCT71	384 19OCT71	385 20OCT71	386 21OCT71	387 22OCT71	388 23OCT71
389 24OCT71	390 25OCT71	391 26OCT71	392 27OCT71	393 28OCT71	H 394 29OCT71	H 395 30OCT71
396 31OCT71	397 1NOV71	398 2NOV71	399 3NOV71	400 4NOV71	401 5NOV71	402 6NOV71
403 7NOV71	404 8NOV71	405 9NOV71	406 10NOV71	407 11NOV71	408 12NOV71	409 13NOV71
410 14NOV71	411 15NOV71	412 16NOV71	413 17NOV71	414 18NOV71	415 19NOV71	H 416 20NOV71
H 417 21NOV71	H 418 22NOV71	419 23NOV71	420 24NOV71	421 25NOV71	422 26NOV71	423 27NOV71
424 28NOV71	425 29NOV71	426 30NOV71	427 1DEC71	428 2DEC71	429 3DEC71	430 4DEC71
431 5DEC71	432 6DEC71	433 7DEC71	434 8DEC71	435 9DEC71	436 10DEC71	437 11DEC71
438 12DEC71	439 13DEC71	440 14DEC71	441 15DEC71	442 16DEC71	443 17DEC71	444 18DEC71
445 19DEC71	446 20DEC71	447 21DEC71	448 22DEC71	449 23DEC71	450 24DEC71	451 25DEC71

END OF REPORT

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                                        IBM PROJECT CONTROL SYSTEM
RUN DATE   1 OCT 70          * *              B A R    G R A P H                     * *          DATA DATE   1 OCT 70
RUN SEQUENCE 0     NETWORK ID 1111       YESILKOY AIRFIELD INFRASTRUCTURE PROJECT            FROM  1 OCT 70 TO 24 DEC 71
SEQUENCE   E S                    ORGANIZATION                                                    PAGE  1 PART  1
        *  DURATION,  X  CRITICAL DURATION,  -  FLOAT,  N  NEGATIVE FLOAT
------------------------------------------------------------------------------------------------------------------------
                                                              MTWTFSS         MTWTFSS         MTWTFSS         MTWTFSS
   W I   D E S C R I P T I O N                   WORK ITEM  MTWTFSS         MTWTFSS         MTWTFSS         MTWTFSS
                                                            28SEP70         12OCT70         26OCT70          9NOV70
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PROJECT START                                      0001     I       I       I       I       I       I       I       I       I
EARTH MOVING-UNDER AREA TO BE PAVED IN N&E         0100     I  XXX XXXXXX  I       I       I       I       I       I       I
BORROW & FILL SELECTED MTL.-OUT.FUEL F.AREA        0110     I  XXX XXXXXX XXXXXX XXXXX    I       I       I       I       I
L.C.-FTO NO.4                                      0207     I  XXX XXXX    I       I       I       I       I       I       I
P.Q.C.-LINK NO.1 SOUTH-WEST STRIP                  0303     I  *-   I       I       I       I       I       I       I       I
DRAINAGE-LINK NO.8 BOTH SIDES                      0602     I  *--  I       I       I       I       I       I       I       I
P.Q.C.-(ZONE 1) LINK NO.1                          0304     I  *** --      I       I       I       I       I       I       I
DRAINAGE-PTW NO.1 EAST & LINK NO.9 SOUTH           0624     I   ** ****** --       I       I       I       I       I       I
P.Q.C.-(ZONE 1) RUNWAY                             0305     I       **--    I       I       I       I       I       I       I
P.Q.C.-(ZONE 1) FTO NO.2                           0306     I       I ***-  I       I       I       I       I       I       I
L.C.-FTO NO.5                                      0208     I       I  XXX XXXX    I       I       I       I       I       I
P.Q.C.-(ZONE 2) FTO NO.2                           0308     I       I    ** **-    I       I       I       I       I       I
MULT.CAB.P.-LINK NO.1 SOUTH WEST SIDE              0803     I       I    ** ------ ------ --- - ------ ------ ------ I
MULT.CAB.P.-LINK NO.8 BOTH SIDES                   0802     I       I     * ***---- ------ --- - ------ ------ ------ I
EARTH MOVING-OUT.THE AREA TO BE PAVED IN N&F       0101     I       I      XXXXXX XXXXXX XXX  X XXXXX  I       I       I
DRAINAGE-(ZONE 1) RUNWAY                           0605     I       I      *--     I       I       I       I       I       I
DRAINAGE-(ZONE 2) FTO NO.2                         0608     I       I      I***--  I       I       I       I       I       I
P.Q.C.-(ZONE 2) RUNWAY                             0309     I       I      I**-    I       I       I       I       I       I
MULT.CAB.P.-PTW NO.1 EAST & LINK NO.9 SOUTH        0824     I       I      I **** ------ --- - ------ ------ ------ I
P.Q.C.-(ZONE 2) FTO NO.3                           0310     I       I      I ***- I       I       I       I       I       I
L.C.-FROM PTW NO.1(24+60) TO END OF LIN.NO.6       0201     I       I      I   XX XXXXXX XXX  X XX      I       I       I
DRAINAGE-(ZONE 2) RUNWAY                           0609     I       I      I   ** --      I       I       I       I       I
P.Q.C.-(ZONE 3) FTO NO.3                           0312     I       I      I   ** **--    I       I       I       I       I
MULT.CAB.P.-(ZONE 1) PTW NO.1                      0807     I       I      I    * **---- --- - ------ ------ ------ I
DRAINAGE-(ZONE 2) FTO NO.3                         0610     I       I      I      *--   -I       I       I       I       I
DRAINAGE-(ZONE 3) FTO NO.3                         0612     I       I      I      I**--  I       I       I       I       I
P.Q.C.-(ZONE 3) RUNWAY                             0313     I       I      I      I**-   I       I       I       I       I
MULT.CAB.P.-(ZONE 1) LINK NO.1                     0804     I       I      I      I **-- --- - ------ ------ ------ I
P.Q.C.-(ZONE 3) FTO NO.4                           0314     I       I      I      I **** --      I       I       I       I
DRAINAGE-(ZONE 3) RUNWAY                           0613     I       I      I      I  *** --      I       I       I       I
MULT.CAB.P.-(ZONE 1) RJNWAY                        0805     I       I      I      I   ** **- - ------ ------ ------ I
P.Q.C.-(ZONE 4) FTO NO.4                           0316     I       I      I      I      **-  - I       I       I       I
DRAINAGE-(ZONE 3) FTO NO.4                         0614     I       I      I      I      ***  * --      I       I       I
MULT.CAB.P.-(ZONE 1) FTO NO.2                      0806     I       I      I      I      I**  - ------ ------ ------ I
P.Q.C.-(ZONE 4) RUNWAY                             0317     I       I      I      I      I *  - -       I       I       I
P.Q.C.-(ZONE 4) FTO NO.5                           0318     I       I      I      I      I *  * ***-    I       I       I
MULT.CAB.P.-(ZONE 2) FTO NO.2                      0808     I       I      I      I      I    * **---- ------ ------ I
DRAINAGE-(ZONE 4) FTO NO.4                         0616     I       I      I      I      I      ***-- I       I       I
L.C.-LINK NO.11                                    0206     I       I      I      I      I      I***** -       I       I
MULT.CAB.P.-(ZONE 2) RUNWAY                        0809     I       I      I      I      I      I**--- ------ ------ I
P.Q.C.-(ZONE 5) FTO NO.5                           0320     I       I      I      I      I      I ***- I       I       I
MULT.CAB.P.-(ZONE 2) FTO NO.3                      0810     I       I      I      I      I      I ***- ------ ------ I
DRAINAGE-(ZONE 4) RUNWAY                           0617     I       I      I      I      I      I  **- -       I       I
P.Q.C.-(ZONE 5) RUNWAY                             0321     I       I      I      I      I      I   ** *-      I       I
MULT.CAB.P.-(ZONE 3) FTO NO.3                      0812     I       I      I      I      I      I   ** **---- ------ I
EARTH MOVING-FUEL FARM AREA                        0102     I       I      I      I      I      I    * ****** ------ I
DRAINAGE-(ZONE 4) FTO NO.5                         0618     I       I      I      I      I      I    * **--   I       I
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IBM PROJECT CONTROL SYSTEM

RUN DATE 1 OCT 70 * * PRECEDENCE REPORT * * DATA DATE 1 OCT 70

RUN SEQUENCE 0 NETWORK ID 1111 YES. LKOY AIRFIELD INFRASTRUCTURE PROJECT FROM 1 OCT 70 TO 24 DEC 71

SEQUENCE W I PAGE 1

W	WORK ITEM DESCRIPTION	PRECEDING WORK ITEM	R F	LAG VALUE	P W I START DATE	ELAPSED TIME	P W I FINISH DATE	FLOAT
0001	PROJECT START	*** NONE ***						
0100	EARTH MOVING-UNDER AREA TO BE PAVED IN N&F	0001		.0	1OCT70	.0	1OCT70	.0
0101	EARTH MOVING-OUT.THE AREA TO BE PAVED IN N&E	0100		.0	1OCT70	9.0	10OCT70	.0
0102	EARTH MOVING-FUEL FARM AREA	0001		.0	1OCT70	.0	1OCT70	.0
		0101		.0	12OCT70	21.0	6NOV70	.0
0110	BORROW & FILL SELECTED MTL.-OUT.FUEL F.AREA	0001		.0	1OCT70	.0	1OCT70	.0
		0100	F	3.0	1OCT70	9.0	10OCT70	.0
0111	BORROW & FILL SELECTED MTL.-FUEL FARM AREA	0102		.0	7NOV70	7.0	5MAY71	141.0
		0110		.0	1OCT70	20.0	23OCT70	.0
0201	L.C.-FROM PTW NO.1(24+60) TO END OF LIN.NO.6	0110	S	13.0	1OCT70	20.0	23OCT70	.0
		0208		.0	8OCT70	6.5	15OCT70	.0
0203	L.C.-PTW NO.2 (FUEL FARM AREA)	0111		.0	16NOV70	6.0	12MAY71	141.0
		0210		.0	23NOV70	5.0	20MAY71	141.6
0205	L.C.-LINK NO.10	0110	S	19.0	1OCT70	20.0	23OCT70	.0
		0206		.0	3NOV70	4.1	9NOV70	1.4
0206	L.C.-LINK NO.11	0110	S	15.0	1OCT70	20.0	23OCT70	.0
		0201		.0	16OCT70	13.5	3NOV70	.0
0207	L.C.-FTO NO.4	0001		.0	1OCT70	.0	1OCT70	.0
0208	L.C.-FTO NO.5	0001		.0	1OCT70	.0	1OCT70	.0
		0207		.0	1OCT70	6.5	8OCT70	.0
0209	L.C.-PTW NO.1 (FUEL FARM AREA)	0111		.0	16NOV70	6.0	12MAY71	141.0
		0203		.0	28NOV70	1.4	21MAY71	141.6

IBM PROJECT CONTROL SYSTEM

RUN DATE 1 OCT 70 * * PRECEDENCE REPORT * * DATA DATE 1 OCT 70

RUN SEQUENCE 0 NETWORK ID 1111 YESILKOY AIRFIELD INFRASTRUCTURE PROJECT FROM 1 OCT 70 TO 24 DEC 71

SEQUENCE W I PAGE 2

WI	WORK ITEM DESCRIPTION	PRECEDING WORK ITEM	R F	LAG VALUE	P W I START DATE	ELAPSED TIME	P W I FINISH DATE	FLOAT
0210	L.C.-LINK NO.7 (FUEL FARM AREA)	0111		.0	16NOV70	6.0	12MAY71	141.0
0300	P.Q.C.-RUNWAY STRIP NO.6 (04+36-19+50)	0001		.0	1OCT70	.0	1OCT70	.0
		0301		.0	20MAY71	6.6	29MAY71	.1
0301	P.Q.C.-RUNWAY STRIP NO.6 (19+50-34+36)	0001		.0	1OCT70	.0	1OCT70	.0
		0339		.0	17MAY71	2.0	20MAY71	.1
0303	P.Q.C.-LINK NO.1 SOUTH-WEST STRIP	0001		.0	1OCT70	.0	1OCT70	.0
0304	P.Q.C.-(ZONE 1) LINK NO.1	0001		.0	1OCT70	.0	1OCT70	.0
		0303		.1	1OCT70	.7	2OCT70	1.2
0305	P.Q.C.-(ZONE 1) RUNWAY	0001		.0	1OCT70	.0	1OCT70	.0
		0304		.2	1OCT70	2.1	6OCT70	1.2
0306	P.Q.C.-(ZONE 1) FTO NO.2	0001		.0	1OCT70	.0	1OCT70	.0
		0305		.1	5OCT70	2.0	8OCT70	1.3
0308	P.Q.C.-(ZONE 2) FTO NO.2	0001		.0	1OCT70	.0	1OCT70	.0
		0306		.1	7OCT70	2.0	10OCT70	1.3
0309	P.Q.C.-(ZONE 2) RUNWAY	0001		.0	1OCT70	.0	1OCT70	.0
		0308		.0	9OCT70	3.3	14OCT70	1.3
0310	P.Q.C.-(ZONE 2) FTO NO.3	0001		.0	1OCT70	.0	1OCT70	.0
		0309		.1	13OCT70	.8	15OCT70	1.3
0312	P.Q.C.-(ZONE 3) FTO NO.3	0001		.0	1OCT70	.0	1OCT70	.0
		0310		.1	14OCT70	2.0	17OCT70	1.3
0313	P.Q.C.-(ZONE 3) RUNWAY	0001		.0	1OCT70	.0	1OCT70	.0
		0312		.0	16OCT70	3.3	22OCT70	1.3

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	FS - J	EE - J	LS - J	LE - J	GF-J	FF-J
0	N		1	PROJECT START	0	0	0	0	0	0	0
1	N		100	E.MOVING-UNDER PAVEMENTS (N&E)	9	0	9	9	18	9	0
100	N		101	E.MOVING-OUT.PAVEMENTS (N&E)	21	9	30	81	102	72	0
1	N		102	E.MOVING-FJEL FARM AREA	7	30	37	102	109	72	0
101	N		102								
100	E-E	3	110	BORROW & FILL S.MTL-OUT.F.F.A.	20	0	20	1	21	1	1
110	N		111	BORROW & FILL S.MTL-F.F.A.	6	37	43	109	115	72	0
102	N		111								
208	N		201	LC-PTW 1(24+60) TO END OF L.6	14	14	28	14	28	0	0
110	S-S	13	201								
210	N		203	LC-PTW 2(FUEL FARM AREA)	2	48	50	120	122	72	0
111	N		203								
206	N		205	LC-L.10	5	32	37	56	61	24	24
110	S-S	19	205								
201	N		206	LC-L.11	4	28	32	52	56	24	0
110	S-S	15	206								
1	N		207	LC-FTO 4	7	0	7	0	7	0	0
207	N		208	LC-FTO 5	7	7	14	7	14	0	0
1	N		208								
203	N		209	LC-PTW 1(FJEL FARM AREA)	5	50	55	122	127	72	71
111	N		209								
111	N		210	LC-L.7 (FJEL FARM AREA)	5	43	48	115	120	72	0
301	N		300	PQC-RW STP.6 (04+36-19+50)	6	99	105	99	105	0	0
1	N		300								
339	N		301	PQC-RW STP.6 (19+50-34+36)	7	92	99	92	99	0	0
1	N		301								
1	N		303	PQC-L.1 SOUTH-WEST STP.	1	0	1	5	6	5	0
303	N		304	PQC-(ZONE 1) L.1	2	1	3	6	8	5	0
1	N		304								
304	N		305	PQC-(ZONE 1) RW	2	3	5	8	10	5	0
1	N		305								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
305 1	N N		306 306	PQC-(ZONE 1) FTO 2	2	5	7	10	12	5	0
306 1	N N		308 308	PQC-(ZONE 2) FTO 2	3	7	10	12	15	5	0
308 1	N N		309 309	PQC-(ZONE 2) RW	1	10	11	15	16	5	0
309 1	N N		310 310	PQC-(ZONE 2) FTO 3	2	11	13	16	18	5	0
310 1	N N		312 312	PQC-(ZONE 3) FTO 3	3	13	16	18	21	5	0
312 1	N N		313 313	PQC-(ZONE 3) RW	1	16	17	21	22	5	0
313 207	N E-S	7	314 314	PQC-(ZONE 3) FTO-4	3	17	20	22	25	5	0
319 1	N N		315 315	PQC-(ZONE 3) PTW 1	4	41	45	41	45	0	0
314 207	N E-S	7	316 316	PQC-(ZONE 4) FTO 4	2	20	22	25	27	5	0
316 1	N N		317 317	PQC-(ZONE 4) RW	1	22	23	27	28	5	0
317 208	N E-S	7	318 318	PQC-(ZONE 4) FTO 5	3	23	26	28	31	5	0
323 201	N E-S	7	319 319	PQC-(ZONE 4) PTW 1	2	39	41	39	41	0	0
318 208	N E-S	7	320 320	PQC-(ZONE 5) FTO 5	2	26	28	31	33	5	0
320 1	N N		321 321	PQC-(ZONE 5) RW	-2	28	30	33	35	5	5
321 201	N E-S	7	322 322	PQC-(ZONE 5) L.6	2	35	37	35	37	0	0
322 201	N E-S	7	323 323	PQC-(ZONE 5) PTW 1	2	37	39	37	39	0	0
358 210	N E-S	7	327 327	PQC-(ZONE 6) L.7 (FUEL F.AREA)	2	135	137	136	138	1	0
332 1	N N		328 328	PQC-(ZONE 6) PTW 2	2	76	78	76	78	0	0

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
361	N		329	PQC-(ZONE 7) L.7 (FUEL F.AREA)	2	131	133	131	133	0	0
210	E-S	7	329								
345	N		330	PQC-(ZONE 7) PTW 1	4	58	62	58	62	0	0
1	N		330								
333	N		331	PQC-(ZONE 7) L.10	2	70	72	70	72	0	0
205	E-S	7	331								
331	N		332	PQC-(ZONE 7) PTW 2	4	72	76	72	76	0	0
1	N		332								
336	N		333	PQC-(ZONE 8) L.10	2	68	70	68	70	0	0
205	E-S	7	333								
330	N		334	PQC-(ZONE 8) PTW 1	2	62	64	62	64	0	0
201	E-S	7	334								
334	N		335	PQC-(ZONE 8) L.11	2	64	66	64	66	0	0
206	E-S	7	335								
335	N		336	PQC-(ZONE 8) PTW 2	2	66	68	66	68	0	0
1	N		336								
344	N		337	PQC-L.11 NORTH STP.	2	86	88	86	88	0	0
206	N		337								
337	N		338	PQC-PTW 1 EAST STP.(BTW L11&6)	2	88	90	88	90	0	0
201	E-S	7	338								
338	N		339	PQC-L.6 NORTH & N-EAST STP.	2	90	92	90	92	0	0
201	E-S	7	339								
328	N		340	PQC-PTW 2 EAST STP.(ZONE 6)	2	78	80	78	80	0	0
1	N		340								
340	N		343	PQC-PTW 2 EAST STP.(ZONE 7)	4	80	84	80	84	0	0
1	N		343								
343	N		344	PQC-PTW 2 EAST STP.(ZONE 8)	2	84	86	84	86	0	0
1	N		344								
367	N		345	PQC-FTD 2 INTERIOR STP.	2	56	58	56	58	0	0
308	E-S	5	345								
306	E-S	5	345								
315	N		346	PQC-FTD 3 INTERIOR STP.	2	45	47	45	47	0	0
312	E-S	5	346								
310	E-S	5	346								
346	N		347	PQC-FTD 4 INTERIOR STP.	2	47	49	47	49	0	0
314	E-S	5	347								
207	E-S	7	347								
316	E-S	5	347								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
347	N		348	PQC-FTO 5 INTERIOR STP.	2	49	51	49	51	0	0
320	E-S	5	348								
208	E-S	7	348								
318	E-S	5	348								
363	N		349	PQC-L.7 INTERIOR STP.(F.F.A.)	1	147	148	214	215	67	0
329	E-S	5	349								
210	E-S	7	349								
327	E-S	5	349								
353	N		350	PQC-L.10 INTERIOR STP.	1	143	144	210	211	67	0
331	E-S	5	350								
333	E-S	5	350								
205	E-S	7	350								
354	N		351	PQC-L.11 INTERIOR STP.	1	122	123	122	123	0	0
337	E-S	5	351								
206	E-S	7	351								
335	E-S	5	351								
327	N		352	PQC-PTW 1 INT.STP.(ZONE 3)	4	137	141	204	208	67	0
330	E-S	5	352								
315	E-S	5	352								
352	N		353	PQC-PTW 1 INT.STP.(ZONE 4)	2	141	143	208	210	67	0
319	E-S	5	353								
201	E-S	7	353								
334	E-S	5	353								
365	N		354	PQC-PTW 1 INT.STP.(ZONE 5)	2	120	122	120	122	0	0
323	E-S	5	354								
201	E-S	7	354								
338	E-S	5	354								
350	N		355	PQC-PTW 2 INT.STP.(ZONE 6)	2	144	146	211	213	67	0
328	E-S	5	355								
340	E-S	5	355								
357	N		356	PQC-PTW 2 INT.STP.(ZONE 7)	4	125	129	125	129	0	0
332	E-S	5	356								
343	E-S	5	356								
351	N		357	PQC-PTW 2 INT.STP.(ZONE 8)	2	123	125	123	125	0	0
336	E-S	5	357								
344	E-S	5	357								
359	N		358	PQC-PTW 1 WEST STP.(F.F.A.)	1	134	135	135	136	1	0
209	E-S	7	358								
329	N		359	PQC-PTW 1 EAST STP.(F.F.A.)	1	133	134	134	135	1	0
209	E-S	7	359								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
349	N		360	PQC-PTW 1 INT.STP.(F.F.A.)	1	148	149	215	216	67	0
359	E-S	5	360								
209	E-S	7	360								
358	E-S	5	360								
362	N		361	PQC-PTW 2 WEST STP.(F.F.A.)	1	130	131	130	131	0	0
203	E-S	7	361								
356	N		362	PQC-PTW 2 EAST STP.(F.F.A.)	1	129	130	129	130	0	0
203	E-S	7	362								
355	N		363	PQC-PTW 2 INT.STP.(F.F.A.)	1	146	147	213	214	67	0
361	E-S	5	363								
362	E-S	5	363								
203	E-S	7	363								
369	N		364	PQC-RW STP.3 (34+36-04+36)	13	170	183	237	250	67	67
1	N		364								
370	E-S	0	365	PQC-L.6 INTERIOR STP.	2	118	120	118	120	0	0
339	E-S	5	365								
322	E-S	5	365								
201	E-S	7	365								
360	N		366	PQC-RW STP.2 (04+36-13+00)	4	149	153	216	220	67	0
1	N		366								
348	N		367	PQC-RW STP.2 (13+00-25+30)	5	51	56	51	56	0	0
1	N		367								
366	N		368	PQC-RW STP.2 (25+30-34+36)	4	153	157	220	224	67	0
1	N		368								
368	N		369	PQC-RW STP.5	13	157	170	224	237	67	0
1	N		369								
300	N		370	PQC-RW STP.4	13	105	118	105	118	0	0
1	N		370								
401	N		400	SH.ST.-RW WEST (04+36-19+50)	11	185	196	206	217	21	0
800	N		400								
801	N		401	SH.ST.-RW WEST (19+50-34+36)	13	172	185	193	206	21	0
439	N		401								
403	N		402	SH.ST.-L.8 BOTH SIDES	5	13	18	33	38	20	0
802	N		402								
803	N		403	SH.ST.-L.1 SOUTH-WEST SIDE	1	10	11	32	33	22	0
407	N		404	SH.ST.-(ZONE 1) L.1	3	28	31	48	51	20	0
804	N		404								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
805	N		405	SH.ST.-(ZONE 1) RW	6	31	37	51	57	20	0
404	N		405								
405	N		406	SH.ST.-(ZONE 1) FTD 2	3	37	40	57	60	20	0
806	N		406								
424	N		407	SH.ST.-(ZONE 1) PTW 1	4	24	28	44	48	20	0
807	N		407								
406	N		408	SH.ST.-(ZONE 2) FTD 2	5	40	45	60	65	20	0
808	N		408								
408	N		409	SH.ST.-(ZONE 2) RW	2	45	47	65	67	20	0
809	N		409								
409	N		410	SH.ST.-(ZONE 2) FTD 3	3	47	50	67	70	20	0
810	N		410								
415	N		411	SH.ST.-(ZONE 2) PTW 1	3	95	98	115	118	20	0
811	N		411								
410	N		412	SH.ST.-(ZONE 3) FTD 3	5	50	55	70	75	20	0
812	N		412								
412	N		413	SH.ST.-(ZONE 3) RW	1	55	56	75	76	20	0
813	N		413								
413	N		414	SH.ST.-(ZONE 3) FTD 4	5	56	61	76	81	20	0
814	N		414								
419	N		415	SH.ST.-(ZONE 3) PTW 1	7	88	95	108	115	20	0
815	N		415								
414	N		416	SH.ST.-(ZONE 4) FTD 4	3	61	64	81	84	20	0
816	N		416								
416	N		417	SH.ST.-(ZONE 4) RW	1	64	65	84	85	20	0
817	N		417								
417	N		418	SH.ST.-(ZONE 4) FTD 5	5	65	70	85	90	20	0
818	N		418								
423	N		419	SH.ST.-(ZONE 4) PTW 1	3	85	88	105	108	20	0
819	N		419								
820	N		420	SH.ST.-(ZONE 5) FTD 5	3	70	73	90	93	20	0
418	N		420								
420	N		421	SH.ST.-(ZONE 5) RW	6	73	79	93	99	20	0
821	N		421								
421	N		422	SH.ST.-(ZONE 5) L.6	3	79	82	99	102	20	0
822	N		422								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
422	N		423	SH.ST.-(ZONE 5) PTW 1	3	82	85	102	105	20	0
823	N		423								
402	N		424	SH.ST.-PTW I EAST & L.9 SOUTH	6	18	24	38	44	20	0
824	N		424								
825	N		425	SH.ST.-(ZONE 6) L.9	2	146	148	146	148	0	0
426	N		425								
429	N		426	SH.ST.-(ZONE 6) PTW 1	2	144	146	144	146	0	0
826	N		426								
428	N		427	SH.ST.-(ZONE 6) L.7 (F.F.A.)	2	150	152	150	152	0	0
827	N		427								
425	N		428	SH.ST.-(ZONE 6) PTW 2	2	148	150	148	150	0	0
828	N		428								
432	N		429	SH.ST.-(ZONE 7) L.7 (F.F.A.)	2	142	144	142	144	0	0
829	N		429								
411	N		430	SH.ST.-(ZONE 7) PTW 1	7	98	105	118	125	20	0
830	N		430								
433	N		431	SH.ST.-(ZONE 7) L.10	2	113	115	133	135	20	0
831	N		431								
431	N		432	SH.ST.-(ZONE 7) PTW 2	7	115	122	135	142	20	0
832	N		432								
436	N		433	SH.ST.-(ZONE 8) L.10	2	111	113	131	133	20	0
833	N		433								
430	N		434	SH.ST.-(ZONE 8) PTW 1	2	105	107	125	127	20	0
834	N		434								
434	N		435	SH.ST.-(ZONE 8) L.11	2	107	109	127	129	20	0
835	N		435								
836	N		436	SH.ST.-(ZONE 8) PTW 2	2	109	111	129	131	20	0
435	N		436								
837	N		437	SH.ST.-L.11 NORTH SIDE	2	165	167	174	176	9	0
442	N		437								
838	N		438	SH.ST.-PTW 1 EAST(BTW L.11&6)	2	167	169	176	178	9	0
437	N		438								
438	N		439	SH.ST.-L.6 NORTH & N-EAST	3	169	172	178	181	9	0
839	N		439								
427	N		440	SH.ST.-PTW 2 EAST (10+80-FFA)	2	152	154	152	154	0	0
840	N		440								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
440 841	N N		441 441	SH.ST.-PTW 2 EAST (F.F.A.)	1	154	155	154	155	0	0
441 842	N N		442 442	SH.ST.-PTW 2 EAST (FFA-28+23)	10	155	165	155	165	0	0
501 700	N N		500 500	SH.A.C.-RW WEST (04+36-19+50)	7	206	213	227	234	21	21
701 539	N N		501 501	SH.A.C.-RW WEST (19+50-34+36)	8	196	204	219	227	23	2
503 702	N N		502 502	SH.A.C.-L.8 BOTH SIDES	4	22	26	89	93	67	0
703	N		503	SH.A.C.-L.1 SOUTH-WEST	1	12	13	88	89	76	9
704 507	N N		504 504	SH.A.C.-(ZONE 1) L.1	2	36	38	100	102	64	4
705 504	N N		505 505	SH.A.C.-(ZONE 1) RW	4	42	46	102	106	60	0
505 706	N N		506 506	SH.A.C.-(ZONE 1) FTO 2	2	46	48	106	108	60	0
707 524	N N		507 507	SH.A.C.-(ZONE 1) PTW 1	3	33	36	97	100	64	0
708 506	N N		508 508	SH.A.C.-(ZONE 2) FTO 2	3	49	52	108	111	59	0
709 508	N N		509 509	SH.A.C.-(ZONE 2) RW	1	52	53	111	112	59	0
710 509	N N		510 510	SH.A.C.-(ZONE 2) FTO 3	2	53	55	112	114	59	4
711 515	N N		511 511	SH.A.C.-(ZONE 2) PTW 1	2	105	107	143	145	38	0
712 510	N N		512 512	SH.A.C.-(ZONE 3) FTO 3	3	59	62	114	117	55	0
713 512	N N		513 513	SH.A.C.-(ZONE 3) RW	1	62	63	117	118	55	2
513 714	N N		514 514	SH.A.C.-(ZONE 3) FTO 4	3	65	68	118	121	53	0
715 519	N N		515 515	SH.A.C.-(ZONE 3) PTW 1	4	101	105	139	143	38	0

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
716	N		516	SH.A.C.-(ZONE 4) FTO 4	2	68	70	121	123	53	0
514	N		516								
516	N		517	SH.A.C.-(ZONE 4) RW	1	70	71	123	124	53	3
717	N		517								
718	N		518	SH.A.C.-(ZONE 4) FTO 5	3	74	77	124	127	50	0
517	N		518								
523	N		519	SH.A.C.-(ZONE 4) PTW 1	2	92	94	137	139	45	7
719	N		519								
518	N		520	SH.A.C.-(ZONE 5) FTO 5	2	77	79	127	129	50	5
720	N		520								
721	N		521	SH.A.C.-(ZONE 5) RW	4	84	88	129	133	45	0
520	N		521								
521	N		522	SH.A.C.-(ZONE 5) L.6	2	88	90	133	135	45	0
722	N		522								
522	N		523	SH.A.C.-(ZONE 5) PTW 1	2	90	92	135	137	45	0
723	N		523								
724	N		524	SH.A.C.-PTW 1 EAST & L.9 SOUTH	4	29	33	93	97	64	0
502	N		524								
526	N		525	SH.A.C.-(ZONE 6) L.9	1	150	151	168	169	18	0
725	N		525								
529	N		526	SH.A.C.-(ZONE 6) PTW 1	2	148	150	166	168	18	0
726	N		526								
727	N		527	SH.A.C.-(ZONE 6) L.7 (F.F.A.)	1	153	154	170	171	17	2
528	N		527								
525	N		528	SH.A.C.-(ZONE 6) PTW 2	1	151	152	169	170	18	1
728	N		528								
729	N		529	SH.A.C.-(ZONE 7) L.7 (F.F.A.)	1	145	146	165	166	20	2
532	N		529								
511	N		530	SH.A.C.-(ZONE 7) PTW 1	4	111	115	152	156	41	0
730	N		530								
731	N		531	SH.A.C.-(ZONE 7) L.10	1	119	120	160	161	41	8
533	N		531								
732	N		532	SH.A.C.-(ZONE 7) PTW 2	4	128	132	161	165	33	13
531	N		532								
733	N		533	SH.A.C.-(ZONE 8) L.10	1	118	119	159	160	41	0
536	N		533								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
530	N		534	SH.A.C.-(ZONE 8) PTW 1	1	115	116	156	157	41	0
734	N		534								
735	N		535	SH.A.C.-(ZONE 8) L.11	1	116	117	157	158	41	0
534	N		535								
736	N		536	SH.A.C.-(ZONE 8) PTW 2	1	117	118	158	159	41	0
535	N		536								
737	N		537	SH.A.C.-L.11 NORTH SIDE	1	181	182	181	182	0	0
542	N		537								
738	N		538	SH.A.C.-PTW 1 EAST(BTW L.11&6)	2	182	184	182	184	0	0
537	N		538								
739	N		539	SH.A.C.-L.6 NORTH & NORTH-EAST	2	184	186	184	186	0	0
538	N		539								
527	N		540	SH.A.C.-PTW 2 EAST(10+80-FFA)	2	156	158	171	173	15	0
740	N		540								
741	N		541	SH.A.C.-PTW 2 EAST(FFA)	1	158	159	173	174	15	15
540	N		541								
742	N		542	SH.A.C.-PTW 2 EAST(FFA-28+23)	7	174	181	174	181	0	0
541	N		542								
601	N		600	DRAIN.-RW WEST (04+36-19+50)	1	123	124	199	200	76	41
1	N		600								
639	N		601	DRAIN.-RW WEST (19+50-34+36)	7	116	123	179	186	63	0
1	N		601								
1	N		602	DRAIN.-L.8 BOTH SIDES	1	0	1	25	26	25	0
624	N		605	DRAIN.-(ZONE 1) RW	1	9	10	47	48	38	0
1	N		605								
605	N		608	DRAIN.-(ZONE 2) FTD 2	3	10	13	52	55	42	0
1	N		608								
608	N		609	DRAIN.-(ZONE 2) RW	2	13	15	55	57	42	0
1	N		609								
609	N		610	DRAIN.-(ZONE 2) FTD 3	1	15	16	57	58	42	0
1	N		610								
615	N		611	DRAIN.-(ZONE 2) PTW 1	1	59	60	101	102	42	0
1	N		611								
610	N		612	DRAIN.-(ZONE 3) FTD 3	2	16	18	58	60	42	0
1	N		612								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
612 1	N N		613 613	DRAIN.-(ZONE 3) RW	3	18	21	60	63	42	0
613 207	N N		614 614	DRAIN.-(ZONE 3) FTJ 4	4	21	25	63	67	42	0
619 1	N N		615 615	DRAIN.-(ZONE 3) PTW 1	7	52	59	94	101	42	0
614 207	N N		616 616	DRAIN.-(ZONE 4) FTJ 4	3	25	28	67	70	42	0
616 1	N N		617 617	DRAIN.-(ZONE 4) RW	2	28	30	70	72	42	0
617 208	N N		618 618	DRAIN.-(ZONE 4) FTJ 5	3	30	33	72	75	42	0
623 201	N N		619 619	DRAIN.-(ZONE 4) PTW 1	3	49	52	91	94	42	0
618 208	N N		620 620	DRAIN.-(ZONE 5) FTD 5	3	33	36	75	78	42	0
620 1	N N		621 621	DRAIN.-(ZONE 5) RW	7	36	43	78	85	42	0
621 201	N N		622 622	DRAIN.-(ZONE 5) L.5	3	43	46	85	88	42	0
622 201	N N		623 623	DRAIN.-(ZONE 5) PTW 1	3	46	49	88	91	42	0
602 1	N N		624 624	DRAIN.-PTW 1 EAST & L.9 SOUTH	8	1	9	26	34	25	0
628 210	N N		627 627	DRAIN.-(ZONE 6) L.7 (F.F.A.)	3	91	94	133	136	42	0
629 1	N N		628 628	DRAIN.-(ZONE 6) PTW 2	3	88	91	130	133	42	0
632 210	N N		629 629	DRAIN.-(ZONE 7) L.7 (F.F.A.)	1	87	88	129	130	42	0
611 1	N N		630 630	DRAIN.-(ZONE 7) PTW 1	7	60	67	102	109	42	0
633 205	N N		631 631	DRAIN.-(ZONE 7) L.10	3	77	80	119	122	42	0
631 1	N N		632 632	DRAIN.-(ZONE 7) PTW 2	7	80	87	122	129	42	0

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
636	N		633	DRAIN.-(ZONE 8) L.10	3	74	77	116	119	42	0
205	N		633								
630	N		634	DRAIN.-(ZONE 8) PTW 1	2	67	69	109	111	42	0
201	N		634								
634	N		635	DRAIN.-(ZONE 8) L.11	3	69	72	111	114	42	0
206	N		635								
635	N		636	DRAIN.-(ZONE 8) PTW 2	2	72	74	114	116	42	0
1	N		636								
642	N		637	DRAIN.-L.11 NORTH SIDE	3	107	110	163	166	56	0
1	N		637								
637	N		638	DRAIN.-PTW 1 EAST(BTW L.1&6)	2	110	112	166	168	56	0
201	N		638								
638	N		639	DRAIN.-L.6 NORTH & NORTH-EAST	4	112	116	168	172	56	0
201	N		639								
627	N		640	DRAIN.-PTW 2 EAST(10+80-FFA)	2	94	96	136	138	42	0
1	N		640								
640	N		641	DRAIN.-PTW 2 EAST(FFA)	2	96	98	138	140	42	0
203	N		641								
641	N		642	DRAIN.-PTW 2 EAST(FFA-28+23)	9	98	107	140	149	42	0
1	N		642								
400	N		700	PVC C.P.-RW WEST (04+35-19+50)	10	196	206	217	227	21	0
701	N		700								
739	N		701	PVC C.P.-RW WEST (19+50-34+36)	11	185	196	206	217	21	0
401	N		701								
703	N		702	PVC C.P.-L.8 BOTH SIDES	4	18	22	64	68	46	0
402	N		702								
403	N		703	PVC C.P.-L.1 SOUTH-WEST	1	11	12	63	64	52	0
707	N		704	PVC C.P.-(ZONE 1) L.1	3	33	36	77	80	44	0
404	N		704								
704	N		705	PVC C.P.-(ZONE 1) RW	5	37	42	80	85	43	0
405	N		705								
705	N		706	PVC C.P.-(ZONE 1) FTJ 2	3	42	45	85	88	43	0
406	N		706								
407	N		707	PVC C.P.-(ZONE 1) PTW 1	4	29	33	73	77	44	0
724	N		707								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
706 408	N N		708 708	PVC C.P.-(ZONE 2) FTD 2	4	45	49	88	92	43	0
708 409	N N		709 709	PVC C.P.-(ZONE 2) RW	1	49	50	92	93	43	0
709 410	N N		710 710	PVC C.P.-(ZONE 2) FTD 3	3	50	53	93	96	43	0
715 411	N N		711 711	PVC C.P.-(ZONE 2) PTW 1	2	101	103	135	137	34	2
710 412	N N		712 712	PVC C.P.-(ZONE 3) FTD 3	4	55	59	96	100	41	0
712 413	N N		713 713	PVC C.P.-(ZONE 3) RW	1	59	60	100	101	41	1
713 414	N N		714 714	PVC C.P.-(ZONE 3) FTD 4	4	61	65	101	105	40	0
719 415	N N		715 715	PVC C.P.-(ZONE 3) PTW 1	6	95	101	129	135	34	0
714 416	N N		716 716	PVC C.P.-(ZONE 4) FTD 4	3	65	68	105	108	40	0
716 417	N N		717 717	PVC C.P.-(ZONE 4) RW	1	68	69	108	109	40	1
717 418	N N		718 718	PVC C.P.-(ZONE 4) FTD 5	4	70	74	109	113	39	0
723 419	N N		719 719	PVC C.P.-(ZONE 4) PTW 1	2	90	92	127	129	37	0
718 420	N N		720 720	PVC C.P.-(ZONE 5) FTD 5	3	74	77	113	116	39	0
720 421	N N		721 721	PVC C.P.-(ZONE 5) RW	5	79	84	116	121	37	0
721 422	N N		722 722	PVC C.P.-(ZONE 5) L.6	3	84	87	121	124	37	0
722 423	N N		723 723	PVC C.P.-(ZONE 5) PTW 1	3	87	90	124	127	37	0
424 702	N N		724 724	PVC C.P.-PTW 1 EAST&L.9 SOUTH	5	24	29	68	73	44	0
726 425	N N		725 725	PVC C.P.-(ZONE 6) L.9	1	148	149	159	160	11	1

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
729	N		726	PVC C.P.-(ZONE 6) PTW 1	2	146	148	157	159	11	0
426	N		726								
728	N		727	PVC C.P.-(ZONE 6) L.7 (FFA)	1	152	153	161	162	9	0
427	N		727								
725	N		728	PVC C.P.-(ZONE 6) PTW 2	1	150	151	160	161	10	0
428	N		728								
732	N		729	PVC C.P.-(ZONE 7) L.7 (FFA)	1	144	145	156	157	12	0
429	N		729								
711	N		730	PVC C.P.-(ZONE 7) PTW 1	6	105	111	137	143	32	0
430	N		730								
733	N		731	PVC C.P.-(ZONE 7) L.10	1	117	118	149	150	32	1
431	N		731								
731	N		732	PVC C.P.-(ZONE 7) PTW 2	6	122	128	150	156	28	0
432	N		732								
736	N		733	PVC C.P.-(ZONE 8) L.10	1	116	117	148	149	32	0
433	N		733								
730	N		734	PVC C.P.-(ZONE 8) PTW 1	2	111	113	143	145	32	0
434	N		734								
435	N		735	PVC C.P.-(ZONE 8) L.11	1	113	114	145	146	32	0
734	N		735								
735	N		736	PVC C.P.-(ZONE 8) PTW 2	2	114	116	146	148	32	0
436	N		736								
437	N		737	PVC C.P.-L.11 NORTH SIDE	1	174	175	178	179	4	0
742	N		737								
438	N		738	PVC C.P.-PTW/1 EAST(BT.L.11&6)	2	175	177	179	181	4	0
737	N		738								
738	N		739	PVC C.P.-L.6 NORTH & N-EAST	3	177	180	181	184	4	4
439	N		739								
727	N		740	PVC C.P.-PTW 2 EAST(10+80-FFA)	2	154	156	162	164	8	0
440	N		740								
740	N		741	PVC C.P.-PTW 2 EAST(FFA)	1	156	157	164	165	8	1
441	N		741								
741	N		742	PVC C.P.-PTW 2 EAST(FFA-28+23)	9	165	174	165	174	0	0
442	N		742								
801	N		800	MUL.C.P.-RW WEST (04+36-19+50)	6	165	171	200	206	35	14
300	N		800								
600	N		800								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
839	N		801	MUL.C.P.-RW WEST (19+50-34+36)	7	158	165	186	193	28	0
601	N		801								
301	E-S	8	801								
803	N		802	MUL.C.P.-L.8 BOTH SIDES	3	10	13	30	33	20	0
602	N		802								
303	E-S	8	803	MUL.C.P.-L.1 SOUTH-WEST	1	9	10	29	30	20	0
807	N		804	MUL.C.P.-(ZONE 1) L.1	2	19	21	46	48	27	0
304	E-S	8	804								
804	N		805	MUL.C.P.-(ZONE 1) RW	3	21	24	48	51	27	0
305	E-S	8	805								
605	N		805								
805	N		806	MUL.C.P.-(ZONE 1) FTO 2	2	24	26	55	57	31	0
306	E-S	8	806								
824	N		807	MUL.C.P.-(ZONE 1) PTW 1	2	17	19	42	44	25	0
1	N		807								
806	N		808	MUL.C.P.-(ZONE 2) FTO 2	3	26	29	57	60	31	0
308	E-S	8	808								
608	N		808								
808	N		809	MUL.C.P.-(ZONE 2) RW	1	29	30	64	65	35	0
309	E-S	8	809								
609	N		809								
809	N		810	MUL.C.P.-(ZONE 2) FTO 3	2	30	32	65	67	35	0
310	E-S	8	810								
610	N		810								
815	N		811	MUL.C.P.-(ZONE 2) PTW 1	1	63	64	113	114	50	6
611	N		811								
810	N		812	MUL.C.P.-(ZONE 3) FTO 3	3	32	35	67	70	35	0
312	E-S	8	812								
612	N		812								
812	N		813	MUL.C.P.-(ZONE 3) RW	1	35	36	72	73	37	0
313	E-S	8	813								
613	N		813								
813	N		814	MUL.C.P.-(ZONE 3) FTO 4	3	36	39	73	76	37	0
314	E-S	8	814								
614	N		814								
819	N		815	MUL.C.P.-(ZONE 3) PTW 1	4	59	63	104	108	45	0
315	E-S	8	815								
615	N		815								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
814	N		816	MUL.C.P.-(ZONE 4) FTD 4	2	39	41	79	81	40	0
316	E-S	8	816								
616	N		816								
816	N		817	MUL.C.P.-(ZONE 4) RW	1	41	42	81	82	40	0
317	E-S	8	817								
617	N		817								
817	N		818	MUL.C.P.-(ZONE 4) FTD 5	3	42	45	82	85	40	0
318	E-S	8	818								
618	N		818								
823	N		819	MUL.C.P.-(ZONE 4) PTW 1	1	55	56	103	104	48	3
319	E-S	8	819								
619	N		819								
818	N		820	MUL.C.P.-(ZONE 5) FTD 5	2	45	47	87	89	42	0
320	E-S	8	820								
620	N		820								
820	N		821	MUL.C.P.-(ZONE 5) RW	4	47	51	89	93	42	0
321	E-S	8	821								
621	N		821								
821	N		822	MUL.C.P.-(ZONE 5) L.6	2	51	53	97	99	46	0
322	E-S	8	822								
622	N		822								
822	N		823	MUL.C.P.-(ZONE 5) PTW 1	2	53	55	100	102	47	0
323	E-S	8	823								
623	N		823								
802	N		824	MUL.C.P.-PTW 1 EAST&L.9 SOUTH	4	13	17	34	38	21	0
624	N		824								
826	N		825	MUL.C.P.-(ZONE 6) L.9	1	143	144	144	145	1	0
1	N		825								
829	N		826	MUL.C.P.-(ZONE 6) PTW 1	1	142	143	143	144	1	0
1	N		826								
828	N		827	MUL.C.P.-(ZONE 6) L.7 (FFA)	1	145	146	146	147	1	0
627	N		827								
327	E-S	8	827								
825	N		828	MUL.C.P.-(ZONE 6) PTW 2	1	144	145	145	146	1	0
328	E-S	8	828								
628	N		828								
832	N		829	MUL.C.P.-(ZONE 7) L.7 (FFA)	1	141	142	141	142	0	0
629	N		829								
329	E-S	8	829								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
330	E-S	8	830	MUL.C.P.-(ZONE 7) PTW 1	4	70	74	114	118	44	0
811	N		830								
630	N		830								
631	N		831	MUL.C.P.-(ZONE 7) L.10	1	80	81	130	131	50	6
833	N		831								
331	E-S	8	831								
332	E-S	8	832	MUL.C.P.-(ZONE 7) PTW 2	4	87	91	131	135	44	24
831	N		832								
632	N		832								
333	E-S	8	833	MUL.C.P.-(ZONE 8) L.10	1	78	79	129	130	51	1
836	N		833								
633	N		833								
830	N		834	MUL.C.P.-(ZONE 8) PTW 1	1	74	75	124	125	50	0
334	E-S	8	834								
634	N		834								
834	N		835	MUL.C.P.-(ZONE 8) L.11	1	75	76	126	127	51	0
335	E-S	8	835								
635	N		835								
835	N		836	MUL.C.P.-(ZONE 8) PTW 2	1	76	77	128	129	52	1
336	E-S	8	836								
636	N		836								
842	N		837	MUL.C.P.-L.11 NORTH SIDE	1	154	155	173	174	19	0
637	N		837								
337	E-S	8	837								
837	N		838	MUL.C.P.-PTW 1 EAST(BT.L.11&6)	1	155	156	175	176	20	0
638	N		838								
338	E-S	8	838								
838	N		839	MUL.C.P.-L.6 NORTH & N-EAST	2	156	158	176	178	20	0
639	N		839								
339	E-S	8	839								
827	N		840	MUL.C.P.-PTW 2 EAST(10+80-FFA)	1	146	147	147	148	1	0
340	E-S	8	840								
640	N		840								
840	N		841	MUL.C.P.-PTW 2 EAST(FFA)	1	147	148	148	149	1	0
641	N		841								
362	E-S	8	841								
841	N		842	MUL.C.P.-PTW 2 EAST(FFA-28+23)	6	148	154	149	155	1	0
642	N		842								
343	E-S	8	842								
344	E-E	8	842								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
905	N		900	TOP SOIL-RW WEST (04+36-19+50)	15	219	234	219	234	0	0
600	N		900								
500	E-E	0	900								
900	N		901	TOP SOIL-RW WEST (19+50-34+36)	16	234	250	234	250	0	0
501	F-F	0	901								
601	N		901								
502	E-E	0	902	TOP SOIL-BETWEEN L.1 & L.8	3	23	26	120	123	97	0
602	N		902								
503	E-E	0	902								
902	N		903	TOP SOIL-L.8 SOUTH-EAST	2	26	28	123	125	97	2
602	N		903								
502	E-E	0	903								
524	E-E	0	904	TOP SOIL-PTW 1 EAST&L.9 SOUTH	3	30	33	125	128	95	4
903	N		904								
624	N		904								
912	N		905	TOP SOIL-PTW 2 EAST&L.11 NORTH	16	203	219	203	219	0	0
537	E-E	0	905								
542	E-E	0	905								
541	E-E	0	905								
540	E-E	0	905								
637	N		905								
642	N		905								
641	N		905								
640	N		905								
539	E-E	0	906	TOP SOIL-PTW 1 EAST&L.6 N&N-E	14	172	186	172	186	0	0
538	E-E	0	906								
911	N		906								
639	N		906								
638	N		906								
506	E-E	0	907	TOP SOIL-ZONE 1	11	37	48	128	139	91	53
904	N		907								
504	E-E	0	907								
507	E-E	0	907								
605	N		907								
505	E-E	0	907								
511	E-E	0	908	TOP SOIL-ZONE 2	6	101	107	139	145	38	0
611	N		908								
907	N		908								
509	E-E	0	908								
508	E-E	0	908								
610	N		908								
609	N		908								
608	N		908								
510	E-E	0	908								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
908	N		909	TOP SOIL-ZONE 3	12	107	119	145	157	38	0
515	E-E	0	909								
615	N		909								
514	E-E	0	909								
513	E-E	0	909								
614	N		909								
613	N		909								
612	N		909								
512	E-E	0	909								
909	N		910	TOP SOIL-ZONE 4	5	119	124	157	162	38	0
519	E-E	0	910								
518	E-E	0	910								
517	E-E	0	910								
516	E-E	0	910								
619	N		910								
618	N		910								
617	N		910								
616	N		910								
910	N		911	TOP SOIL-ZONE 5	10	124	134	162	172	38	38
523	E-E	0	911								
522	E-E	0	911								
521	E-E	0	911								
623	N		911								
622	N		911								
621	N		911								
620	N		911								
520	E-E	0	911								
913	N		912	TOP SOIL-ZONE 6	4	199	203	199	203	0	0
528	E-E	0	912								
525	E-E	0	912								
526	E-E	0	912								
627	N		912								
628	N		912								
527	E-E	0	912								
914	N		913	TOP SOIL-ZONE 7	10	189	199	189	199	0	0
529	E-E	0	913								
532	E-E	0	913								
530	E-E	0	913								
629	N		913								
632	N		913								
631	N		913								
630	N		913								
531	E-E	0	913								
906	N		914	TOP SOIL-ZONE 8	3	186	189	186	189	0	0
533	E-E	0	914								
536	E-E	0	914								
535	E-E	0	914								
534	E-E	0	914								
633	N		914								
636	N		914								
634	N		914								
635	N		914								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
901	N		1000	PROJECT END	0	250	250	250	250	0	0
900	N		1000								
905	N		1000								
912	N		1000								
913	N		1000								
914	N		1000								
906	N		1000								
364	N		1000								
369	N		1000								
368	N		1000								
366	N		1000								
360	N		1000								
349	N		1000								
363	N		1000								
355	N		1000								
350	N		1000								
353	N		1000								
352	N		1000								
911	N		1000								
356	N		1000								
357	N		1000								
910	N		1000								
351	N		1000								
354	N		1000								
909	N		1000								
370	N		1000								
908	N		1000								
345	N		1000								
367	N		1000								
348	N		1000								
347	N		1000								
907	N		1000								
346	N		1000								
904	N		1000								
101	N		1000								
903	N		1000								
902	N		1000								
365	N		1000								

STOP 501

ONE CRITICAL PATH

JOBCODE	START	END	
1	0	0	
207	0	7	
208	7	14	
201	14	28	
322	35	37	
323	37	39	
319	39	41	
315	41	45	
346	45	47	
347	47	49	
348	49	51	
367	51	56	
345	56	58	
330	58	62	
334	62	64	
335	64	66	
336	66	68	
333	68	70	
331	70	72	
332	72	76	
328	76	78	
340	78	80	
343	80	84	
344	84	86	
337	86	88	
338	88	90	
339	90	92	
301	92	99	
300	99	105	
370	105	118	
365	118	120	
354	120	122	
351	122	123	
357	123	125	
356	125	129	
362	129	130	
361	130	131	
329	131	133	
829	141	142	
429	142	144	
426	144	146	
425	146	148	
428	148	150	
427	150	152	
440	152	154	
441	154	155	
442	155	165	
742	165	174	
542	174	181	
537	181	182	
538	182	184	
539	184	186	
906	172	186	NEUTRAL
914	186	189	
913	189	199	
912	199	203	
905	203	219	
901	219	235	
900	235	250	

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
0	N		1	PROJECT START	0	0	0	0	0	0	0
1	N		100	E.MOVING-UNDER PAVEMENTS (N&E)	9	0	9	0	9	0	0
100	N		101*	E.MOVING-OUT.PAVEMENTS (N&E)	21	9	30	9	30	0	0
1	N		102*	E.MOVING-FUEL FARM AREA	7	30	37	69	76	39	0
101	N		102								
100	E-E	3	110*	BORROW & FILL S.MTL-OUT.F.F.A.	20	0	20	0	20	0	(1)
110	N		111*	BORROW & FILL S.MTL-F.F.A.	6	37	43	76	82	39	0
102	N		111								
208	N		201	LC-PTW 1(24+60) TO END OF L.6	14	14	28	14	28	0	0
110	S-S	13	201								
210	N		203	LC-PTW 2(FUEL FARM AREA)	2	48	50	87	89	39	0
111	N		203								
206	N		205*	LC-L.10	5	32	37	33	38	1	(24)
110	S-S	19	205								
201	N		206	LC-L.11	4	28	32	29	33	1	0
110	S-S	15	206								
1	N		207	LC-FTO 4	7	0	7	0	7	0	0
207	N		208	LC-FTO 5	7	7	14	7	14	0	0
1	N		208								
203	N		209*	LC-PTW 1(FUEL FARM AREA)	5	50	55	89	94	39	(71)
111	N		209								
111	N		210	LC-L.7 (FUEL FARM AREA)	5	43	48	82	87	39	0
301	N		300	PQC-RW STP.6 (04+36-19+50)	6	99	105	99	105	0	0
1	N		300								
339	N		301	PQC-RW STP.6 (19+50-34+36)	7	92	99	92	99	0	0
1	N		301								
1	N		303	PQC-L.1 SOUTH-WEST STP.	1	0	1	5	6	5	0
303	N		304	PQC-(ZONE 1) L.1	2	1	3	6	8	5	0
1	N		304								
304	N		305	PQC-(ZONE 1) RW	2	3	5	8	10	5	0
1	N		305								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
305	N		306	PQC-(ZONE 1) FTO 2	2	5	7	10	12	5	0
1	N		306								
306	N		308	PQC-(ZONE 2) FTO 2	3	7	10	12	15	5	0
1	N		308								
308	N		309	PQC-(ZONE 2) RW	1	10	11	15	16	5	0
1	N		309								
309	N		310	PQC-(ZONE 2) FTO 3	2	11	13	16	18	5	0
1	N		310								
310	N		312	PQC-(ZONE 3) FTO 3	3	13	16	18	21	5	0
1	N		312								
312	N		313	PQC-(ZONE 3) RW	1	16	17	21	22	5	0
1	N		313								
313	N		314	PQC-(ZONE 3) FTO 4	3	17	20	22	25	5	0
207	E-S	7	314								
319	N		315	PQC-(ZONE 3) PTW 1	4	41	45	41	45	0	0
1	N		315								
314	N		316	PQC-(ZONE 4) FTO 4	2	20	22	25	27	5	0
207	E-S	7	316								
316	N		317	PQC-(ZONE 4) RW	1	22	23	27	28	5	0
1	N		317								
317	N		318	PQC-(ZONE 4) FTO 5	3	23	26	28	31	5	0
208	E-S	7	318								
323	N		319	PQC-(ZONE 4) PTW 1	2	39	41	39	41	0	0
201	E-S	7	319								
318	N		320	PQC-(ZONE 5) FTO 5	2	26	28	31	33	5	0
208	E-S	7	320								
320	N		321	PQC-(ZONE 5) RW	2	28	30	33	35	5	5
1	N		321								
321	N		322	PQC-(ZONE 5) L.6	2	35	37	35	37	0	0
201	E-S	7	322								
322	N		323	PQC-(ZONE 5) PTW 1	2	37	39	37	39	0	0
201	E-S	7	323								
358	N		327	PQC-(ZONE 6) L.7 (FUEL F.AREA)	2	135	137	135	137	0	0
210	E-S	7	327								
332	N		328	PQC-(ZONE 6) PTW 2	2	76	78	76	78	0	0
1	N		328								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
361	N		329	PQC-(ZONE 7) L.7 (FUEL F.AREA)	2	131	133	131	133	0	0
210	E-S	7	329								
345	N		330	PQC-(ZONE 7) PTW 1	4	58	62	58	62	0	0
1	N		330								
333	N		331	PQC-(ZONE 7) L.10	2	70	72	70	72	0	0
205	E-S	7	331								
331	N		332	PQC-(ZONE 7) PTW 2	4	72	76	72	76	0	0
1	N		332								
336	N		333	PQC-(ZONE 8) L.10	2	68	70	68	70	0	0
205	E-S	7	333								
330	N		334	PQC-(ZONE 8) PTW 1	2	62	64	62	64	0	0
201	E-S	7	334								
334	N		335	PQC-(ZONE 8) L.11	2	64	66	64	66	0	0
206	E-S	7	335								
335	N		336	PQC-(ZONE 8) PTW 2	2	66	68	66	68	0	0
1	N		336								
344	N		337	PQC-L.11 NORTH STP.	2	86	88	86	88	0	0
206	N		337								
337	N		338	PQC-PTW 1 EAST STP.(BTW L11&6)	2	88	90	88	90	0	0
201	E-S	7	338								
338	N		339	PQC-L.6 NORTH & N-EAST STP.	2	90	92	90	92	0	0
201	E-S	7	339								
328	N		340	PQC-PTW 2 EAST STP.(ZONE 6)	2	78	80	78	80	0	0
1	N		340								
340	N		343	PQC-PTW 2 EAST STP.(ZONE 7)	4	80	84	80	84	0	0
1	N		343								
343	N		344	PQC-PTW 2 EAST STP.(ZONE 8)	2	84	86	84	86	0	0
1	N		344								
367	N		345	PQC-FTD 2 INTERIOR STP.	2	56	58	56	58	0	0
308	E-S	5	345								
306	E-S	5	345								
315	N		346	PQC-FTD 3 INTERIOR STP.	2	45	47	45	47	0	0
312	E-S	5	346								
310	E-S	5	346								
346	N		347	PQC-FTD 4 INTERIOR STP.	2	47	49	47	49	0	0
314	E-S	5	347								
207	E-S	7	347								
316	E-S	5	347								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
347	N		348	PQC-FTO 5 INTERIOR STP.	2	49	51	49	51	0	0
320	E-S	5	348								
208	E-S	7	348								
318	E-S	5	348								
363	N		349	PQC-L.7 INTERIOR STP.(F.F.A.)	1	147	148	147	148	0	0
329	E-S	5	349								
210	E-S	7	349								
327	E-S	5	349								
353	N		350	PQC-L.10 INTERIOR STP.	1	143	144	143	144	0	0
331	E-S	5	350								
333	E-S	5	350								
205	E-S	7	350								
354	N		351	PQC-L.11 INTERIOR STP.	1	122	123	122	123	0	0
337	E-S	5	351								
206	E-S	7	351								
335	E-S	5	351								
327	N		352	PQC-PTW 1 INT.STP.(ZONE 3)	4	137	141	137	141	0	0
330	E-S	5	352								
315	E-S	5	352								
352	N		353	PQC-PTW 1 INT.STP.(ZONE 4)	2	141	143	141	143	0	0
319	E-S	5	353								
201	E-S	7	353								
334	E-S	5	353								
365	N		354	PQC-PTW 1 INT.STP.(ZONE 5)	2	120	122	120	122	0	0
323	E-S	5	354								
201	E-S	7	354								
338	E-S	5	354								
350	N		355	PQC-PTW 2 INT.STP.(ZONE 6)	2	144	146	144	146	0	0
328	E-S	5	355								
340	E-S	5	355								
357	N		356	PQC-PTW 2 INT.STP.(ZONE 7)	4	125	129	125	129	0	0
332	E-S	5	356								
343	E-S	5	356								
351	N		357	PQC-PTW 2 INT.STP.(ZONE 8)	2	123	125	123	125	0	0
336	E-S	5	357								
344	E-S	5	357								
359	N		358	PQC-PTW 1 WEST STP.(F.F.A.)	1	134	135	134	135	0	0
209	E-S	7	358								
329	N		359	PQC-PTW 1 EAST STP.(F.F.A.)	1	133	134	133	134	0	0
209	E-S	7	359								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
349	N		360	PQC-PTW 1 INT.STP.(F.F.A.)	1	148	149	148	149	0	0
359	E-S	5	360								
209	E-S	7	360								
358	E-S	5	360								
362	N		361	PQC-PTW 2 WEST STP.(F.F.A.)	1	130	131	130	131	0	0
203	E-S	7	361								
356	N		362	PQC-PTW 2 EAST STP.(F.F.A.)	1	129	130	129	130	0	0
203	E-S	7	362								
355	N		363	PQC-PTW 2 INT.STP.(F.F.A.)	1	146	147	146	147	0	0
361	E-S	5	363								
362	E-S	5	363								
203	E-S	7	363								
369	N		364*	PQC-RW STP.3 (34+36-04+36)	13	170	183	170	183	0	(114)
1	N		364								
370	E-S	0	365	PQC-L.6 INTERIOR STP.	2	118	120	118	120	0	0
339	E-S	5	365								
322	E-S	5	365								
201	E-S	7	365								
360	N		366	PQC-RW STP.2 (04+36-13+00)	4	149	153	149	153	0	0
1	N		366								
348	N		367	PQC-RW STP.2 (13+00-25+30)	5	51	56	51	56	0	0
1	N		367								
366	N		368	PQC-RW STP.2 (25+30-34+36)	4	153	157	153	157	0	0
1	N		368								
368	N		369	PQC-RW STP.5	13	157	170	157	170	0	0
1	N		369								
300	N		370	PQC-RW STP.4	13	105	118	105	118	0	0
1	N		370								
401	N		400	SH.ST.-RW WEST (04+36-19+50)	11	232	243	232	243	0	0
800	N		400								
801	N		401	SH.ST.-RW WEST (19+50-34+36)	13	219	232	219	232	0	0
439	N		401								
403	N		402	SH.ST.-L.8 BOTH SIDES	5	80	85	80	85	0	0
802	N		402								
803	N	*	403	SH.ST.-L.1 SOUTH-WEST SIDE	1	79	80	79	80	0	0
407	N		404	SH.ST.-(ZONE 1) L.1	3	95	98	95	98	0	0
804	N		404								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
805	N		405	SH.ST.-(ZONE 1) RW	6	98	104	98	104	0	0
404	N		405								
405	N		406	SH.ST.-(ZONE 1) FTO 2	3	104	107	104	107	0	0
806	N		406								
424	N		407	SH.ST.-(ZONE 1) PTW 1	4	91	95	91	95	0	0
807	N		407								
406	N		408	SH.ST.-(ZONE 2) FTO 2	5	107	112	107	112	0	0
808	N		408								
408	N		409	SH.ST.-(ZONE 2) RW	2	112	114	112	114	0	0
809	N		409								
409	N		410	SH.ST.-(ZONE 2) FTO 3	3	114	117	114	117	0	0
810	N		410								
415	N		411	SH.ST.-(ZONE 2) PTW 1	3	162	165	162	165	0	0
811	N		411								
410	N		412	SH.ST.-(ZONE 3) FTO 3	5	117	122	117	122	0	0
812	N		412								
412	N		413	SH.ST.-(ZONE 3) RW	1	122	123	122	123	0	0
813	N		413								
413	N		414	SH.ST.-(ZONE 3) FTO 4	5	123	128	123	128	0	0
814	N		414								
419	N		415	SH.ST.-(ZONE 3) PTW 1	7	155	162	155	162	0	0
815	N		415								
414	N		416	SH.ST.-(ZONE 4) FTO 4	3	128	131	128	131	0	0
816	N		416								
416	N		417	SH.ST.-(ZONE 4) RW	1	131	132	131	132	0	0
817	N		417								
417	N		418	SH.ST.-(ZONE 4) FTO 5	5	132	137	132	137	0	0
818	N		418								
423	N		419	SH.ST.-(ZONE 4) PTW 1	3	152	155	152	155	0	0
819	N		419								
820	N		420	SH.ST.-(ZONE 5) FTO 5	3	137	140	137	140	0	0
418	N		420								
420	N		421	SH.ST.-(ZONE 5) RW	6	140	146	140	146	0	0
821	N		421								
421	N		422	SH.ST.-(ZONE 5) L.6	3	146	149	146	149	0	0
822	N		422								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
422	N		423	SH.ST.-(ZONE 5) PTW 1	3	149	152	149	152	0	0
823	N		423								
402	N		424	SH.ST.-PTW 1 EAST & L.9 SOUTH	6	85	91	85	91	0	0
824	N		424								
825	N		425	SH.ST.-(ZONE 6) L.9	2	193	195	193	195	0	0
426	N		425								
429	N		426	SH.ST.-(ZONE 6) PTW 1	2	191	193	191	193	0	0
826	N		426								
428	N		427	SH.ST.-(ZONE 6) L.7 (F.F.A.)	2	197	199	197	199	0	0
827	N		427								
425	N		428	SH.ST.-(ZONE 6) PTW 2	2	195	197	195	197	0	0
828	N		428								
432	N		429	SH.ST.-(ZONE 7) L.7 (F.F.A.)	2	189	191	189	191	0	0
829	N		429								
411	N		430	SH.ST.-(ZONE 7) PTW 1	7	165	172	165	172	0	0
830	N		430								
433	N		431	SH.ST.-(ZONE 7) L.10	2	180	182	180	182	0	0
831	N		431								
431	N		432	SH.ST.-(ZONE 7) PTW 2	7	182	189	182	189	0	0
832	N		432								
436	N		433	SH.ST.-(ZONE 8) L.10	2	178	180	178	180	0	0
833	N		433								
430	N		434	SH.ST.-(ZONE 8) PTW 1	2	172	174	172	174	0	0
834	N		434								
434	N		435	SH.ST.-(ZONE 8) L.11	2	174	176	174	176	0	0
835	N		435								
836	N		436	SH.ST.-(ZONE 8) PTW 2	2	176	178	176	178	0	0
435	N		436								
837	N		437	SH.ST.-L.11 NORTH SIDE	2	212	214	212	214	0	0
442	N		437								
838	N		438	SH.ST.-PTW 1 EAST(BTW L.11&6)	2	214	216	214	216	0	0
437	N		438								
438	N		439	SH.ST.-L.6 NORTH & N-EAST	3	216	219	216	219	0	0
839	N		439								
427	N		440	SH.ST.-PTW 2 EAST (10+80-FFA)	2	199	201	199	201	0	0
840	N		440								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
440	N		441	SH.ST.-PTW 2 EAST (F.F.A.)	1	201	202	201	202	0	0
841	N		441								
441	N		442	SH.ST.-PTW 2 EAST (FFA-28+23)	10	202	212	202	212	0	0
842	N		442								
501	N		500*	SH.A.C.-RW WEST (04+36-19+50)	7	253	260	254	261	1	(21)
700	N		500								
701	N		501	SH.A.C.-RW WEST (19+50-34+36)	8	243	251	246	254	3	2
539	N		501								
503	N		502	SH.A.C.-L.8 BOTH SIDES	4	89	93	136	140	47	0
702	N		502								
703	N		503	SH.A.C.-L.1 SOUTH-WEST	1	81	82	135	136	54	7
704	N		504	SH.A.C.-(ZONE 1) L.1	2	103	105	147	149	44	4
507	N		504								
705	N		505	SH.A.C.-(ZONE 1) RW	4	109	113	149	153	40	0
504	N		505								
505	N		506	SH.A.C.-(ZONE 1) FTO 2	2	113	115	153	155	40	0
706	N		506								
707	N		507	SH.A.C.-(ZONE 1) PTW 1	3	100	103	144	147	44	0
524	N		507								
708	N		508	SH.A.C.-(ZONE 2) FTO 2	3	116	119	155	158	39	0
506	N		508								
709	N		509	SH.A.C.-(ZONE 2) RW	1	119	120	158	159	39	0
508	N		509								
710	N		510	SH.A.C.-(ZONE 2) FTO 3	2	120	122	159	161	39	4
509	N		510								
711	N		511	SH.A.C.-(ZONE 2) PTW 1	2	172	174	190	192	18	0
515	N		511								
712	N		512	SH.A.C.-(ZONE 3) FTO 3	3	126	129	161	164	35	0
510	N		512								
713	N		513	SH.A.C.-(ZONE 3) RW	1	129	130	164	165	35	2
512	N		513								
513	N		514	SH.A.C.-(ZONE 3) FTO 4	3	132	135	165	168	33	0
714	N		514								
715	N		515	SH.A.C.-(ZONE 3) PTW 1	4	168	172	186	190	18	0
519	N		515								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
716	N		516	SH.A.C.-(ZONE 4) FTO 4	2	135	137	168	170	33	0
514	N		516								
516	N		517	SH.A.C.-(ZONE 4) RW	1	137	138	170	171	33	3
717	N		517								
718	N		518	SH.A.C.-(ZONE 4) FTO 5	3	141	144	171	174	30	0
517	N		518								
523	N		519	SH.A.C.-(ZONE 4) PTW 1	2	159	161	184	186	25	7
719	N		519								
518	N		520	SH.A.C.-(ZONE 5) FTO 5	2	144	146	174	176	30	5
720	N		520								
721	N		521	SH.A.C.-(ZONE 5) RW	4	151	155	176	180	25	0
520	N		521								
521	N		522	SH.A.C.-(ZONE 5) L.6	2	155	157	180	182	25	0
722	N		522								
522	N		523	SH.A.C.-(ZONE 5) PTW 1	2	157	159	182	184	25	0
723	N		523								
724	N		524	SH.A.C.-PTW 1 EAST & L.9 SOUTH	4	96	100	140	144	44	0
502	N		524								
526	N		525	SH.A.C.-(ZONE 6) L.9	1	202	203	215	216	13	0
725	N		525								
529	N		526	SH.A.C.-(ZONE 6) PTW 1	2	200	202	213	215	13	0
726	N		526								
727	N		527	SH.A.C.-(ZONE 5) L.7 (F.F.A.)	1	204	205	217	218	13	0
528	N		527								
525	N		528	SH.A.C.-(ZONE 6) PTW 2	1	203	204	216	217	13	0
728	N		528								
729	N		529	SH.A.C.-(ZONE 7) L.7 (F.F.A.)	1	199	200	212	213	13	0
532	N		529								
511	N		530	SH.A.C.-(ZONE 7) PTW 1	4	178	182	199	203	21	0
730	N		530								
731	N		531	SH.A.C.-(ZONE 7) L.10	1	186	187	207	208	21	8
533	N		531								
732	N		532	SH.A.C.-(ZONE 7) PTW 2	4	195	199	208	212	13	0
531	N		532								
733	N		533	SH.A.C.-(ZONE 8) L.10	1	185	186	206	207	21	0
536	N		533								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
530	N		534	SH.A.C.-(ZONE 8) PTW 1	1	182	183	203	204	21	0
734	N		534								
735	N		535	SH.A.C.-(ZONE 8) L.11	1	183	184	204	205	21	0
534	N		535								
736	N		536	SH.A.C.-(ZONE 8) PTW 2	1	184	185	205	206	21	0
535	N		536								
737	N		537	SH.A.C.-L.11 NORTH SIDE	1	228	229	228	229	0	0
542	N		537								
738	N		538	SH.A.C.-PTW 1 EAST(BTW L.11&6)	2	229	231	229	231	0	0
537	N		538								
739	N		539	SH.A.C.-L.6 NORTH & NORTH-EAST	2	231	233	231	233	0	0
538	N		539								
527	N		540	SH.A.C.-PTW 2 EAST(10+80-FFA)	2	205	207	218	220	13	0
740	N		540								
741	N		541	SH.A.C.-PTW 2 EAST(FFA)	1	207	208	220	221	13	13
540	N		541								
742	N		542	SH.A.C.-PTW 2 EAST(FFA-28+23)	7	221	228	221	228	0	0
541	N		542								
601	N		600	DRAIN.-RW WEST (04+36-19+50)	1	125	126	164	165	39	39
1	N		600								
639	N		601	DRAIN.-RW WEST (19+50-34+36)	7	118	125	151	158	33	0
1	N		601								
1	N		602	DRAIN.-L.8 BOTH SIDES	1	0	1	1	2	1	0
624	N		605	DRAIN.-(ZONE 1) RW	1	9	10	10	11	1	0
1	N		605								
605	N		608	DRAIN.-(ZONE 2) FTD 2	3	10	13	11	14	1	0
1	N		608								
608	N		609	DRAIN.-(ZONE 2) RW	2	13	15	14	16	1	0
1	N		609								
609	N		610	DRAIN.-(ZONE 2) FTD 3	1	15	16	16	17	1	0
1	N		610								
615	N		611*	DRAIN.-(ZONE 2) PTW 1	1	59	60	60	61	1	21
1	N		611								
610	N		612	DRAIN.-(ZONE 3) FTD 3	2	16	18	17	19	1	0
1	N		612								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
612 1	N N		613 613	DRAIN.-(ZONE 3) RW	3	18	21	19	22	1	0
613 207	N N		614 614	DRAIN.-(ZONE 3) FTD 4	4	21	25	22	26	1	0
619 1	N N		615 615	DRAIN.-(ZONE 3) PTW 1	7	52	59	53	60	1	0
614 207	N N		616 616	DRAIN.-(ZONE 4) FTD 4	3	25	28	26	29	1	0
616 1	N N		617 617	DRAIN.-(ZONE 4) RW	2	28	30	29	31	1	0
617 208	N N		618 618	DRAIN.-(ZONE 4) FTD 5	3	30	33	31	34	1	0
623 201	N N		619 619	DRAIN.-(ZONE 4) PTW 1	3	49	52	50	53	1	0
618 208	N N		620 620	DRAIN.-(ZONE 5) FTD 5	3	33	36	34	37	1	0
620 1	N N		621 621	DRAIN.-(ZONE 5) RW	7	36	43	37	44	1	0
621 201	N N		622 622	DRAIN.-(ZONE 5) L.6	3	43	46	44	47	1	0
622 201	N N		623 623	DRAIN.-(ZONE 5) PTW 1	3	46	49	47	50	1	0
602 1	N N		624 624	DRAIN.-PTW 1 EAST & L.9 SOUTH	8	1	9	2	10	1	0
628 210	N N		627 627	DRAIN.-(ZONE 6) L.7 (F.F.A.)	3	93	96	126	129	33	0
629 1	N N		628 628	DRAIN.-(ZONE 6) PTW 2	3	90	93	123	126	33	0
632 210	N N		629 629	DRAIN.-(ZONE 7) L.7 (F.F.A.)	1	89	90	122	123	33	0
611 1	N N	*	630 630	DRAIN.-(ZONE 7) PTW 1	7	62	69	95	102	33	0
633 205	N N		631 631	DRAIN.-(ZONE 7) L.10	3	79	82	112	115	33	0
631 1	N N		632 632	DRAIN.-(ZONE 7) PTW 2	7	82	89	115	122	33	0

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
636 205	N N		633 633	DRAIN.-(ZONE 8) L.10	3	76	79	109	112	33	0
630 201	N N		634 634	DRAIN.-(ZONE 8) PTW 1	2	69	71	102	104	33	0
634 206	N N		635 635	DRAIN.-(ZONE 8) L.11	3	71	74	104	107	33	0
635 1	N N		636 636	DRAIN.-(ZONE 8) PTW 2	2	74	76	107	109	33	0
642 1	N N		637 637	DRAIN.-L.11 NORTH SIDE	3	109	112	142	145	33	0
637 201	N N		638 638	DRAIN.-PTW 1 EAST(BTW L.11&6)	2	112	114	145	147	33	0
638 201	N N		639 639	DRAIN.-L.6 NORTH & NORTH-EAST	4	114	118	147	151	33	0
627 1	N N		640 640	DRAIN.-PTW 2 EAST(10+80-FFA)	2	96	98	129	131	33	0
640 203	N N		641 641	DRAIN.-PTW 2 EAST(FFA)	2	98	100	131	133	33	0
641 1	N N		642 642	DRAIN.-PTW 2 EAST(FFA-28+23)	9	100	109	133	142	33	0
400 701	N N		700* 700	PVC C.P.-RW WEST (04+36-19+50)	10	243	253	243	253	0	0
739 401	N N		701 701	PVC C.P.-RW WEST (19+50-34+36)	11	232	243	232	243	0	0
703 402	N N		702 702	PVC C.P.-L.8 BOTH SIDES	4	85	89	111	115	26	0
403	N		703	PVC C.P.-L.1 SOUTH-WEST	1	80	81	110	111	30	0
707 404	N N		704 704	PVC C.P.-(ZONE 1) L.1	3	100	103	124	127	24	0
704 405	N N		705 705	PVC C.P.-(ZONE 1) RW	5	104	109	127	132	23	0
705 406	N N		706 706	PVC C.P.-(ZONE 1) FTO 2	3	109	112	132	135	23	0
407 724	N N		707 707	PVC C.P.-(ZONE 1) PTW 1	4	96	100	120	124	24	0

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
706 408	N N		708 708	PVC C.P.-(ZONE 2) FTO 2	4	112	116	135	139	23	0
708 409	N N		709 709	PVC C.P.-(ZONE 2) RW	1	116	117	139	140	23	0
709 410	N N		710 710	PVC C.P.-(ZONE 2) FTO 3	3	117	120	140	143	23	0
715 411	N N		711 711	PVC C.P.-(ZONE 2) PTW 1	2	168	170	182	184	14	2
710 412	N N		712 712	PVC C.P.-(ZONE 3) FTO 3	4	122	126	143	147	21	0
712 413	N N		713 713	PVC C.P.-(ZONE 3) RW	1	126	127	147	148	21	1
713 414	N N		714 714	PVC C.P.-(ZONE 3) FTO 4	4	128	132	148	152	20	0
719 415	N N		715 715	PVC C.P.-(ZONE 3) PTW 1	6	162	168	176	182	14	0
714 416	N N		716 716	PVC C.P.-(ZONE 4) FTO 4	3	132	135	152	155	20	0
716 417	N N		717 717	PVC C.P.-(ZONE 4) RW	1	135	136	155	156	20	1
717 418	N N		718 718	PVC C.P.-(ZONE 4) FTO 5	4	137	141	156	160	19	0
723 419	N N		719 719	PVC C.P.-(ZONE 4) PTW 1	2	157	159	174	176	17	0
718 420	N N		720 720	PVC C.P.-(ZONE 5) FTO 5	3	141	144	160	163	19	0
720 421	N N		721 721	PVC C.P.-(ZONE 5) RW	5	146	151	163	168	17	0
721 422	N N		722 722	PVC C.P.-(ZONE 5) L.6	3	151	154	168	171	17	0
722 423	N N		723 723	PVC C.P.-(ZONE 5) PTW 1	3	154	157	171	174	17	0
424 702	N N		724 724	PVC C.P.-PTW 1 EAST&L.9 SOUTH	5	91	96	115	120	24	0
726 425	N N		725 725	PVC C.P.-(ZONE 6) L.9	1	198	199	206	207	8	0

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
729	N		726	PVC C.P.-(ZONE 6) PTW 1	2	196	198	204	206	8	0
426	N		726								
728	N		727	PVC C.P.-(ZONE 6) L.7 (FFA)	1	200	201	208	209	8	0
427	N		727								
725	N		728	PVC C.P.-(ZONE 6) PTW 2	1	199	200	207	208	8	0
428	N		728								
732	N		729	PVC C.P.-(ZONE 7) L.7 (FFA)	1	195	196	203	204	8	0
429	N		729								
711	N		730	PVC C.P.-(ZONE 7) PTW 1	6	172	178	184	190	12	0
430	N		730								
733	N		731	PVC C.P.-(ZONE 7) L.10	1	184	185	196	197	12	1
431	N		731								
731	N		732	PVC C.P.-(ZONE 7) PTW 2	6	189	195	197	203	8	0
432	N		732								
736	N		733	PVC C.P.-(ZONE 8) L.10	1	183	184	195	196	12	0
433	N		733								
730	N		734	PVC C.P.-(ZONE 8) PTW 1	2	178	180	190	192	12	0
434	N		734								
435	N		735	PVC C.P.-(ZONE 8) L.11	1	180	181	192	193	12	0
734	N		735								
735	N		736	PVC C.P.-(ZONE 8) PTW 2	2	181	183	193	195	12	0
436	N		736								
437	N		737	PVC C.P.-L.11 NORTH SIDE	1	221	222	225	226	4	0
742	N		737								
438	N		738	PVC C.P.-PTW 1 EAST(BT.L.11&6)	2	222	224	226	228	4	0
737	N		738								
738	N		739	PVC C.P.-L.6 NORTH & N-EAST	3	224	227	228	231	4	4
439	N		739								
727	N		740	PVC C.P.-PTW 2 EAST(10+80-FFA)	2	201	203	209	211	8	0
440	N		740								
740	N		741	PVC C.P.-PTW 2 EAST(FFA)	1	203	204	211	212	8	3
441	N		741								
741	N		742	PVC C.P.-PTW 2 EAST(FFA-28+23)	9	212	221	212	221	0	0
442	N		742								
801	N		800*	MUL.C.P.-RW WEST (04+36-19+50)	6	165	171	165	171	0	(61)
300	N		800								
600	N		800								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
839	N		801	MUL.C.P.-RW WEST (19+50-34+36)	7	158	165	158	165	0	0
601	N		801								
301	E-S	8	801								
803	N		802	MUL.C.P.-L.8 BOTH SIDES	3	10	13	77	80	67	0
602	N		802								
303	E-S	8	803	MUL.C.P.-L.1 SOUTH-WEST	1	9	10	76	77	67	0
807	N		804	MUL.C.P.-(ZONE 1) L.1	2	19	21	86	88	67	0
304	E-S	8	804								
804	N		805	MUL.C.P.-(ZONE 1) RW	3	21	24	88	91	67	0
305	E-S	8	805								
605	N		805								
805	N		806	MUL.C.P.-(ZONE 1) FTD 2	2	24	26	91	93	67	0
306	E-S	8	806								
824	N		807	MUL.C.P.-(ZONE 1) PTW 1	2	17	19	84	86	67	0
1	N		807								
806	N		808	MUL.C.P.-(ZONE 2) FTD 2	3	26	29	93	96	67	0
308	E-S	8	808								
608	N		808								
808	N		809	MUL.C.P.-(ZONE 2) RW	1	29	30	96	97	67	0
309	E-S	8	809								
609	N		809								
809	N		810	MUL.C.P.-(ZONE 2) FTD 3	2	30	32	97	99	67	0
310	E-S	8	810								
610	N		810								
815	N		811	MUL.C.P.-(ZONE 2) PTW I	1	63	64	127	128	64	6
611	N		811								
810	N		812	MUL.C.P.-(ZONE 3) FTD 3	3	32	35	99	102	67	0
312	E-S	8	812								
612	N		812								
812	N		813	MUL.C.P.-(ZONE 3) RW	1	35	36	102	103	67	0
313	E-S	8	813								
613	N		813								
813	N		814	MUL.C.P.-(ZONE 3) FTD 4	3	36	39	103	106	67	0
314	E-S	8	814								
614	N		814								
819	N		815	MUL.C.P.-(ZONE 3) PTW 1	4	59	63	123	127	64	0
315	E-S	8	815								
615	N		815								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EF - J	LS - J	LF - J	GF-J	FF-J
814	N		816	MUL.C.P.-(ZONE 4) FTO 4	2	39	41	106	108	67	0
316	E-S	8	816								
616	N		816								
816	N		817	MUL.C.P.-(ZONE 4) RW	1	41	42	108	109	67	0
317	E-S	8	817								
617	N		817								
817	N		818	MUL.C.P.-(ZONE 4) FTO 5	3	42	45	109	112	67	0
318	E-S	8	818								
618	N		818								
823	N		819	MUL.C.P.-(ZONE 4) PTW 1	1	55	56	122	123	67	3
319	E-S	8	819								
619	N		819								
818	N		820	MUL.C.P.-(ZONE 5) FTO 5	2	45	47	112	114	67	0
320	E-S	8	820								
620	N		820								
820	N		821	MUL.C.P.-(ZONE 5) RW	4	47	51	114	118	67	0
321	E-S	8	821								
621	N		821								
821	N		822	MUL.C.P.-(ZONE 5) L.6	2	51	53	118	120	67	0
322	E-S	8	822								
622	N		822								
822	N		823	MUL.C.P.-(ZONE 5) PTW 1	2	53	55	120	122	67	0
323	E-S	8	823								
623	N		823								
802	N		824	MUL.C.P.-PTW 1 EAST(L.9 SOUTH	4	13	17	80	84	67	0
624	N		824								
826	N		825	MUL.C.P.-(ZONE 6) L.9	1	143	144	143	144	0	0
1	N		825								
829	N		826	MUL.C.P.-(ZONE 6) PTW 1	1	142	143	142	143	0	0
1	N		826								
828	N		827	MUL.C.P.-(ZONE 6) L.7 (FFA)	1	145	146	145	146	0	0
627	N		827								
327	E-S	8	827								
825	N		828	MUL.C.P.-(ZONE 6) PTW 2	1	144	145	144	145	0	0
328	E-S	8	828								
628	N		828								
832	N		829	MUL.C.P.-(ZONE 7) L.7 (FFA)	1	141	142	141	142	0	0
629	N		829								
329	E-S	8	829								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
330	E-S	8	830	MUL.C.P.-(ZONE 7) PTW 1	4	70	74	128	132	58	0
811	N		830								
630	N		830								
631	N		831	MUL.C.P.-(ZONE 7) L.10	1	82	83	136	137	54	6
833	N		831								
331	E-S	8	831								
332	E-S	8	832	MUL.C.P.-(ZONE 7) PTW 2	4	89	93	137	141	48	48
831	N		832								
632	N		832								
333	E-S	8	833	MUL.C.P.-(ZONE 8) L.10	1	79	80	135	136	56	2
836	N		833								
633	N		833								
830	N		834	MUL.C.P.-(ZONE 8) PTW 1	1	74	75	132	133	58	0
334	E-S	8	834								
634	N		834								
834	N		835	MUL.C.P.-(ZONE 8) L.11	1	75	76	133	134	58	0
335	E-S	8	835								
635	N		835								
835	N		836	MUL.C.P.-(ZONE 8) PTW 2	1	76	77	134	135	58	2
336	E-S	8	836								
636	N		836								
842	N		837	MUL.C.P.-L.11 NORTH SIDE	1	154	155	154	155	0	0
637	N		837								
337	E-S	8	837								
837	N		838	MUL.C.P.-PTW 1 EAST(BT.L.11&6)	1	155	156	155	156	0	0
638	N		838								
338	E-S	8	838								
838	N		839	MUL.C.P.-L.6 NORTH & N-EAST	2	156	158	156	158	0	0
639	N		839								
339	E-S	8	839								
827	N		840	MUL.C.P.-PTW 2 EAST(10+80-FFA)	1	146	147	146	147	0	0
340	E-S	8	840								
640	N		840								
840	N		841	MUL.C.P.-PTW 2 EAST(FFA)	1	147	148	147	148	0	0
641	N		841								
362	E-S	8	841								
841	N		842	MUL.C.P.-PTW 2 EAST(FFA-28+23)	6	148	154	148	154	0	0
642	N		842								
343	E-S	8	842								
344	E-E	8	842								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
905	N		900	TOP SOIL-RW WEST (04+36-19+50)	15	266	281	266	281	0	0
600	N		900								
500	E-E	0	900								
900	N		901	TOP SOIL-RW WEST (19+50-34+36)	16	281	297	281	297	0	0
501	E-E	0	901								
601	N		901								
502	E-E	0	902	TOP SOIL-BETWEEN L.1 & L.8	3	90	93	167	170	77	0
602	N		902								
503	E-E	0	902								
902	N		903	TOP SOIL-L.8 SOUTH-EAST	2	93	95	170	172	77	2
602	N		903								
502	E-E	0	903								
524	E-E	0	904	TOP SOIL-PTW 1 EAST&L.9 SOUTH	3	97	100	172	175	75	4
903	N		904								
624	N		904								
912	N		905	TOP SOIL-PTW 2 EAST&L.11 NORTH	16	250	266	250	266	0	0
537	E-E	0	905								
542	E-E	0	905								
541	E-E	0	905								
540	E-E	0	905								
637	N		905								
642	N		905								
641	N		905								
640	N		905								
539	F-E	0	906	TOP SOIL-PTW 1 EAST&L.6 N&N-E	14	219	233	219	233	0	0
538	E-E	0	906								
911	N		906								
639	N		906								
638	N		906								
506	E-E	0	907	TOP SOIL-ZONE 1	11	104	115	175	186	71	53
904	N		907								
504	E-E	0	907								
507	E-E	0	907								
605	N		907								
505	E-E	0	907								
511	E-E	0	908	TOP SOIL-ZONE 2	6	168	174	186	192	18	0
907	N		908								
509	E-E	0	908								
508	E-F	0	908								
611	N		908								
610	N		908								
609	N		908								
608	N		908								
510	E-E	0	908								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	LE - J	GF-J	FF-J
908	N		909	TOP SOIL-ZONE 3	12	174	186	192	204	18	0
515	E-E	0	909								
514	E-E	0	909								
513	E-E	0	909								
615	N		909								
614	N		909								
613	N		909								
612	N		909								
512	E-E	0	909								
909	N		910	TOP SOIL-ZONE 4	5	186	191	204	209	18	0
519	E-E	0	910								
518	E-E	0	910								
517	E-E	0	910								
516	E-E	0	910								
619	N		910								
618	N		910								
617	N		910								
616	N		910								
910	N		911	TOP SOIL-ZONE 5	10	191	201	209	219	18	18
523	E-E	0	911								
522	E-E	0	911								
521	E-E	0	911								
623	N		911								
622	N		911								
621	N		911								
620	N		911								
520	E-E	0	911								
913	N		912	TOP SOIL-ZONE 6	4	246	250	246	250	0	0
528	E-E	0	912								
525	E-E	0	912								
526	E-E	0	912								
627	N		912								
628	N		912								
527	E-E	0	912								
914	N		913	TOP SOIL-ZONE 7	10	236	246	236	246	0	0
529	E-E	0	913								
532	E-E	0	913								
530	E-E	0	913								
629	N		913								
632	N		913								
631	N		913								
630	N		913								
531	E-E	0	913								
906	N		914	TOP SOIL-ZONE 8	3	233	236	233	236	0	0
533	E-E	0	914								
536	E-E	0	914								
535	E-E	0	914								
534	E-E	0	914								
633	N		914								
636	N		914								
634	N		914								
635	N		914								

JOB - I	TYP	T.D.	JOB - J	JOB - DESCRIPTION	D-J	ES - J	EE - J	LS - J	E - J	GF-J	FF-J
901	N		1000	PROJECT END	0	297	297	297	297	0	0
900	N		1000								
905	N		1000								
912	N		1000								
913	N		1000								
914	N		1000								
906	N		1000								
911	N		1000								
910	N		1000								
909	N		1000								
364	N		1000								
908	N		1000								
369	N		1000								
368	N		1000								
366	N		1000								
360	N		1000								
349	N		1000								
363	N		1000								
355	N		1000								
350	N		1000								
353	N		1000								
352	N		1000								
356	N		1000								
357	N		1000								
351	N		1000								
354	N		1000								
370	N		1000								
907	N		1000								
904	N		1000								
903	N		1000								
902	N		1000								
345	N		1000								
367	N		1000								
348	N		1000								
347	N		1000								
346	N		1000								
101	N		1000								
365	N		1000								

STOP 501

ONE CRITICAL PATH

JOBCODE	START	END	
403	79	80	
402	80	85	
424	85	91	
407	91	95	
404	95	98	
405	98	104	
406	104	107	
408	107	112	
409	112	114	
410	114	117	
412	117	122	
413	122	123	
414	123	128	
416	128	131	
417	131	132	
418	132	137	
420	137	140	
421	140	146	
422	146	149	
423	149	152	
419	152	155	
415	155	162	
411	162	165	
430	165	172	
434	172	174	
435	174	176	
436	176	178	
433	178	180	
431	180	182	
432	182	189	
429	189	191	
426	191	193	
425	193	195	
428	195	197	
427	197	199	
440	199	201	
441	201	202	
442	202	212	
742	212	221	
542	221	228	
537	228	229	
538	229	231	
539	231	233	
906	219	233	NEUTRAL
914	233	236	
913	236	246	
912	246	250	
905	250	266	
900	266	281	
901	281	297	

WORK CALENDAR

BT	0	1	2	3	4	5	6	7	8	9
0	1 10 70	2 10 70	3 10 70	5 10 70	6 10 70	7 10 70	8 10 70	9 10 70	10 10 70	12 10 70
10	13 10 70	14 10 70	15 10 70	16 10 70	17 10 70	19 10 70	20 10 70	21 10 70	22 10 70	23 10 70
20	24 10 70	26 10 70	27 10 70	28 10 70	31 10 70	2 11 70	3 11 70	4 11 70	5 11 70	6 11 70
30	7 11 70	9 11 70	10 11 70	11 11 70	12 11 70	13 11 70	14 11 70	16 11 70	17 11 70	18 11 70
40	19 11 70	20 11 70	21 11 70	23 11 70	24 11 70	25 11 70	26 11 70	27 11 70	28 11 70	30 11 70
50	1 12 70	2 12 70	3 12 70	4 12 70	5 12 70	7 12 70	8 12 70	9 12 70	10 12 70	11 12 70
60	12 12 70	14 12 70	16 4 71	17 4 71	19 4 71	20 4 71	21 4 71	22 4 71	24 4 71	26 4 71
70	27 4 71	28 4 71	29 4 71	30 4 71	3 5 71	4 5 71	5 5 71	6 5 71	7 5 71	8 5 71
80	10 5 71	11 5 71	12 5 71	13 5 71	14 5 71	15 5 71	17 5 71	18 5 71	20 5 71	21 5 71
90	22 5 71	24 5 71	25 5 71	26 5 71	28 5 71	29 5 71	31 5 71	1 6 71	2 6 71	3 6 71
100	4 6 71	5 6 71	7 6 71	8 6 71	9 6 71	10 6 71	11 6 71	12 6 71	14 6 71	15 6 71
110	16 6 71	17 6 71	18 6 71	19 6 71	21 6 71	22 6 71	23 6 71	24 6 71	25 6 71	26 6 71
120	28 6 71	29 6 71	30 6 71	1 7 71	2 7 71	3 7 71	5 7 71	6 7 71	7 7 71	8 7 71
130	9 7 71	10 7 71	12 7 71	13 7 71	14 7 71	15 7 71	16 7 71	17 7 71	19 7 71	20 7 71
140	21 7 71	22 7 71	23 7 71	24 7 71	26 7 71	27 7 71	28 7 71	29 7 71	30 7 71	31 7 71
150	2 8 71	3 8 71	4 8 71	5 8 71	6 8 71	7 8 71	9 8 71	10 8 71	11 8 71	12 8 71
160	13 8 71	14 8 71	16 8 71	17 8 71	18 8 71	19 8 71	20 8 71	21 8 71	23 8 71	24 8 71
170	25 8 71	26 8 71	27 8 71	28 8 71	31 8 71	1 9 71	2 9 71	3 9 71	4 9 71	6 9 71
180	7 9 71	8 9 71	9 9 71	10 9 71	11 9 71	13 9 71	14 9 71	15 9 71	16 9 71	17 9 71
190	18 9 71	20 9 71	21 9 71	22 9 71	23 9 71	24 9 71	25 9 71	27 9 71	28 9 71	29 9 71
200	30 9 71	1 10 71	2 10 71	4 10 71	5 10 71	6 10 71	7 10 71	8 10 71	9 10 71	11 10 71
210	12 10 71	13 10 71	14 10 71	15 10 71	16 10 71	18 10 71	19 10 71	20 10 71	21 10 71	22 10 71
220	23 10 71	25 10 71	26 10 71	27 10 71	28 10 71	1 11 71	2 11 71	3 11 71	4 11 71	5 11 71
230	6 11 71	8 11 71	9 11 71	10 11 71	11 11 71	12 11 71	13 11 71	15 11 71	16 11 71	17 11 71
240	18 11 71	19 11 71	21 11 71	22 11 71	23 11 71	24 11 71	25 11 71	26 11 71	27 11 71	29 11 71
250	30 11 71	1 12 71	2 12 71	3 12 71	4 12 71	6 12 71	7 12 71	8 12 71	9 12 71	10 12 71
260	11 12 71	13 12 71	14 12 71	15 12 71	16 12 71	17 12 71	18 12 71	20 12 71	21 12 71	22 12 71
270	23 12 71	24 12 71	25 12 71	27 12 71	28 12 71	29 12 71	30 12 71	31 12 71	3 1 72	4 1 72
280	5 1 72	6 1 72	7 1 72	8 1 72	10 1 72	11 1 72	12 1 72	13 1 72	14 1 72	15 1 72
290	17 1 72	18 1 72	19 1 72	20 1 72	21 1 72	22 1 72	24 1 72	25 1 72		

JOB - J	JOB - DESCRIPTION	START	FINISH		
1	PROJECT START	1 10 70	1 10 70	* 0	* 100 *
100	E.MOVING-UNDER PAVEMENTS (N&E)	1 10 70	10 10 70	* 0	* 100 *
101	E.MOVING-OUT.PAVEMENTS (N&E)	12 10 70	6 11 70	* 0	* 100 *
102	E.MOVING-FUEL FARM AREA	7 11 70	14 11 70	* 0	* 100 *
110	BORROW & FILL S.MTL-OUT.F.F.A.	1 10 70	23 10 70	* 0	* 100 *
111	BORROW & FILL S.MTL-F.F.A.	16 11 70	21 11 70	* 0	* 100 *
201	LC-PTW 1(24+60) TO END OF L.6	17 10 70	4 11 70	* 0	* 100 *
203	LC-PTW 2(FUEL FARM AREA)	28 11 70	30 11 70	* 0	* 100 *
205	LC-L.10	10 11 70	14 11 70	* 0	* 100 *
206	LC-L.11	5 11 70	9 11 70	* 0	* 100 *
207	LC-FTO 4	1 10 70	8 10 70	* 0	* 100 *
208	LC-FTO 5	9 10 70	16 10 70	* 0	* 100 *
209	LC-PTW 1(FUEL FARM AREA)	1 12 70	5 12 70	* 0	* 100 *
210	LC-L.7 (FUEL FARM AREA)	23 11 70	27 11 70	* 0	* 100 *
300	PQC-RW STP.6 (04+36-19+50)	3 6 71		* 0	* 100 *
301	PQC-RW STP.6 (19+50-34+36)	25 5 71	2 6 71	* 0	* 100 *
303	PQC-L.1 SOUTH-WEST STP.	1 10 70	1 10 70	* 0	* 100 *
304	PQC-(ZONE 1) L.1	2 10 70	3 10 70	* 0	* 100 *
305	PQC-(ZONE 1) RW	5 10 70	6 10 70	* 0	* 100 *
306	PQC-(ZONE 1) FTO 2	7 10 70	8 10 70	* 0	* 100 *
308	PQC-(ZONE 2) FTO 2	9 10 70	12 10 70	* 0	* 100 *
309	PQC-(ZONE 2) RW	13 10 70	13 10 70	* 0	* 100 *
310	PQC-(ZONE 2) FTO 3	14 10 70	15 10 70	* 0	* 100 *
312	PQC-(ZONE 3) FTO 3	16 10 70	19 10 70	* 0	* 100 *
313	PQC-(ZONE 3) RW	20 10 70	20 10 70	* 0	* 100 *
314	PQC-(ZONE 3) FTO 4	21 10 70	23 10 70	* 0	* 100 *
315	PQC-(ZONE 3) PTW 1	20 11 70	24 11 70	* 0	* 100 *
316	PQC-(ZONE 4) FTO 4	24 10 70	26 10 70	* 0	* 100 *
317	PQC-(ZONE 4) RW	27 10 70	27 10 70	* 0	* 100 *

APPENDIX D

GLOSSARY

Borrow and Fill of the Selected Material - Seçme Malzeme Ariyet ve Dolgusu

Drainage - Drenaj

Earth Moving - Toprak İşleri

FTO (Fast Turn-off) - Sürat Geçidi

L.C. (Lean Concrete) - Zayıf Temel Betonu

Lay.Top Soil - Nebati Toprak Serilmesi

Link - Bağlantı

Mult.Cab.Pas.(Multi-cell Cable Passes) - Çok delikli Kablo geçitleri

P.Q.C. (Pavement Quality Concrete) - Kaplama Beton

Project End - Proje Bitimi

Project Start - Proje Başlangıcı

PTW (Parallel Taxiway) - Paralel Servis Yolu

PVC Cab.P.(PVC Cable Pipes) - PVC Kablo Boruları

Runway - Pist

Sh.Asp.C. (Forming Asphaltic Concrete Layer on Shoulders) - Banketlerin Beton-Asfaltla Kaplanması

Sh.St.(Shoulder Stabilization)- Banket Stabilizasyonu

Zone - Bölge