การพัฒนาการวางแผนทรัพยากรมนุษย์สำหรับหน่วยเครื่องมือระบบควบคุม

นาย ฉัตรชัย มาวงศ์

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DEVELOPMENT OF HUMAN RESOURCE PLANNING FOR CONTROL INSTRUMENT PROJECT DEPARTMENT

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for the Degree of Master of Engineering in Engineering Management

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(DEVELOPMENT OF HUMAN RESOURCE PLANNING FOR CONTROL INSTRUMENT PROJECT DEPARTMENT)

อ. ที่ปรึกษา : รศ. ดร.ชูเวช ชาญสง่าเวช, อ. ที่ปรึกษาร่วม :นาย วิวัฒน์ ชาญเชิงพานิช

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การวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาการวางแผนทรัพยากรมนุษย์สำหรับหน่วยเครื่องมือระบบควบคุมในโครงการก่อสร้างโรงไฟฟ้าพลังความร้อนร่วมราชบุรี โดยการใช้ Microsoft Project ช่วยในการวางแผนนี้ การพัฒนาดังกล่าวจะครอบคลุมใน 3 หัวข้อหลักคือ การวางแผนการทำงานของทรัพยากรมนุษย์, การวางแผนการใช้ทรัพยากรมนุษย์ และ การวางแผนการใช้เงินงบประมาณสำหรับทรัพยากรมนุษย์ นอกจากนี้การวางแผนดังกล่าวสามารถนำไปประยุกต์ใช้สำหรับหน่วยงานอื่นๆ ของโครงการก่อสร้างโรงไฟฟ้าในอนาคตได้อีกด้วย

ขั้นตอนการวิจัยเริ่มด้วยการศึกษาและรวบรวมวิธีการการวางแผนทรัพยากรมนุษย์จากแหล่งข้อมูลต่างๆ และนำข้อมูลที่ได้ไปกำหนดหัวข้อที่ต้องการศึกษา จากนั้นจะเริ่มดำเนินการเก็บข้อมูลที่ต้องการใช้เพื่ออ้างอิงและเพื่อการพัฒนาการวางแผนทรัพยากรมนุษย์ ขั้นตอนต่อไปจะเสนอวิธีการวางแผนอย่างเป็นระบบโดยปรับปรุงมาจากการวางแผนทรัพยากรมนุษย์ของ Department of Health and Human Services (HHS) ประกอบไปด้วย 6 ขั้นตอน คือ Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis, Solution Analysis and Evaluation วิธีการดังกล่าวจะนำไปวางแผนทรัพยากรมนุษย์ของหน่วยเครื่องมือระบบควบคุมในปีงบประมาณ 2543 แล้วนำผลที่ได้ไปเปรียบเทียบกับวิธีการวางแผนแบบเดิมในปีงบประมาณเดียวกันเพื่ออภิปรายผลการพัฒนาวิธีการวางแผน และผลการเปรียบเทียบ

จากการพัฒนาการวางแผนสรุปได้ว่า วิธีการวางแผนอย่างเป็นระบบสามารถวางแผนการทำงานของทรัพยากรมนุษย์, วางแผนการใช้ทรัพยากรมนุษย์ และ วางแผนการใช้เงินงบประมาณสำหรับทรัพยากรมนุษย์ ได้ใกล้เคียงกับความเป็นจริงมากกว่าวิธีการวางแผนแบบเดิม และวิธีการที่ได้สามาถนำไปประยุกต์ใช้ใช้สำหรับหน่วยงานอื่นๆ ของโครงการก่อสร้างโรงไฟฟ้าในอนาคตได้อีกด้วย

ผลจากการวิจัยนี้คือ สามารถปรับปรุงแผนการทำงานของทรัพยากรมนุษย์, แผนการใช้ทรัพยากรมนุษย์ และ แผนการใช้เงินงบประมาณสำหรับทรัพยากรมนุษย์ ได้ใกล้เคียงกับความเป็นจริงมากกว่าวิธีการวางแผนแบบเดิมโดยเฉลี่ยถึง 29%, 22% และ 3% ตามลำดับ โดยถ้าคิดเป็นจำนวนเงินสามารถลดเงินงบประมาณลงได้โดยเฉลี่ย 1.7 ล้านบาทต่อปีงบประมาณ

ศูนย์ระดับภูมิภาคทางวิศวกรรมการผลิต ลายมือชื่อนิสิต..

สาขาวิชา การจัดการทางวิศวกรรม ลายมือชื่ออาจารย์ที่ปรึกษา...

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CHATCHAI MAWONG: DEVELOPMENT OF HUMAN RESOURCE PLANNING FOR CONTROL INSTRUMENT PROJECT DEPARTMENT. THESIS ADVISOR: ASSOC. PROF. CHUVEJ CHANSA-NGAVEJ, Ph.D. THESIS CO-ADVISOR: Mr. WIWAT CHANCHERNGPANICH, 111 pp., ISBN: 974-13-0574-5

This study aims to develop human resource planning for Control Instrument Project Department, Ratchaburi Combined Cycle Plant Construction Project by using Microsoft Project as a tool. This development is focused on three main topics: Workload planning, Utilization planning and Budget planning. It can also apply to other departments in power plant construction project.

The research methodologies were initiated to study and gather the data and methods of human resource planning from various sources so that the development topics could be determined in specific areas. Then, the required data would be collected in order to use for reference and development of human resource planning. After that, a systematic method was proposed in six steps: Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis, Solution Analysis and Evaluation. This method was based on the workforce planning of Department of Health and Human Services (HHS). In next step, the proposed method was applied to plan the human resource of Control Instrument Project Department in fiscal year 2000. Its results then would be compared with the existing method in the same fiscal year and discussed in several areas. Finally, the outcomes of development would be concluded and recommended.

The conclusions from the development of human resource planning for Control Instrument Project Department show that the proposed method more minimize the workload planning, utilization planning and budget planning than the existing method. In addition, It can apply to other departments in power plant construction project.

The findings of this thesis provide the minimization of workload plan by 29%, utilization plan by 22% and budget plan by 3%. In other word, the budget can be minimized to 1.7 million bath per fiscal year.

The Regional Centre for Manufacturing Systems Engineering	Student's signature………………...……...
Field of Study Engineering Management	Advisor's signature…………………….…..
Academic year 2000	Co-advisor's signature……………………

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CHAPTER 1

INTRODUCTION

1.1 Background

EGAT, Electricity Generating Authority of Thailand is a state enterprise of Thailand, which has main responsibilities to produce and distribute electricity energy to two main distributing utilities namely Metropolitan Electricity Authority [MEA] and Provincial Electricity Authority [PEA]. In addition, EGAT sells directly to a small number of large industries and to neighboring utilities namely Electriccite du Loas [EDL] and Tenaga Nasional Berrdhad [TNB] of Malaysia. In response to the fast increase in power demand, EGAT has to expand the investment in the power construction. Thus, the construction division plays a main role to serve that situation.

Ratchaburi Power Plant Project is the largest power plant construction of EGAT. This project comprises three blocks of Combined Cycle Power Plant and two units of Thermal Power Plant. The rated capacity of each combined cycle block is 600 MW, consisting of two 200 MW heavy gas turbine units with two waste heat boilers and one 200 MW steam turbine generating unit. Consequently, the total capacity of combined cycle power plant is 1,800 MW. In addition, the total capacity of thermal power plant is 1,400 MW, consisting of 700 MW per unit.

The Ratchaburi Power Plant Construction is organized by functional departments and divided into construction unit and support unit. The construction unit consists of Civil Department, Mechanical Department, Electrical Department and Control & Instrument Department. These units conduct the construction works in accordance with the Technical Specification Document (TSD) of the project contract. The support unit serves the construction unit to make sure that the construction unit proceeds smoothly. The support unit includes Construction Coordination Department, Account & Treasury Department, Supply & Procurement Department, Personnel Section, Legal Counselor section, Health Section and Safety Section.

For construction work, the Civil Department constructs the foundations and building whereas the Mechanical Department constructs the steel structure work, then installs the machine and mechanical equipment. Finally, the Electrical Department and the Control & Instrument Department equip and approve the mechanical and electrical control systems. These works must be completed before the power plant is handed to the Operator and Maintenance Division which will generate the electric power linked to the existing power system of EGAT and then distribute to the customers.

The Control & Instrument Department is a construction unit that consists of a manpower about 126 people. This department is divided into two main groups: the Combined Cycle Plant group and the Thermal Power Plant group. The manpower of Combined Cycle Plant group is organized into three sections: the Mechanical C&I Section, the Information C&I Section and the Electrical C&I Section. ***First, the Mechanical C&I Section*** has main responsibility to equip the local control instrument that includes the control measurement, the signal transmitter, the control valve positioner and actuator. The control instrument is the sensor that is used to measure the variable parameters in the power plant processes such as flow measurement, pressure measurement, level measurement, temperature measurement, etc. These measurement signals are interfaced to the control system by signal transmitters. The signal transmitters standardize the measured signals and send them to the control system. Most of the control valves in the power plant are pneumatic and hydraulic valves. Each valve can be moved by its actuator. When the actuator is forced to move in any position by operator commands, the positioner which is equipped on the valve, detects the position signal of valve and standardizes the signals in order to send them to control system. ***Second, the Information C&I Section*** is responsible to setting up the control network and information system supporting the control system of the power plant. The control network is the communication route of the control signal. The information system is related to the graphical display of the control system and the database of the alarm signals. It has to be finished before the control function of the power plant is tested. ***Finally, the Electrical C&I Section*** has the responsibility to set up the control system. Its scope of work is to install the control cabinets, interface the control signal from local instrument to control cabinets and test and approve the control function of power plant. For the Thermal Power Plant group, the manpower is also organized into three sections. Their functions are the same as the Combined Cycle Plant group. However, the detail of the control system differs by designs and suppliers.

The major resource in the construction project is the manpower, both technical and nontechnical. People are distinguished from other resources because of the ability to learn, adapt to new project situations and set goals. A systematic process can be applied to the construction project in order to improve the human resource planning. Consequently, the project managers can ensure that the number of employees both quality and quantity are sufficient.

1.2 Problem Statement

The Control&Instrument department has the responsibility setting up the control system of power plant construction project. Its scope is to install the control cabinets, interface the control signal from local instrument to control cabinets and test and approve the control function of power plant. Generally, the tasks of C&I department always depend on the other departments and the dynamic change of project schedule. Thus, the project managers should carefully plan the human resource in order to increase the management efficiency. The human resource planning can help the managers forecasting the required number of manpower with required skills. The managers can analyze the current human resource and develop the action plan solving those problems.

To date, there is no proper tool to help managers planning the human resource for Control Instrument Project Department. In fact, if the managers require human resource with skills, they often not sure that the human resource will be available in term of quantity, quality and budget. In addition, the managers also have to allocate the manpower to other projects and do not have any guidelines for deciding when and how much manpower they should release to those projects. Therefore, a more systematic tool is necessary to calculate and predict the human resource requirements in order to have the right number of employees with required skills and budgets. Also, the allocation of human resource to other project will be properly managed.

1.3 Objective of Thesis

To develop a systematic method of human resource planning for Control Instrument Project Department by using "*Microsoft Project*" as a management tool, which the proposed method will help the project managers to ensure that they can achieve the project goal through the efficient utilization of human resource.

1.4 Scope of Study

This thesis is focused on human resource planning of Control Instrument Project Department, Ratchaburi Combined Cycle Plant Project. This department is responsible to set up the control system of combined cycle plant project that comprises of three blocks with the total power capacity of 1,800 MW. Each block has two 200 MW heavy gas turbine units with two waste boilers and one 200 MW steam turbine unit.

1.5 Proposed Methodology

1.5.1 Preliminary Investigation: review the literatures of human resource planning in several sources such as text book, journals, internet and etc, the project planning involved with human resource planning and the human resource management in Microsoft Project as well as investigate the existing method of human resource planning within Control Instrument Project Department.

1.5.2 Requirement Determination: define the development topics of human resource planning such as human resource workload, human resource utilization, human resource budget and etc.

1.5.3Data Collection: collect the required data from Control Instrument Project Department by interviewing, observing or recording. The data may include the project objective, human resource workload, human resource utilization and human resource budget.

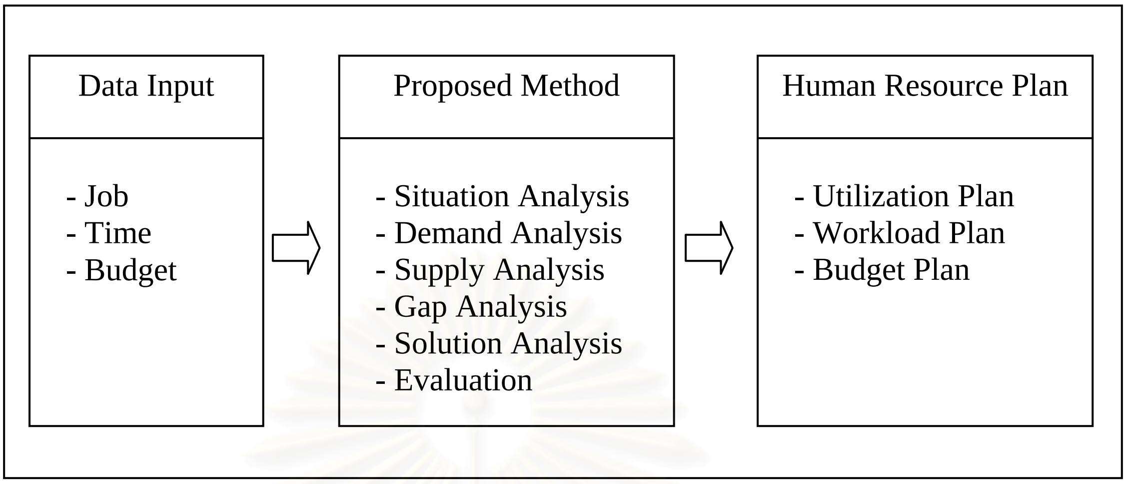
1.5.4 Data Analysis: analyze and arrange the obtained data into appropriate form in order to apply to the proposed method and Microsoft Project.

1.5.5 Method Development: propose a systematic method of human resource planning based on the previous surveys.

1.5.6 Proposed Method Application: apply the proposed method to planning the human resource of Control Instrument Project Department.

1.5.7 Results and Discussion: present the results of existing method, proposed method and development topics, then discuss the results by comparing the proposed method to the existing method.

1.5.8 Conclusion and Recommendation: conclude the development from proposing the method through the results, and then recommend the further study.



Development of Human Resource Planning for C&I Department

1.6 Expected Benefits

1.6.1 To develop a human resource planning both short-term and long-term.

1.6.2 To estimate the budget of human resource.

1.6.3 To efficiently allocate the human resource.

1.6.4 To create an appropriate method of human resource planning and apply to other construction projects.

CHAPTER 2

LITERATURE REVIEWS

This chapter provides various literature reviews in three main areas: *Project Planning, Microsoft Project and Human Resource Planning*. To achieve these reviews, we will begin with the project planning that covers on the project characteristics, project planning definitions, project planning considerations and project plan elements. In addition, we will review the applications of Microsoft Project in human resource planning. After we complete reviews both of them, we will start to survey the literature of human resource planning. In this section, we will explain the human resource planning in term of definition, benefit, process and model in several organizations. Moreover, we will summarize the articles and papers in various journals in last section.

2.1 Project Planning

The planning is an essential activity for management of a project. Plans provide the guidance and information of a project. In order to cover the project planning in general, we will describe the key issues as follows.

2.1.1 Project Characteristics

There are four main characteristics (**Rosenau, 1998**) that are different from other businesses: *Objective, Uniqueness, Resource and Organization*. These characteristics are explained as below.

- *Objective*
  Project objective consists of three main dimensions: *Performance specification, Time schedule and Cost budget*. Generally, these objectives can be called as *Triple Constraint*. The Triple Constraint must be measurable and attainable.

- *Uniqueness*
  Each project is unique because it is conducted only once. Although a new project is very similar to a last project, there will be some differences such as plan formats, report formats, authorization, resources and so on.

- *Resource*
  The resources are very important to accomplish a project, which they include people and things. The conflicts of resource are always occurred through the project. Thus, the project manager must spend lots of time with resource.

- *Organization*
  Every organization has a complicated purpose at any given moment because it is established from many individuals with varied skills, interests,

personalities and unpredictabilities. Therefore, the project manager will often be frustrated by the many other directions of organization.

2.1.2 Project Planning Definitions

Project planning is an essential process, which determines in advance about the key activities to complete a project. Its process defines: *What to be done, When it should be done and Who is responsible for doing it*. Actually, the project planning is a continuous process, so project plans must be revised when the changes are occurred. Consequently, **Cleland** (**1999:p.269**) proposes that project planning deals with the development of a strategy for the commitment of resources to support the project objectives and goals. The project plan reflects the strategy plan of the organization in providing the guidance of strategic fit. In addition, the project planing is defined as developing the plan in the required level of detail with accompanying milestones and the use of available tools for preparing and monitoring the plan (**McNeil, 1986:p.36**). We can present the interrelationship between project planning and control in **Figure 2.1**. In addition, **Rosenau** (**1998:p.56**) note that the project plans are needed to support the coordination and communication, provide a basis for monitoring, satisfy the requirements and avoid the problems. In summary, an effective project plan can be provided the following functions:

- Define requirements needed to successfully complete the project
- Provide a time schedule of tasks and related milestones
- Identify the required resources that will be available at the appropriate time, and reflect the participation of these resources and their management
- Contain a cost budget for each task
- Include risk management

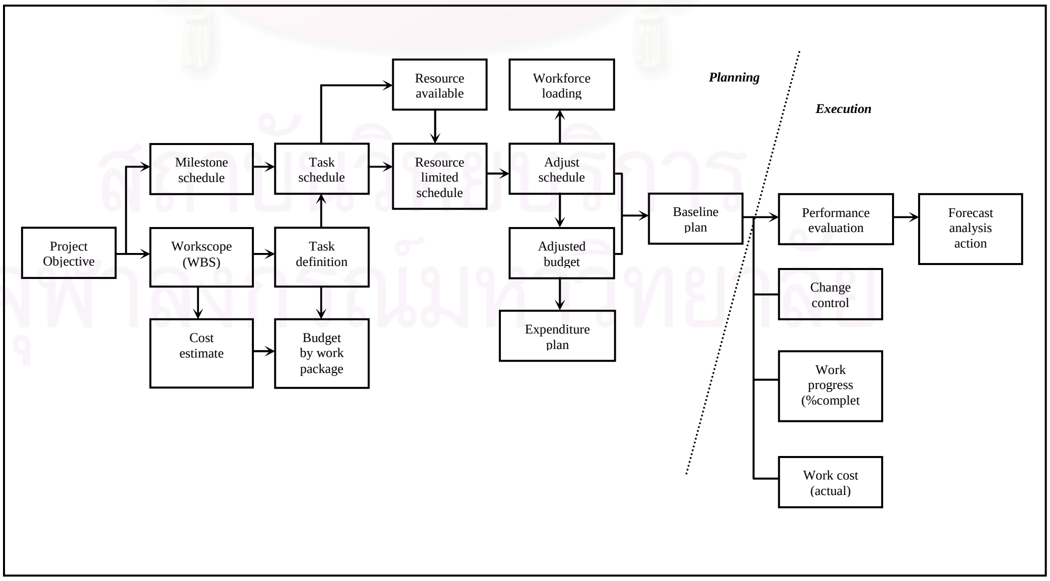


Figure 2.1 A flowchart of typical planning and control functions

2.1.3 Project Planning Considerations

Rosenau (**1998:p.60**) proposed the project planning considerations as below.

- *Uncertainty and Risk*

The uncertainty and risk is any potential threats that may make the project failed. Some of them can be predictable or controllable, however many of them are unpredictable. It may affect timescale, cost, quality or benefit. In fact, the uncertainty and risk can not be eliminated, but it can be avoided in some instances or minimized the disruption to the project. Therefore, the uncertainty and risk should be addressed at the first step of planning including prevention, reduction, transference, contingency and acceptance.

- *A Choice Between Options*

In project planning, you are often face with a choice between options. For instance, the choices may be involved with program management options, product quality standards, extent of subcontracting to be undertaken, and etc. The plan should be included the record of those choices between options that depend on addressing of risk in previous phase. Before you select any choices, you should care other plans and suggestions.

- *Hazards*

With regard to planning, there are several hazards. When you try to gain time in the early phase of project or you are addicted to your own ideas, the hazards may be occurred. You may do the planning very hard by yourself. Actually, it is important to involve the participants so that they plan their work as much as possible. This method can motivate those people. In addition, the project manager or core team should use a good planning technique creating the work breakdown structure and identifying the task interdependencies. The planning techniques can adjust everything to meet with satisfactory and believable compromise.

- *Currentness*

In order to achieve the planning, it is very important to keep everyone on the current revision of the plan. The revisions must have a revision serial number and date. In addition, you should record the copies of plan. When you revise plans, you can absolutely provide new revisions to all people who have the previous copy.

2.1.4 Project Plan Elements

In general, there are many topics addressed in the project plan. The main elements identified in project plan are explained as follow.

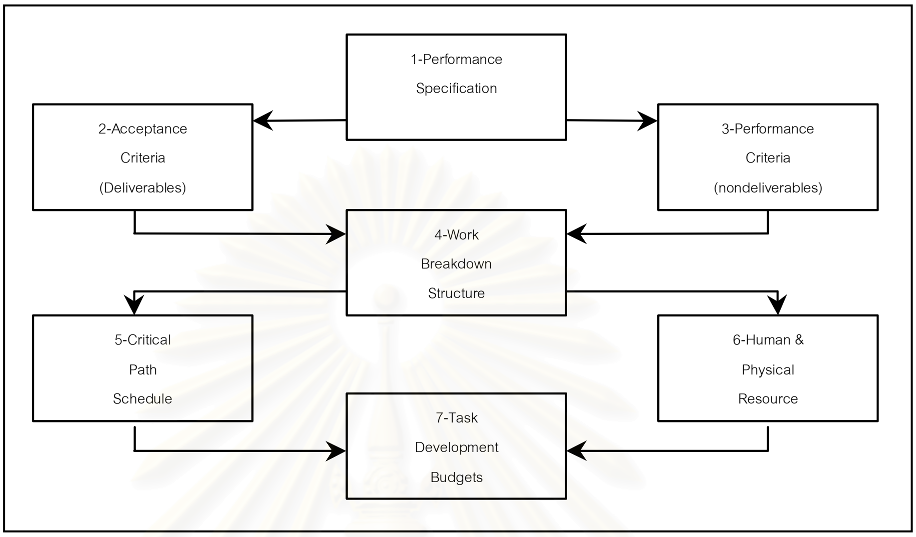


Figure 2.2 Relationship between project plan elements

- ***Performance Specification***
  The performance specification is the first requirement. This presents a complete statement of work, which is prepared by the performer, the sponsor or both together. The statement of work should be clarified the communication between contractor and customer, contract assumption and contract performance.

- ***Acceptance Criteria***
  In the project plan, the acceptance criteria for all deliverables must be stated explicitly in order to provide a certain target for the development team. It should be measurable and specific. Actually, the acceptance criteria are based on the statement of work defined in the performance specification.

- ***Performance Criteria***
  The performance criteria also are complied in the project plan. It is the standard parts or specific vendors that is not deliverable. For example, the company may require to complying with ISO 9000. Thus, the plan may be determined the standard parts of special procurement or special quality.

- ***Work Breakdown Structure***
  According to the first three components, the work breakdown structure (WBS) is identified all work package or activity or task that must be completed. A WBS can assure that all required project activities are logical identified and related. Most of the WBS will derive directly from the statement of work or performance specification. However, the acceptance

criteria and the performance criteria may require to including of further WBS elements.

- ***Critical Path Schedule***
  After all WBS are entered into a critical path network, the milestones, Gantt chart and network diagram schedules may be derived.

- ***Human and Physical Resource***
  In project planning, the resource is required to accomplish the WBS. The resource includes both human and physical resource. In fact, the resources committed in the project affect to the project schedule. If the required resources are shortage when the work is to be done, the schedule will be unrealistic and must be adjusted. The resource available for a project depends on priorities and the resource assigned to other work. Consequently, any project can be delayed by other corporate activities.

- ***Task Development Budgets***
  After creating the schedule and assigning the resource, the budget for each task can be estimated. Its estimation is based on the resource committed to the project. The appropriate budget can help you avoid a situation where actual project cost overruns the estimation. However, if you overestimated costs during the planning, you may loss the benefits.

2.2 Microsoft Project

Microsoft Project is a powerful project management program that you can use to efficiently plan, manage and communicate a project schedule and information. With Project, it is easy to create and modify a set of task to meet the project goals. In addition, it quickly recalculates schedules and presents the changes in the part of project that will affect to the overall plan. The Project also quickly produces the reports and information needed to keep all participants informed. In this review, we will focus on the working with resource that is useful to help us planning of human resource. The review includes the following items.

2.2.1Create Resource List

Before you begin assigning resources, you can enter all of the resource information for your project, such as resource groups and costs, at once by creating a resource list. This will save your time when assigning resources to your tasks. Or, you can create a list as you add and assign resources to your project. A resource list includes the names of the resources and the maximum number of units as a percentage of each resource’s availability.

2.2.2 Assign Resource

Assigning resources to tasks can be an important part of managing a successful project. You should assign resources to tasks when you want to:

- Track the costs and amount of work done by the people and equipment assigned to the tasks.

- Ensure high accountability. When responsibilities are clear, there is less risk of tasks being overlooked.
- Have greater flexibility in planning how long tasks will take.

2.2.3 Change Work Schedule of Resource

By default, the working hours and days off defined by the project calendar are the default working hours and days off for each resource. If your resources will work the same days and hours, you can use this calendar for all resources. But, if you need to specify different working times for individual resources, you can modify individual resource calendars for those resources.

2.2.4 View Resource Usage

The Resource Usage view shows project resources with their assigned tasks grouped underneath them. Using the Resource Usage view, you can find out how many hours each resource is scheduled to work on specific tasks and see which resources are overallocated. You can also determine how much time each resource has available for additional work assignments.

2.2.5 Assign Pay Rate to Resource

Microsoft Project allows you to assign rates to resources so you can manage project costs accurately. You can assign multiple standard rates, overtime rates, or per-use rates to resources along with the dates for each rate to go into effect.

- *Overtime*: The amount of work beyond a resource's normal working hours. It is the amount of existing work that is considered by Microsoft Project to be overtime work. When overtime hours are entered for a resource, Microsoft Project subtracts overtime hours from regular hours before the duration is calculated.

  Duration = (Work – Overtime Work) Units

2.2.6 Change Accrual Method

In Microsoft Project, resource costs are prorated by default and their accrual is based on the percentage of completion of the task and is distributed over its duration. However, you can change the accrual method for resource costs to take effect at the start or end of the task instead.

To	Select
Accrue the cost when the task begins	Start
Accrue the cost when the task is completed	End
Accrue the cost based on the percentage of completion of the task	Prorated

2.2.7 Update or Add Pay Rate

To allow for changes in resource rates, such as pay increases or decreases, you can assign different rate values to be applied at times you specify. You can save up to five different sets of rates for each resource to support different charges for different types of work.

2.2.8 View Resource Cost

After you assign rates to tasks or resources, you may want to review the total cost of these assignments to make sure they fall within your expectations. If the total cost of a task or resource does not meet your budget, you may need to examine each individual task's costs and each resource's task assignments to see where costs can be reduced.

- You can also view how costs are distributed over a task's duration in the Task Usage view by displaying its cost details.
- You can view resource costs in more detail by Resource Usage view.
- You can also see resource cost totals displayed graphically by Resource Graph.

In addition, you can view your project's current, baseline, actual, and remaining costs to see whether you're staying within your overall budget. These costs are updated each time Microsoft Project recalculates your project.

2.3 Human Resource Planning

2.3.1 Definitions of Human Resource Planning

There are variations in terminology of Human Resource Planning. Many organizations use "*Workforce Planning*" or *"Manpower Planning"* instead of "*Human Resource Planning*". However, we will use the term of "***Human Resource Planning***" through this paper, which it has become more popular usage than the other terms in recent year. The human resource planning is explained in several definitions. Therefore, we will present only some of them that are widely accepted by most human resource planners.

According to **Ripley (1996:p1)**, "*Human Resource Planning is defined as the systematic assessment of future human resource needs and the determination of the actions required to meet those needs*". This definition includes the planning in both macro and micro levels. The macro level involves planning in national basis by Government Department. It provides the action plan to correct the gap of labor supply and demand for industry. The micro level involves planning in organizational level, which it scopes of this thesis. Consequently, the definition in micro level that is adopted by the **Department of Transportation (2000)** is " *Human Resource Planning is looking at what an organization needs to accomplish in a given period of time; what knowledge, skills, and experience are required to get the job done; and how large and what type of workforce is required to provide that mix of knowledge, skills, and experience*". Its planning aim is to provide managers with a framework for making human resource decisions based on the organization's mission, strategic plan, budgetary resources, and set of needed workforce competencies.

In addition, **Office of Human Resources (1999)** and **Department of Interior (1999)** present a simple term of human resource planning that " *The right number of people with the right skills, experiences, and competencies in the right job at the right time*". The purpose of this definition is the same as definition of DOT, which it outlines managers with a strategic planning process to making human resource decisions.

A variety of previous definitions, most of them cover the same key issues. In this paper, we will adopt the following definition:

" *Human Resource Planning is a systematic process that provide managers to ensuring the adequate human resource of the future*".

Analyzing previous literature review, we can summary key results from the human resource planning as follows.

- Identify human resource shortages
- Identify human resource surpluses
- Forecast changes
- Provide proper action to these forecasting

2.3.2 Benefits of Human Resource Planning

With regard to the definitions, the human resource planning can provide many benefits as listed below.

- Contribute to the successful accomplishment of an organization's strategic goals and business objectives
- Provide a means to address employee needs as well as business needs of an organization
- Provide the knowledge and necessary background information need to make decisions when business plans must be modified to deal with the unexpected
- Help to reduce cost brought about by retrenchment and outplacement
- Help to prevent and unexpected shortage of labor, especially skilled labor
- Enable a more stable, pro-active, long-term approach to problems to be taken (it may actually prevent many of them from arising)
- Help to minimize recruitment and selection cost associated with high turnover

2.3.3 Framework of Human Resource Planning Process

The human resource planning is becoming more popular technique in recent year. Its process depends on the characteristics of organization. It can be simple or complex. In practice, the process should be simple, especially when first introduced. In addition, it should reflect the size and complexity of the organization (**Ripley: 1996**). Basically, the process of human resource planning is similar framework that divided into four stages: *Analyzing, Forecasting, Planning and Implementing* (**CCH: 1988-1998**).

- ***Analyzing***: The first stage of human resource planning is analyzing that deal with investigating of the current situation within the organization. The effective planning is based on the details and accuracy of the information. Thus, the factors that will effect to future demand and supply of human resource are needed to identify.

- ***Forecasting***: This involves an estimation of future demand and supply of human resource, which its process results in making of various assumptions based on current information and possible future occurrences. There are three types of forecasting as follows.

  Transaction-based forecasting involves with tracking the movement information of human resources through organization over time. Its approach can be divided into bottom-up and top-down.

  Event-based forecasting involves with changing the drivers both inside and outside the organization. These events can either support or oppose the proposed organization's strategies.

  Process-based forecasting involves with designing the model to address the changes from multiple perspectives such as work flows, human resources, re-engineering of work function and etc.

- ***Planning***: This stage involves deciding how to develop a coherent approach of future people management. The plan covers the strategic aspects of human resource management, staff development, financial/budgets and logistical. Briefly, the action plan is summarized into four main areas:
  Resourcing: recruitment, succession planning
  Development: training, performance management
  Reward: reward, pay
  Relation with employees: health and safety, staff welfare

- ***Implementing***: This process refers to continuous monitoring and evaluation of workforce planning. Its purpose is to ensure that the plan is remained in validity.

2.3.4 Technique in Human Resource Planning

2.3.4.1 Job Analysis is the process to determine the details in the particular job duties and related requirements. In the other word, job analysis is a systematic exploration of the activities within the job. It is a technical procedure used to define the duties, responsibilities and accountabilities of a job. Henderson (**1994:p37**) noted that *job analysis involves the identification and description of what is happening on the job, accurately and precisely identifying the required tasks, the knowledge, and the skills necessary for performing them, and the conditions under which they must be performed.*

Basically, there are four methods used for gathering information of job elements and the essential knowledge, skills, and abilities for successful performance.

- *Interview Method:* The job analysis may interview the employee who performs the job, the supervisor, or both. This technique may be time consuming and the error exists. In some case, the persons interviewed may exaggerate the importance of their job. In addition, they may forget certain duties or responsibilities that are an important part of job, but that are undertaken on an infrequent basis.

- *Observation Method:* This approach collects the information by monitoring the individuals performing a job and recording observations. This is possible for some jobs, but impossible for many jobs required certain condition.

- *Questionnaire Method:* Using questionnaires, it seems to be the least costly method of collecting data. If well preparing questionnaires, the information can be collected efficiently in a short time. However, the information may not be complete, or inaccurate in describing the actual task.

- *Diary or Log Method:* This method is to use the diaries or logs in which employees record their daily activities and tasks. However, it is difficult to connect the procedure that has the wide interval performing.

Job Analysis provides two types of information: Job description and Job specification.

Job Description is *a written statement of what the jobholder does, how it is done, under what conditions it is done, and why it is done* (**DeCenzo, 1999:p143**). In the other word, job description provides the job characteristics in term of job content, environment and condition of employment. In general, its format includes the job title, the duties to be performed, the distinguish characteristics of the job, environmental conditions, and the authority and responsibilities of jobholder. One source that has proven useful to many organizations in developing job description is Dictionary of Occupational Titles (DOT). Compiled by the Department of Labor, DOT contains actual descriptions of more than 20,000 occupation covering virtually all jobs in the United States.

Job Specification *states the minimum acceptable qualifications that the incumbent must possess to perform the job successfully* (**DeCenzo, 1999:p144**). In the other word, job specification is a statement of human qualifications required to perform the job. It identifies the knowledge, skills, education, experience, certification, and abilities needed to do the job effectively.

2.3.4.2 Forecasting Techniques: There are several techniques for forecasting in human resource planning. These techniques are different in degree and complexity. However, most organizations use a combination of them. Applying the proper techniques, the factors that have to be considered are presented as follows.

- Time frame
- Data pattern
- Critical variables
- Cost and accuracy
- Ease of use

Several techniques that are widely used in forecasting are explained as below.

- ***Work Measurement***: This method calculates the workload in term of total employee hours. Then, the number of staffs are determined according the calculated workload.

- ***Trend and Time Series***: The forecasting is based on the past results that show the organization's progress over the time. Then, it can be projected into the future periods. Generally, the data is presented in a graph form that is easy to access.

- ***Productivity Data***: This involves the trend of output per employee. After making allowances for predicted changes, it can be projected into the future in the same way of trend and time series technique.

- ***Managerial Estimation***: This technique, managers evaluate the various internal and external sources of information. Then, they judge the trends with their knowledge and experiences.

- ***Delphi Method***: This method is started with allowing the managers to forecast the trend with their judgments. After that, the coordinator collects these predictions and compiles an average judgment that is provided to managers again. Then, the managers review their original predictions based on the average judgment and make the new predictions. This process continues until a consensus prediction is achieved.

- ***Nominal Group Method***: This method is similar to Delphi method except its process emphasizes on discussion among managers rather than written submissions.

- ***Replacement Chart***: This chart shows a list of people who could replace a specific position which it become vacant. This technique is also called "succession plan".

- ***Probability Forecasting***: This technique involves estimating workforce for each job with its duration. Then, the probability of obtaining the job is estimated. After that, the results of multiplying workforce levels by probability are concluded in order to indicate the expected needs of staffing level. This method is more effective, if the various jobs are similar in type and size.

- ***Cost Constraints***: The required workforce is limited by the cost constraint. In practice, this method may or may not be efficient because there is no reference of past information.

- ***Models***: This technique varies according to its scope, level of technical complexity and versatility of application. In practice, the complex model can be operated by computerized systems.

2.3.5 Models of Human Resource Planning

According to the definitions, the human resource planning model provide a systematic approach that is widely applied to many organizations. Those organizations have developed the model as a management tool to help in making decision of human resource issues. Some models of several organizations are presented in following.

2.3.5.1 Model of Health and Human Services (HHS)

The HHS workforce-planning model is based on the model of workforce planning developed by *Logistics Management Institute, Inc*.(LMI). This model is also widely used by public and private sector organizations. The contents of model are consist of analyzing the current workforce, identifying organization's objectives and the workforce competencies needed to achieve them, comparing current workforce competencies to those needed in the future, then developing plans to transition from the current workforce to the future workforce. In this model, there are four planning steps as follows:

Demand Analysis deals with developing measures of future activities and workload, and describing the competency sets needed by the workforce of the future. Demand analysis must take into account not only workforce changes driven by changing work but also workforce changes driven by changing workload and changing functions. Technology and process improvement will continue to have an impact on how work is performed and must be considered in the demand analysis process.

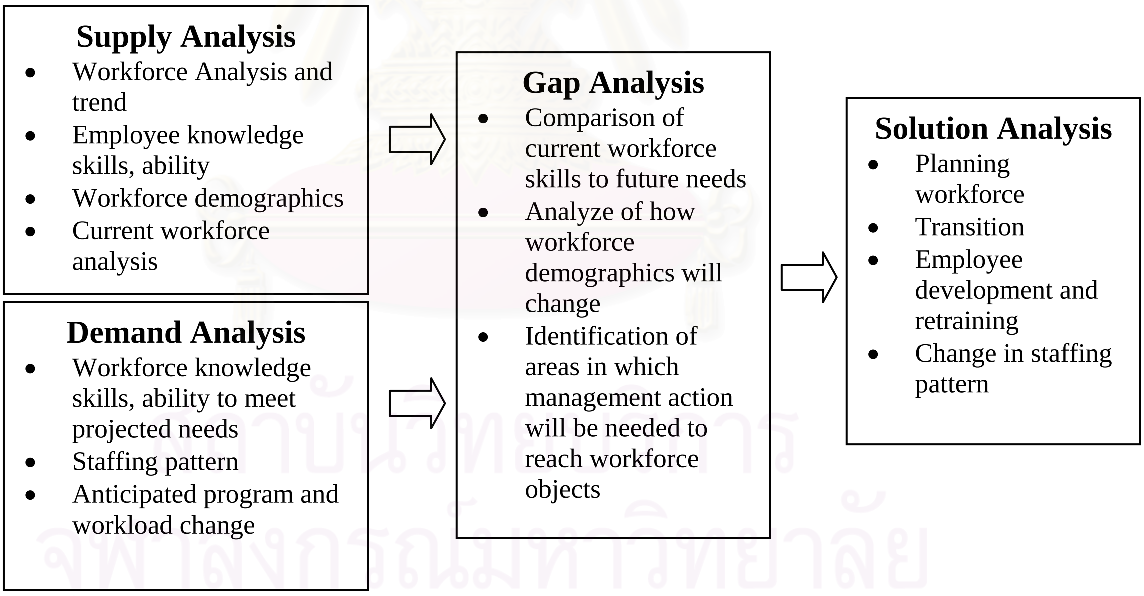


Figure 2.3 HHS Workforce Planning Model

Source: Office of Human Resources, Assistant Secretary for Management and Budget, Building Successful Organizations as Workforce Planning in HHS, Nov 1999 (http://www.os.dhhs.gov)

Supply Analysis focuses on identifying organizational competencies, analyzing staff demographics, and identifying employment trends. Competency analysis provides baseline data on the existing organization and present staff. Trend analysis provides both descriptive and forecasting model describing how turnover will affect the workforce in the absence of management action. Trend analysis is essential to the solution analysis phase.

Gap Analysis is the process of comparing information from the supply analysis and demand analysis to identifying the differences (gap) between the current organizational competencies and the competency set needed in the future workforce. The comparison requires the competency sets developed in supply analysis and demand analysis phases to be comparable “not independently developed. Gap analysis identifies situations in which the number of personnel or competencies in the current workforce will not meet the future needs (demand exceeds supply) and situation in which current workforce personnel or competencies exceed the needs of the future (supply exceed demand).

Solution Analysis is the process of developing strategies for closing gaps in competencies and reducing surplus competencies. A variety of strategies are available in solution analysis including planned recruiting, training, re-training and placing employees. Solution analysis must take into account employment trends, which may work either in the favor of or counter to the direction of planned workforce change.

Evaluation involves a periodic and systematic review of the workforce plan, reviewing mission and objectives to assure they remain valid and making adjustment as required by changes in mission, objectives and workforce competencies.

2.3.5.2 Model of the Office of Personnel Management (OPM)

The OPM workforce-planning model consists of five planning steps as follows:

STEP1 Strategic Direction Setting deals with preparing a model for long-term organizational success. In setting strategic direction, planners carefully come to conclusions about what the organization must do as a result of the major issues and opportunities facing it. These conclusions include what overall accomplishments the organization should achieve and the method to achieve these accomplishments.

STEP2 Supply, Demand & Discrepancies

- Supply involves identifying organizational competencies, analyzing staff demographics, identifying employment trends
- Demand deals with developing measures of future activities and workload, describing the competency sets needed by the workforce of the future.
- Discrepancies present comparing information from the supply analysis and demand analysis to identifying the differences (gap) between the current organizational

competencies and the competency set needed in the future workforce.

STEP3 Develop Action Plan is the process of developing strategies for closing gaps in competencies and reducing surplus competencies. The action plan help us to identifies where we are, where we are going and how we are going to get there. The strategies are available in solution analysis including planned recruiting, training, re-training and placing employees. Action plan must take into account employment trends, which may work either in the favor of or counter to the direction of planned workforce change.

STEP4 Implement Action Plan involves finalizing strategies and developing timetables for the accomplishment of the as determined in action plan. Effective implementation of the plan must include highly detailed, well-documented and well-illustrated quantifiable incremental actions. These actions must have realistic and achievable milestone and deadline date scheduled concisely with substantial stakeholder input.

STEP5 Monitor Evaluate & Revise involves a periodic and systematic review of the workforce plan, reviewing mission and objectives to assure they remain valid and making adjustment as required by changes in mission, objectives and workforce competencies.

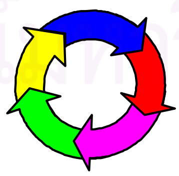


Figure 2.4 OPM Workforce Planning Model
Source: Office of Personnel Management, Workforce Planning Model

2.3.5.3 Model of Department of the Interior (DOI)

The DOI workforce-planning model is based on the model of workforce planning developed by the Office of Personnel Management (OPM). The DOI model consists of a five-phase process:

Phase 1: Strategic Direction Setting

- Organize and mobilize strategic partners
- Set vision/mission, value/objectives
- Review organizational structure and conduct business process reengineering
- Measure organization performance
- Position human resource to be a strategic partner

Phase 2: Supply, Demand & Discrepancies

- Analyze demographics, workforce trends, workforce projections, workforce diversity, educational pipeline
- Conduct competency assessments
- Compare workforce needs against available skills

Phase 3: Develop Action Plan

- Design a workforce plan to address skills gaps
- Set specific goals
- Develop a human resource infrastructure

Phase 4: Implement Action Plan

- Communicate the workforce plan
- Gain organizational buy-in
- Conduct organization assessments
- Conduct recruitment, hiring and placement
- Conduct succession planning
- Restructure where necessary
- Implement retention strategies

Phase 5: Monitor, Evaluate & Revise

- Access success and failure
- Make adjustment to the plan
- Address new workforce/organization issues

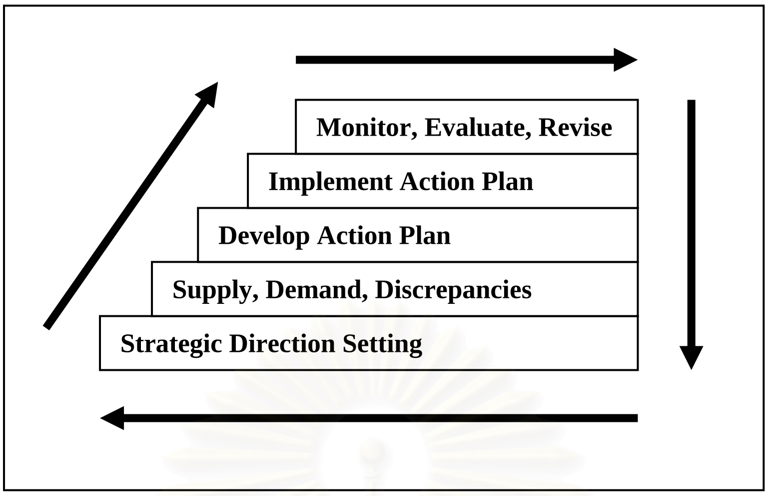


Figure 2.5 DOI Workforce Planning Model
Source: U.S. Department of Interior, Right People, Right Place, Right Time, 1999 (http://www.doi.gov)

2.3.5.4 Model of Department of Transportation (DOT)

The methodology developed by the workforce planning work group involves three overarching phases that include eight sub-steps. The process can be viewed as cycle, with knowledge and experience gained over time. The result will be adjustments to the numbers and strategies planned for the current strategic plan. The three phases and their respective sub-steps are described below.

Phase I: What work must your organization do to accomplish its mission?

Step 1: Obtain leadership commitment

Step 2: Analyze strategic goals and objectives

Step 3: Determine functional requirements

Phase II: Who can do what needs to be done?

Step 4: Create future workforce profile

Step 5: Develop workforce profile

Step 6: Estimate workforce requirements

Phase III: Choosing the right strategies

Step 7: Develop workforce strategy & budget projections

Step 8: Evaluate workforce planning process

2.3.5.5 Model of Federal Highway Administration (FHWA)

The FHWA workforce-planning model is developed by the Task Force (**see in Figure 2.6**). This model combines the HHS workforce-planning model and DOT workforce-planning model, which it focuses on functions and people with a multidimensional view of gap analysis. According to other models, the principal gap is the difference between demand (Future State-Functions) and supply (Future State-People). However, effective workforce planning also requires consideration of the gaps between the future and current states for both functions and people (e.g., changes in the agency's functions or changes in workforce demographics)

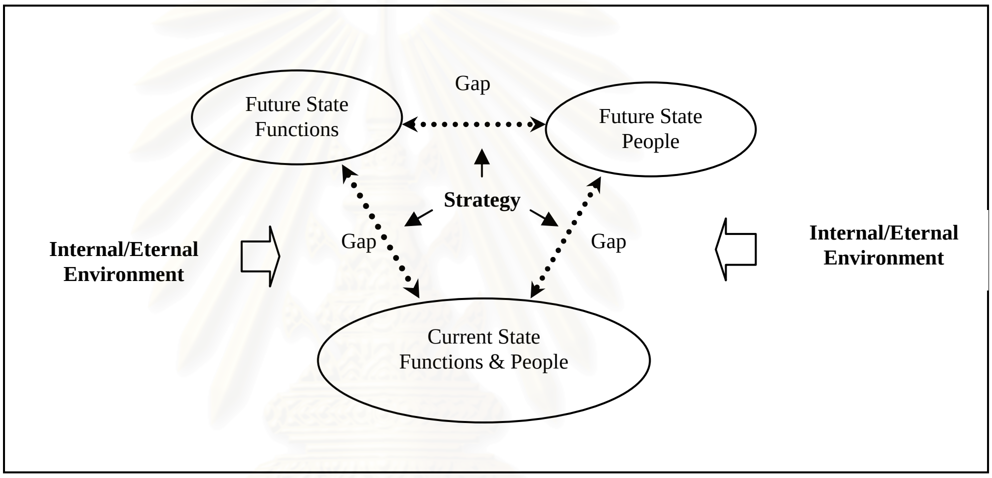


Figure 2.6 FHWA Workforce Planning Model

Source: U.S. Department of Transportation, Federal Highway Administration, Workforce Planning and Professional as Development Task Force Final Report , Positioning FHWA for the future, December 1, 2000 (http://www.fhwa.dot.gov/report/workforce)

2.4 Articles and Papers in Various Journals

How to Determine Future Workforce Needs
Personnel Journal, July 1996
Ripley, D.E.

Ripley defined the process of workforce planning as the systematic assessment of future HR needs and the determination of the actions required to meet those needs. He classified the workforce planning into macro and micro levels. The macro level involved the national planning by government department. In the other hand, the micro level involved the organizational planning. In addition, he suggested that the process of workforce planning should be simple, especially when first introduced and should also reflect the size and complexity of the implementing organization. To be successful, the workforce plan requires the support of HR, the involvement of supervisors and department head, and the commitment from senior management. In this article, the workforce planning consists of two major activities.

1. Developing and analyzing data that identify HR needs. The data include the future gaps and surpluses of the workforce, diversity statistics, population demographics, health and safety statistics, turnover rates and causes, and the survey results of employee opinion. It also includes the organization's mission, values, strategic goals, business objectives, state and federal laws and regulations.
2. Developing response to the identified needs. These responses involve developing the action plan and special programs.

In addition, Ripley describes the methodology of workforce planning into eight steps as below.

1. Lay out a plan and schedule: This step involves creating the planning teams for each department. These teams will help to implementing the workforce process later on.
2. Perform a staffing assessment: The staffing assessment deals with benchmarking the size and skill of the organization's staff in the specific processes or functions.
3. Develop a demand data: This step involves estimating the number of employees and skills that are needed to meet the business objectives. Its results need to be reviewed continuously.
4. Develop a supply data: This step requires to making the assumptions about attrition in term of resignations, transfers, retirements, deaths, and the number of trainees. However, the assumption may vary from department to department because the different departments have the different factors of attrition.
5. Compare demand and supply: This step deals with determining the future gaps and surpluses in both numbers and skills, especially the critical needs.
6. Develop the workforce plan: This step involves developing the workforce plan and the strategies.
7. Communicate and implement the workforce plan: This step involves communicating the workforce plan, the plan strategies and the assumptions. It is necessary to make it clear to employees so that they can understand its value.
8. Evaluate and update the plan: This step provides the guidance to success the workforce plan.

Model of Public Sector Management for a Competitive Australia: A Computer Simulation Model for Workforce planning
Australia Journal of Public Administration, 1993, 52 (3), pp. 339-349
Saliba, G.

This paper describes the workforce-planning model that operates as a simulation of the organization. The model is based on using the mathematical and statistical techniques. These techniques show the relationship between the different components of the system by indicating the overall effects when one component is changed. Saliba suggest the PRISM (Planning, Resourcing, Integrating and Staffing Model) as a workforce planning model. The PRISM was originally developed for Australian Taxation Office (ATO). The model is used as a management tool for supporting the decision making about people issues and particular workforce planning.

The PRISM is assumed that there is a “ trickle-down” effect regarding the demand for people. If a job is vacant, the organization will seek to fill it through promotion. It will create a gap at the next level down and then achieve a goal of “steady state”. The model includes organizational requirements and career requirements of its people. These requirements are influenced by the changing patterns in the organization, physical aging, family responsibilities, health and personal interests.

The PRISM uses a computer simulation tool called “ithink” which is a software tool operating in a MacIntosh environment. PRISM consists of eight sectors. Within each sector and for each period of simulation, PRISM models as following.

- Number of people in each of the four categories
- Level of development attained in relation to becoming ready for promotion
- Effect of wasting rates
- Desire for new positions or the abolishment of excess positions
- Promotion of people from one sector to the next

Choosing the right employee: Chinese vs US preferences
Management Decision, 23 February 1999, vol. 37, no. 1, pp. 7-13(7)
Peppas S.C., Peppas S.R., Jin K.

Explicit or implicit sets of selection criteria are always used when hiring decisions are made. When employers and job applicants come from similar cultural backgrounds, applicants may better understand what job-related attributes employers think are important and can develop and stress those qualities. Many studies have attempted to identify important job attributes, but despite recent globalization trends, there is little information comparing the importance of different criteria to individuals from different cultures. For this exploratory study, Chinese and US individuals were surveyed to ascertain their ratings of the importance of 26 job selection attributes. Given the cultural distance between the USA and China, it was hypothesized that significant differences would be found. As China emerges as an important global player with increasing interaction between US and Chinese organizations, the results of this study should help each culture better understand the other and lead to better business relationships between the two countries.

Evolution of a decision support system for human resource planning in a petroleum company
International Journal of Production Economics, 15 September 1997, vol. 51, no. 3, pp. 251-261(11)
Mohanty R.P., Deshmukh S.G.

A comprehensive human resource planning system has been discussed for a large multi-divisional, multi-location petroleum company in India. A Decision Support System (DSS) has been designed using the principles of a resource support approach which primarily focuses on providing the critical tools and resources needed for Human Resource Management. The design provides the company alternative directions to plan for manpower requirements, recruitment, placement, promotion, appraisal and development. Further, the DSS has helped the Human Resource Division of the company analyze human resource decisions to overcome many problems, to cut down delays in implementing new projects and to expand the business in new areas.

Optimization of staff numbers in the process industries: an application of DEA
International Journal of Manpower, 23 March 2000, vol. 21, no. 1, pp. 47-60(14)
Al-Harbi K.M.A-S.

The process industries are particularly vulnerable to plant, process, and product failures. They are also interested in reducing labor costs and improving the efficiency and manpower utilization of the maintenance labor and supervision. This article suggests the utilization of data envelopment analysis (DEA) as an objective optimization approach for the comparative efficiency evaluation of the maintenance sections of a maintenance department. An example is presented with real life data from a local petrochemical company to demonstrate the application of the method. Comparative efficiency scores indicate that the petrochemical company could reduce the number of staff and supervisors in a number of maintenance sections or, alternatively, improve their outputs.

Planning to Solve the ''Skills Problem'' in the Virtual Information Management Organization
International Journal of Information Management, February 1998, vol. 18, no. 1, pp. 3-16(14)
Heckman R.

Client-server architectures increase technology skill demands in line departments. Thus, the "skills problem" in the virtual IM organization extends beyond the boundaries of the centralized IS department. It also involves more than information technology skills, as demands for social, conceptual, and marketplace skills increase as well. The "skills problem" can be expressed in terms of three basic questions: (1) what skills are needed in a virtual IM organization? (2) how can the firm obtain them? (3) how should these skills be deployed within the firm? This paper addresses each of these questions. It presents a model which helps managers think systematically about the skills required by their organizations and sub-units. It reviews the four options which are available to a manager for acquiring skills needed by the organization. Finally, it describes an approach to tactical human resource planning which will enable an organization to deploy skills effectively and create an environment where discretionary collaboration between distributed units is encouraged.

Reconceptualising human resource planning in response to institutional change

International Journal of Manpower, 9 October 1998, vol. 19, no. 5, pp. 343-357(15)
Idris A.R.B., Eldridge D.

The article aims to shift the basis of organizational human resource planning away from the traditional prescriptive approach to a systems based model that incorporates an emphasis on learning. A brief history of human resource planning is presented showing how it has evolved towards current needs and the specification for the new model. The new model is conceived in the context of increased environmental pressures on organizations and resultant management approaches. At the heart of the new approach is the process of transformation by which inputs to the model are processed in a way that involves all stakeholders in planning to produce viable outputs for managerial decision making.

Strategic planning of human resources in the library system of the Pontifical Catholic University of Chile
Library Management, 1 April 1995, vol. 16, no. 3, pp. 15-23(9)
Franco M.L.A., Diaz R.I.

To achieve the strategic objectives necessary for an organization to face the future with confidence, human resource planning has been implemented in the library system of the Pontificial Catholic University of Chile (SIBUC). Analyzes the environment and its impact on SIBUC using an organizational model, which also permits strategic objectives to be established and personnel to be analyzed in terms of strengths, weaknesses, opportunities and threats. Based on this approach, specifies human resource objectives, and assures optimal achievement with well-defined individual strategies that also include plans for action and control measures. Finally, and as a result of the whole methodology, creates a matrix to structure an organizational design of the direction of human resources in the library system.

Strategic human resource planning at Zeneca Pharmaceuticals
Management Development Review, 1 April 1995, vol. 8, no. 2, pp. 11-15(5)
Ainsworth C.

Examines the human resource strategy undertaken at Zeneca Pharmaceuticals. Gives the business content then goes on to consider the process and impact of work on line functions and the personnel department. Concludes with a list of areas of improvement indicated by the planning of the strategy.

A review of existing models for project planning and estimation and the need for a new approach
International Journal of Project Management, 1996, vol. 14, no. 3, pp. 173-183(11)
Mizrahi S., Chatzoglou P.D., Macaulay L.A.

Although planning is a crucial part of the system development process, it is often neglected by project managers. The problem being addressed by this paper is that of inadequate models for planning the requirements capture and analysis stage (RCA) of a software development project. It is stressed that there is a need for a new model because the existing models give inaccurate, inconsistent or unreliable predictions. Additionally, they are based on either inappropriate variables or variables that can not be measured at the beginning of the development process. Finally, existing models do not support the planning of individual stages of the development process but only try to make predictions about the project development process as a whole. This paper examines existing models and provides evidence about their inadequacy and lack of accuracy, and then introduces a new model and presents the approach followed for its development.

An efficient approach for large scale project planning based on fuzzy Delphi method
Fuzzy Sets and Systems, 22 December 1995, vol. 76, no. 3, pp. 277-288(12)
In S.C., Tsujimura Y., Gen M., Tozawa T.

The goal of this paper is to replace probabilistic or deterministic considerations in the project network analysis by possible ones and to reduce the difficulty arising from the inexact and insufficient information of activity times. The activity times are considered as fuzzy numbers (fuzzy intervals or time intervals) and the fuzzy Delphi method is used to estimate a reliable time interval of each activity. Based on these time estimates, we then propose an efficient methodology for calculating the fuzzy project completion time and the degree of criticality for each path in a project.

An integrated approach for risk response development in project planning
Journal of the Operational Research Society, January 2001, vol. 52, no. 1, pp. 14-25(12)
Ben-David I., Raz T.

The risk response development phase is a major phase in the project risk management process. This paper presents a model that integrates project work contents, risk events, and risk reduction actions and their effects into a comprehensive framework. The model allows the representation of the overlapping effects of multiple risk reduction actions and of the impacts of secondary risk events, and supports the evaluation of the total risk exposure of the project under various combinations of risk reduction actions. The model can be treated with optimistic techniques in order to generate the most cost-effective combination of risk reduction actions. In this work we describe the model, outline a solution procedure and illustrate its application with an example taken from the software industry.

Network-based project planning and scheduling
Industrial Management & Data Systems, 1 December 1996, vol. 96, no. 8, pp. 13-22(10)
Khamooshi H.

Discusses the twofold purpose of this study, first to introduce a number of measures devised to be used in comparing and evaluating two schedules for the same project, second to present and evaluate a heuristic procedure developed in this research for solving the resource constrained project scheduling problem. Posits that the new procedure is based on the notion that a project can be partitioned into a number of sections and there is no obligation to use a single policy all the way through all the sections of project. Shows that this research is also an attempt to bridge the gap between the theory and practice by eliminating the question of which priority rule to use for which project. Develops a new model showing that selecting from a number of priority rules is not required and, using the measures of performance introduced, decides on a suitable schedule from the schedules produced under varied assumptions is shown to be much easier. Concludes with suggestions for further research.

On the sensitivity of project variability to activity mean duration - Project Planning and Control by Network Models
International Journal of Production Economics, 20 September 1999, vol. 62, no. 3, pp. 219-232(14)
Elmaghraby S.E., Fathi Y., Taner M.R.

Traditionally the `importance' of an activity in the PERT model of projects is measured by its `critical index', which is defined as the probability that the activity will be on the longest path. An insightful discussion by Williams (1992, Journal of Operational Research Society 43, 353-357) revealed that the classical criticality index is not always informative or intuitively appealing. In a recent study by Cho and Yum (1997, International Journal of Production Research 35, 2737-2757), a new `Uncertainty Importance Measure' is defined to measure the effect of the variability in an activity duration on the variability of the overall project duration. They propose Taguchi's sampling technique as a method for analyzing the network. The main contribution of this paper is to study the impact of changing the mean duration of an activity on the variability of the project duration. Consequently, the network is further investigated the accuracy of Taguchi's sampling method for approximating the mean and standard deviation of the project duration, and propose steps that could result in computational savings in large networks.

Practical proposals for managing uncertainty and risk in project planning
International Journal of Project Management, October 1998, vol. 16, no. 5, pp. 299-310(12)
Dawson R.J., Dawson C.W.

Standard planning techniques, such as PERT, and the popular software tools that support them are inadequate for projects involving uncertainty in the project direction and task durations. Probability distributions for task durations and generalized activity networks with probabilistic branching and looping have long been established as viable techniques to manage these project uncertainties. Unfortunately, their complexity has meant that their use in industry is minimal. This paper proposes extensions to existing software tools to specify and manage such uncertainties that would be easy to learn and use. A survey has shown that if these extensions were available, commercial and government organizations would regularly use them.

Project planning in a virtual world: information management metamorphosis or technology going too far? - A new way of working

International Journal of Information Management, December 1999, vol. 19, no. 6, pp. 485-494(10)
Gardiner P.D., Ritchie J.M.

The paper considers the emerging technology of virtual reality (VR) as a tool to help to manage and make sense of complex management information systems. Project management is taken as an example business system, with broad commercial and industrial applications, that depend on the efficient and effective communication of information at several organizational levels to succeed. This paper also presents the use of a virtual world that comprises of three physical dimensions and a time dimension. It is a metaphor to represent planning, sequencing, and scheduling information in a way that improves the communication process is considered. In addition, this paper provides examples of how the technology has been used to date. The technology is shown in order to have a lot to offer complex information environments such as large projects. However, there are clearly gaps in how the technology can be used cost effectively and how far the concept of a virtual world should be taken as a replacement for more traditional, two dimensional and symbolic, methods of communicating information.

Sensitivity Analysis for Project Planning and Scheduling under Uncertain Completions

Computers & Chemical Engineering, 24 May 1998, vol. 22, no. 1001, pp. 871-874(4)
Samikoglu O., Honkomp S.J., Pekny J.F., Reklaitis G.V.

Development of a sensitivity analysis (SA) procedure is a significant part of constructing robust solutions for a class of resource constrained planning and scheduling problems. The key uncertain parameters, the probabilities that projects will be terminated, occur in both the objective function and the left-hand side of the constraints. Estimates of the mean probability of failure for a task can be extracted from historical data; however, it is important to take into account the sensitivity of the proposed solution to variations in these estimates. Parameter studies show complex interactions between the objective function and the resource constraints. A method to study the behavior of the solution using branch and bound algorithms enhanced with logical programming is introduced.

Timing of control activities in project planning

International Journal of Project Management, February 1998, vol. 16, no. 1, pp. 51-58(8)
de Falco M., Macchiaroli R.

This paper deals with the timing of monitoring and control in project planning. The need for monitoring and control actions arises because projects are dynamic in nature and because of changing environments. The monitoring of the project deviations from the planned schedule due to environmental changes allows the generation of proper feedback to enable corrective actions. After having reviewed the main reasons that suggest the opportunity to use structured approaches to project control, we make a proposal for the quantitative determination of the time instants when the monitoring and control actions should take place in order to effectively manage the projects. The proposal is based on the definition of an Effort Function. The quantitative analysis of its concentration allows the allocation of the monitoring and control activities.

CHAPTER 3

PROPOSED METHOD

This chapter, we first review the existing method of human resource planning for Control Instrument Project Department. Then, we describe a proposed method based on its assumptions. The proposed method is explained in six steps: *Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis, Solution Analysis and Evaluation*. Finally, we apply both existing method and proposed method to plan the human resource of Control Instrument Project Department in fiscal year 2000.

3.1 Existing Method

Actually, the existing method is not written in an instruction manual or any document. Thus, most data involved in the human resource planning is obtained by interviewing and observing the planner. In a fiscal year, Control Instrument Project Department has to establish a human resource plan about utilization plan and budget plan. To accomplish these plans, CIPD first collects the human resource schedule from each section i.e. *Mechanical Instrument Section, Electrical Instrument Section and Information Section*. Then, all of section' schedules are concluded in one schedule plan for CIPD. According to the data, it was found that the planning method can be classified into three main steps: *Analyzing, Forecasting and Planning*. The details are described as shown in **Figure 3.1**.

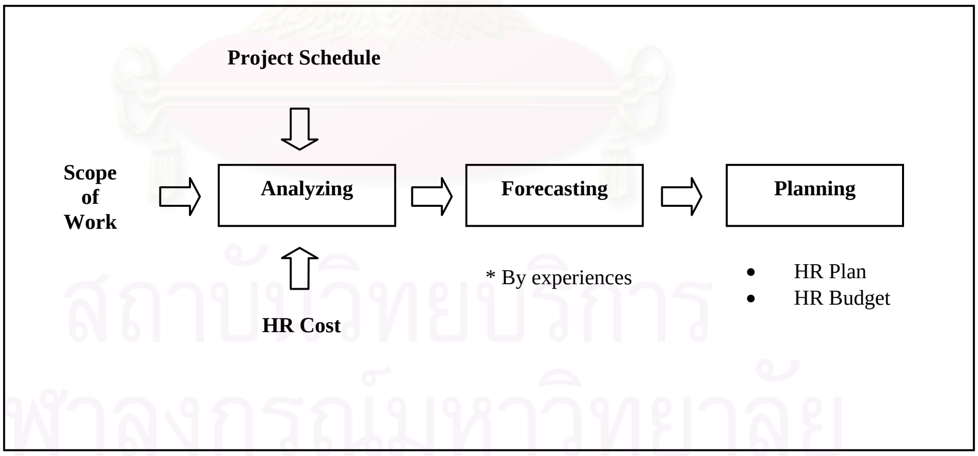


Figure 3.1 Existing Method of Human Resource Planning

3.1.1 Analyzing

The first step is to analyze the current situation. This analysis includes the Project Schedule, Scope of Work and HR Cost. At the beginning, the Chief of C&I Department provides the new revision of Project Schedule to each head of section in order to realize the sequence of task, duration and milestones of the project. Then, each head of section will define the scope of work that will be done in that period. In addition, the human resource cost is analyzed in this step. The cost types (**see in Table 3.1**) comprise of the followings.

- **Average Salary** (AS) shows bath per day of each position group. It is calculated by dividing total salary of position group with number of employees that are in that group.

Average Salary (AS) = (Total Salary of Position Group) / (Number of Employees)
[Bath/Day]

- **Site Allowance** (SA) shows bath per day of house rental and allowance. Its value depends on the position level.

Site Allowance (SA) = (Allowance) + (House Rental)
[Bath/Day]

- **Electricity Allowance** (EA) is estimated by 14% of Average salary.

Electricity Allowance (EA) = 14% of (Average Salary)
[Bath/Day]

- **Providence Fund** (PF) is estimated by 10% of Average salary.

Providence Fund (PF) = 10% of (Average Salary)
[Bath/Day]

- **Skill Premium** (SP) is provided only Engineer and Skilled Labor.

Engineer = 145.45 [Bath/Day]

Skilled Labor = 50 [Bath/Day]

- **Fringe Benefit** (FB) is calculated by 3 % of all costs that include Average salary, Site allowance, Electricity allowance, Providence fund and Skill premium.

Fringe Benefit (FB) = 3% of (AS+SA+EA+ PF+ SP)
[Bath/Day]

- **Standard Rate** (SR) shows the bath per day for regular work performed by human resource. Its value is summed up all costs.

Standard Rate (SR) = (AS+SA+EA+ PF+ SP)
[Bath/Day]

- **Overtime Rate** (OT) shows the bath per hour for overtime work performed by human resource. It is calculated by dividing Average Salary by Working Hour.

Overtime Rate (OT) = (Average Salary) / (Working Hour)
[Bath/Hr]

Table 3.1 CIPD Human Resource Cost

Source: Control Instrument Project Department, as of 30 Sep 1999

Group	Position	Average Salary SD [bath/day]	Site Allowance SA [bath/day]	Electricity Allowance EA [bath/day]	Providence Fund PF [bath/day]	Skill Premium SP [bath/day]	Overtime Rate OT [bath/hr]	Fringe Benefit FB [bath/day]	Std.Rate [bath/day]
Admin	*Chief -C&I Division*	฿2,982.73	฿450.00	฿417.58	฿298.27	฿145.45	฿426.10	฿141.60	฿4,435.64
Admin	*Consultant Engineer*	฿2,192.61	฿400.00	฿306.97	฿219.26	฿145.45	฿313.23	฿107.33	฿3,371.62
Admin	*C&I Officer*	฿1,788.30	฿360.00	฿250.36	฿178.83		฿255.47	฿84.99	฿2,662.48
Admin	*C& I Employee*	฿240.00					฿30.00	฿8.10	฿248.10
MCI	*Head-MCI Section*	฿2,092.67	฿400.00	฿292.97	฿209.27	฿145.45	฿298.95	฿103.18	฿3,243.55
MCI	*M Engineer*	฿1,788.30	฿360.00	฿250.36	฿178.83	฿145.45	฿255.47	฿89.35	฿2,812.30
MCI	*M Technician*	฿1,940.30	฿360.00	฿271.64	฿194.03		฿277.19	฿91.29	฿2,857.27
MCI	*M Skilled Labor*	฿821.91	฿320.00	฿115.07	฿82.19	฿50.00	฿117.42	฿45.20	฿1,434.37
MCI	*M Employee*	฿240.00					฿30.00	฿8.10	฿248.10
ECI	*Head-ECI Section*	฿2,092.67	฿400.00	฿292.97	฿209.27	฿145.45	฿298.95	฿103.18	฿3,243.55
ECI	*E Engineer*	฿1,788.30	฿360.00	฿250.36	฿178.83	฿145.45	฿255.47	฿89.35	฿2,812.30
ECI	*E Technician*	฿1,940.30	฿360.00	฿271.64	฿194.03		฿277.19	฿91.29	฿2,857.27
ECI	*E Skilled Labor*	฿821.91	฿320.00	฿115.07	฿82.19	฿50.00	฿117.42	฿45.20	฿1,434.37
ECI	*E Employee*	฿240.00					฿30.00	฿8.10	฿248.10
INF	*Head-INF Section*	฿2,092.67	฿400.00	฿292.97	฿209.27	฿145.45	฿298.95	฿103.18	฿3,243.55
INF	*I Engineer*	฿1,788.30	฿360.00	฿250.36	฿178.83	฿145.45	฿255.47	฿89.35	฿2,812.30
INF	*I Technician*	฿1,940.30	฿360.00	฿271.64	฿194.03		฿277.19	฿91.29	฿2,857.27
INF	*I Skilled Labor*	฿821.91	฿320.00	฿115.07	฿82.19	฿50.00	฿117.42	฿45.20	฿1,434.37
INF	*I Employee*	฿240.00					฿30.00	฿8.10	฿248.10

3.1.2 Forecasting

After identifying the scope of work, the heads of section begin to estimate the requirement of human resource in accordance with the project schedule. As know, there is no a tool for forecasting. Consequently, each section estimates the future of human resource in different style depended on the experiences. They may use the previous data comparing with requirement and then adapt it to creating the new plan. They also estimate from their draft work schedule, which it might not agree with the Department' schedule. Again, they may keep the same number of human resource through the fiscal year because they might not have any ideas for estimating. Furthermore, they may estimate over the actual need because they might fear to face the future uncertainties. These reasons may cause the errors in the human resource schedule planning.

3.1.3 Planning

In this step, the department uses the spreadsheet as a tool for planning the human resource. The Chief of C&I Department conclude the sub-plan from each section, then present the plan on the spreadsheet. When obtaining the number of human resource over time, the chief can calculate the budget based on the analyzed costs that are presented in analyzing step. The existing human resource plan consists of two components as follows.

- *Human Resource Utilization*: The utilization plan presents the number of human resource classified by section and position across the month.

- *Human Resource Budget*: The budget monthly displays the human resource cost classified by section across the month.

The existing method can be summarized to the participant matrix as shown below (**Figure 3.2**).

Process	**Activities**	**Participants**
Analyzing	• Project Schedule • Scope of Work • HR Cost	C&I MCI,ECI,INF C&I
Forecasting	• Number of HR	MCI,ECI,INF
Planning	• HR Plan • HR Budget	C&I

Note: C&I = The Chief of Control Instrument Project Department
MCI = The Head of Mechanical Control Instrument Project Section
ECI = The Head of Electrical Control Instrument Project Section
INF = The Head of Information Control Instrument Section

Figure 3.2 Participants in Human Resource Planning

3.2 Proposed Method

The Human Resource Planning (HRP) has been developed as a systematic method for Control Instrument Project Department (CIPD), which it is a necessary tool for making strategic human resource decisions. As such, this chapter describes guidance and information on all aspects of human resource planning. Most importantly, the assumption of proposed method must be determined so that this method can arrange the Department's expectation for human resource planning. After introducing the assumptions, the components of the proposed method are explained in six steps: *Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis Solution Analysis and Plan Evaluation*. Actually, this method is a dynamic process, which it is effected by the changing environment both current and future. Thus, it must be based on consistent data and common assumptions. Finally, the human resource plan is formulated in term of human resource utilization, human resource workload, human resource budget, action plan and evaluation.

3.2.1 Assumptions of Proposed Method

The proposed method provides a systematic approach of human resource planning for Control Instrument Project Department, Ratchaburi Combined Cycle Project. However, it can be adapted to different project departments because this approach is a flexible method. In facts, the proposed method provides a means for planning a human resource in order to meet the Department's expectations. The results of this method are human resource utilization, human resource workload, human resource budget, the action plan and evaluation. To be useful a managerial tool, the proposed method must be determined a common set of assumptions so that this method can be extended to other departments.

Assumptions

- The proposed method focuses on the planning results more than on its process. Its results cover human resource workload, human resource utilization, human resource budget, action plan and evaluation.

- According to the project characteristics, the project is uniqueness because it is conducted only once. In addition, it is temporary and always involves a different group of people. Thus, the situation analysis of each project provides the different results of examination. In this study, the situation analysis covers the project schedule, the department structure, the HR framework and the HR cost.

- The results of demand analysis depend on the Technical Scope Document (TSD) and Job Analysis. The TSD provides the scope of work and work breakdown structure, which are consistent to the situation analysis. As well as the job analysis give job description, job specification and workload. In this study, the job analysis is proceeded by interviewing the relevant people. Its results may be not accurate.

- In supply analysis, the analysis of current staff is based on the situation analysis and demand analysis. Again, the turnover rate and the absenteeism rate are calculated from the database of department. Both rates may not project the trend of human resource because they are calculated from only two-year data.

- The gap analysis compares the demand and supply by using Microsoft Project. The Microsoft Project provides the gap or overallocation report. This report shows the human resource needs in term of man-hours across the month. The calculations of man-hours are based on the project schedule and the calendar identified in the program.

- The strategies applying in the solution analysis depend on policies of the project. In this study, there are three main strategies: increasing HR, adding overtime and giving training.

- The evaluation determines the periodic and systematic review of HR Plan. In this method, the evaluation is reviewed every month by using Microsoft Project.

3.2.2 Components of Proposed Method

The proposed method for CIPD is based on the workforce planning model of *Department of Health and Human Services* (HHS) that is developed by *Logistics Management Institute, Inc* (LMI). This model is used widely by several public and private sector organizations. The HHS model components consist of four planning steps: *Supply Analysis*, *Demand Analysis, Gap Analysis and Solution Analysis, plus an ongoing evaluation step* (**see Figure 2.3 in Chapter 2**). Its content covers analyzing the present workforce, identifying organizational objective and workforce competencies needed to achieve them, comparing the present workforce competencies to those needed in the future, then developing plans to transition from the present workforce to the future workforce.

As above principle, the proposed method for CIPD (**Figure 3.3**) is developed to six planning steps: *Situation Analysis*, *Demand Analysis*, *Supply Analysis*, *Gap Analysis*, *Solution Analysis and Plan Evaluation*. While the terminology used in this method is different from HHS's model, the content is closely consistent.

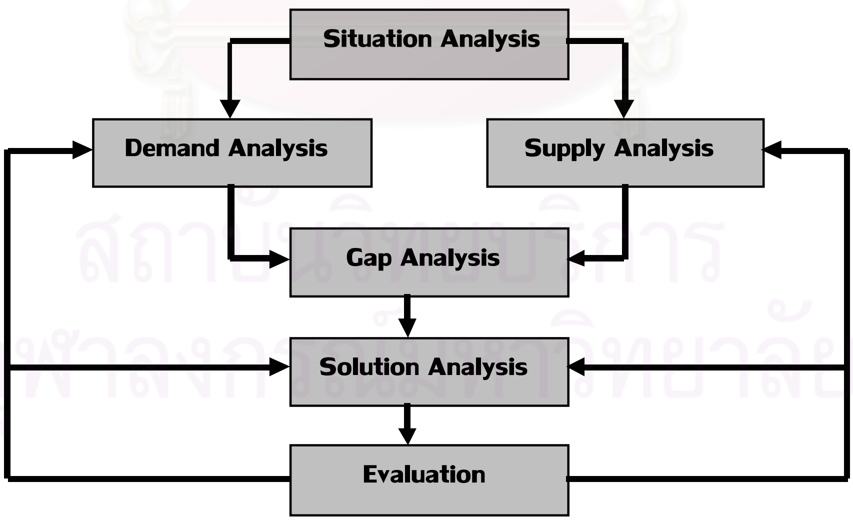


Figure 3.3 The Proposed Method of Human Resource Planning for CIPD

STEP 1. Situation Analysis

Situation Analysis examines the organizational current state that is needed to identify the requirements of human resource. This analysis covers project schedule, CIPD structure, human resource framework and human resource cost.

- ***Project Schedule***: The project schedule is identified and revised by the Construction Coordination Project Department. It indicates the details of activity duration and project milestone. Thus, we can take these data to create the CIPD schedule in accordance with the project schedule. In fact, the schedule contains inherent risk. This risk has to be reduced and the remained risk must be managed. Therefore, the planner should include the proper amount of contingencies to the project schedule in order to reduce the effect of risk.

- ***Department Structure***: This analysis aims to concern the department structure in order that planners ensure that the existed structure is the current state. In practice, the structure is determined at the beginning of the project and hardly changes though the project.

- ***Human Resource Framework***: Before planning the human resource, we should recognize the framework of human resource. The framework indicates the characteristics of the current human resources. Generally, the chief of department defines this framework both positions and functions. The framework bases on the project design, which it is always explained in the Technical Scope Document (TSD) of the project.

- ***Human Resource Cost***: The human resource cost presents the actual expenses of human resources that perform the task in a period. The cost types of the proposed method are the same as the cost types of existing method (**see 3.1.1 Analyzing**). In the project, the Account & Treasury Department always identifies the cost types and the calculation.

STEP 2. Demand Analysis

Demand Analysis focuses on forecasting of future activities or workload, and identifying the competency sets of needed human resource. In order to calculate workload, the Scope of Work (SOW) should be identified in the first step. The SOW is extracted from the Technical Scope Document (TSD) of the project. Then, the Work Breakdown Structure (WBS) is approached to dividing the scope of work into work elements so that we can write the job description and job specification of each work element. Finally, we can calculate the workload of CIPD for all three blocks. The workload is calculated by multiplying the standard man-hour to the amount of work. In fact, the standard man-hour is obtained by interviewing the relevant people. It may not be accurate. Its value depends on the judgment of each person who is interviewed. Again, the amount of work can be extracted from the TSD and involved drawing. Its value may have some error because some work may miss in TSD or drawing.

STEP 3. Supply Analysis

Supply analysis deals with identifying present organizational competencies and analyzing staff demographics and trend. The trend can consider in two factors: Turnover rate and Absenteeism rate.

- *Turnover Rate* (TR): This rate shows the average percentage of employees leaving over a period of time.

$$\textbf{Turnover Rate} = \frac{\textbf{Leavers per period}}{\textbf{Average number employed during that period}} \times 100\%$$

- *Absenteeism Rate* (AR): This rate shows the average percentage of loss hours over a period of time.

$$\textbf{Absenteeism Rate (TR)} = \frac{\textbf{Loss hours per period}}{\textbf{Total hours during that period}} \times 100\%$$

STEP 4. Gap Analysis

Gap Analysis is the process of comparing the future needs with the present human resource in order to identify competency gaps and surpluses. The most information is provided by the previous analysis. This analysis, we will apply Microsoft Project to identify the gap, which it has three steps as follows.

- ***Create schedule***
- ***Assign human resource***
- ***View human resource gap***

STEP 5. Solution Analysis

Solution Analysis is the process of preparing the strategic plans for building the human resource needed in the future in order to close gaps and decrease surplus in competencies. After we finish gap analysis, we can resolve the gap and define the action plan as followings.

- ***Resolve human resource gap***

  - **Increase human resource**

    Increasing human resource units reduces the number of hours a single unit of the human resource that must work on the task. Before increasing the maximum units of a human resource, be sure that the extra units are available to the project and determine the impact on the cost of the project.

  - **Add overtime**

    By adding overtime, work is scheduled beyond a resource's regular working hours, but additional work is not added. Assigning overtime shortens the duration of a task. Before assigning overtime work, determine the impact on the cost of the project. After increasing the maximum units of a human resource, the remaining overallocation can be solved by adding overtime.

- **Provide training course**

  If we shortage the human resource in the critical position, we can develop the potential employees by training. In the project, the on-job training is always conducted because it takes a short time and low cost.

- ***Establish human resource plan***

  - **Set a baseline plan:** A baseline is useful for comparing the planned schedule with later versions of the schedule to see what changes have occurred.

  - **Prepare human resource plan**: human resource utilization, human resource workload, human resource budget and action plan.

STEP 6. Plan Evaluation

Plan evaluation involves a periodic and systematic review of human resource plan by using Microsoft Project. The plan must be reviewed the validity of its objective and assumptions. If the objectives and assumptions are changed, the effective adjustments are required.

- ***Define tracking progress***: Task Usage and Resource Usage views

- ***Compare the baseline to actual data***: costs, work, and dates

3.3 Application of Proposed Method

In this section, we will apply the proposed method to plan the human resource of Control Instrument Project Department in fiscal year 2000 in order to compare its results to the results of existing method in the same fiscal year. The application of proposed method is based on the assumptions that explained in section 3.2.1. The proposed method comprises of six steps: *Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis, Solution Analysis and Plan Evaluation*.

STEP 1. Situation Analysis

In this step, we examines the organizational current state of Control Instrument Project Department that is involved in project schedule, CIPD structure, human resource framework and human resource cost.

- ***Project Schedule***

First, we will review the project schedule of Ratchaburi Combined Cycle Project, which comprises three blocks of Combined Cycle Power Plant. Each block consists of two gas turbine units with two waste heat boilers and one steam turbine generating unit. The project schedule is presented in bar chart as shown in **Appendix A**. These schedules are prepared and revised by Construction Coordination Project Department. Actually, we extract the data from the project schedules creating the detail schedule of Control Instrument Project Department. Therefore, we can ensure that the human resource planning is consistent to the project schedule.

- ***CIPD Structure***

The CIPD structure is organized into four groups (as shown in **Figure 3.4**): Administration and Support, Mechanical C&I Section, Electrical C&I Section and Information Section.

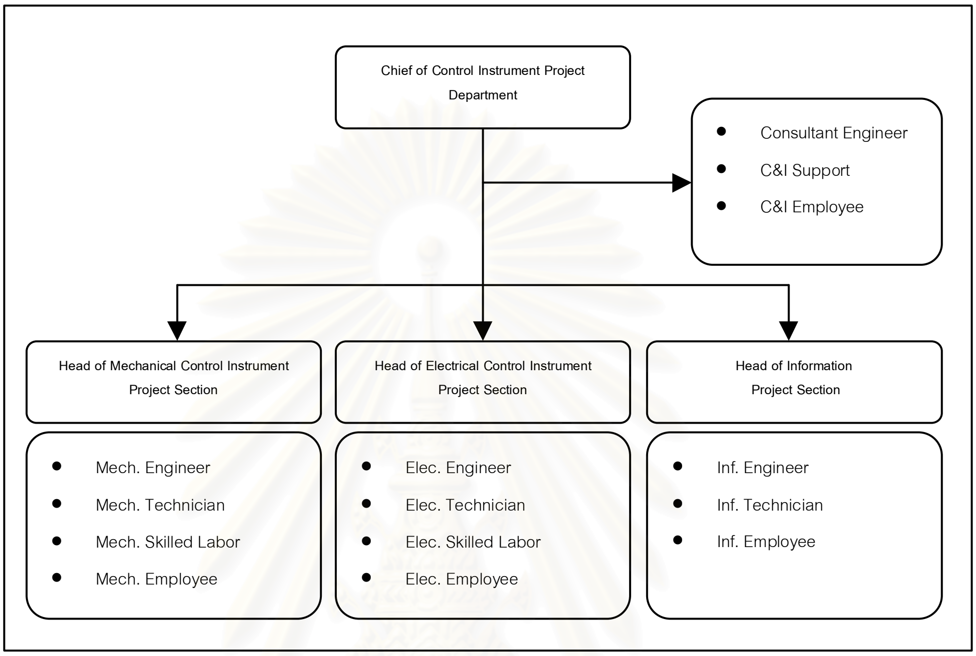


Figure 3.4 Structure of Control Instrument Project Department

- ***Human Resource Framework***

In approaching HR planning, the CIPD should develop a framework to characterize of the present human resource. The framework (**see Table 3.2**) presents a matrix that comprises of functions and positions. It is defined by using the historical data from the same previous project. The framework should cover the scope of work that is described in the Technical Scope Document (TSD) of the project. In this study, the functions are the main activities of CIPD as listed below.

1.Calibrate & install instrument: The instrument calibration and installation shall follow completion of site preparation and precede the control cable laying. The instrument shall be calibrated and installed in accordance with the specifications in section 4.4.5, *Field-Mounted Instruments*.

2.Adjust control valve: The control valve adjustment shall follow completion of site preparation and precede the control cable laying. The control valve shall be adjusted in accordance with the specifications in section 4.4.6, *Control Valve and MOVs*.

3.Install control cabinet: The control cabinet installation shall follow completion of control room and service air, and precede the control cable terminating. The control cabinets shall be installed in accordance with the specifications in section 4.3.8, *Boxes and Cabinets*.

4.Inspect panel & enclosure installation: The panel & enclosure installation shall follow completion of site preparation and precede the control cable laying. The panel & enclosure installation shall be inspected in accordance with the specifications in section 4.3.8, *Boxes and Cabinets*.

5.Install stainless tube: The stainless tube installation shall follow completion of site preparation and precede the instrument in service. The stainless tube shall be installed in accordance with the specifications in section 1.4.2, *Mechanical Design Criteria*.

6.Install cable tray & conduit: The cable tray and conduit installation shall follow completion of site preparation and precede the control cable laying. The cable tray and conduit shall be furnished and installed in accordance with the specifications in section 4.3.6, *Conduit Design*.

7.Inspect control cable laying: The control cable laying shall follow completion of tray and conduit installation and precede the control cable termination. The control cable laying shall be inspected in accordance with the specifications in section 4.3.11, Cable and Conductors.

8.Terminate control cable: The control cable termination shall follow completion of control cable laying and precede the instrument loop test. The control cable shall be terminated in accordance with the specifications in section 4.3.11, *Cable and Conductors*.

9.Test instrument loop: The instrument loop testing shall follow completion of control cable termination and precede the control function test. The instrument loop shall be tested in accordance with the specifications in section 6.1.6, *Calibration, Test and Pre-operation Checkout*.

10.Test control function: The control function testing shall follow completion of instrument loop testing and precede the commissioning test. The control function shall be tested in accordance with the specifications in section 6.1.6, *Calibration, Test and Pre-operation Checkout*.

11.Test & Commissioning: The test and commissioning shall follow completion of control function testing and precede the commercial date. The commissioning shall be tested in accordance with the specifications in section 6.2.2, *Acceptance Tests and Guarantee*.

In addition, the positions are the core groups that characterize the CIPD’s work. There are seven main groups as follows.

1.Chief of Control Instrument Project Department: A chief sets the vision, provides direction, sets goals and provides guidance and management of a department. The chief is held accountable to achieve the project’s goals. Responsibilities include management and leadership of section heads as supervisor to set direction and guide the actions for the benefit of the CIPD. The chief should have special knowledge in the overall and particular area of the Control Instrument project and/or technical expertise.

2.Head of Control Instrument Project Section: A head provides plan, sets goals and provides guidance and management of a section. The head is held accountable to achieve the project’s goals. Responsibilities include management and leadership of engineers, technicians and other employees as supervisor to set plan and guide the actions for the benefit of the CIPD. The head should have special knowledge in the overall and particular area of technical expertise.

3.Administrative Support: Administrative support includes the people who are necessary to keep the department operating. They provide critical contributions on a daily basis in the areas of data management, computers, secretarial support, procurement, personnel, logistics for travel and hosting of conferences and workshops.

4.Engineer: An engineer provides plan, guidance and management of a team. Responsibilities include management and leadership of technicians and other employees as coach to guide the actions for the benefit of the CIPD. The engineer should have special knowledge in the particular area of technical expertise.

5.Technician: A technician follows the plan of a team. Responsibilities include problem solving and specialist to conduct the actions for the benefit of the CIPD. The technician should have special knowledge in the particular area of technical expertise.

6.Skilled Labor: A skilled labor follows the plan of a team. Responsibilities conduct the actions needed skills for the benefit of the CIPD. The skilled labor should have special knowledge in the particular area of technical welding.

7.Contracted Employee: A contracted employee follows the plan of a team. Responsibilities conduct the actions for the benefit of the CIPD. The employee should have some knowledge in the technical areas. Some of them can be developed to replace technician position.

Table 3.2 Framework of CIPD Human Resource

	Administration & Support	**Mechanical C&I Section**	**Electrical C&I Section**	**Information Section**
1. C&I Administration	C&I Chief Consultant Engineer C&I Support C&I Employee	Head of MCI	Head of ECI	Head of INF
2.Calibrate & install instrument		M Engineer M Technician M Employee		
3.Adjust control valve		M Engineer M Technician M Employee		
4.Install control cabinet			E Engineer E Technician E Employee	I Engineer I Technician I Employee
5.Inspect panel & enclosure installation		M Engineer M Technician M Employee		
6.Install stainless tube		M Engineer M Technician M Skilled Labor M Employee		
7.Install cable tray & conduit			E Engineer E Technician E Skilled Labor E Employee	
8.Inspect control cable laying			E Engineer E Technician E Employee	I Engineer I Technician I Employee
9.Terminate control cable			E Engineer E Technician E Employee	I Engineer I Technician I Employee
10.Test instrument loop			E Engineer E Technician E Employee	I Engineer I Technician I Employee
11.Test control function			E Engineer E Technician E Employee	I Engineer I Technician I Employee
12.Test & Commissioning			E Engineer E Technician E Employee	I Engineer I Technician I Employee

- ***Human Resource Cost***

The proposed method classifies the human resource cost in similar way of existing method. The eight types (**see in Table 3.1**) of human resource cost are *Average Salary, Site Allowance, Electricity Allowance, providence Fund, Skill Premium, Fringe Benefit, Standard Rate and Overtime Rate*. In this project, the cost types are determined by the Account & Treasury Department.

STEP 2. Demand Analysis

Demand Analysis determines the forecasting workload and competency sets of CIPD human resource. In this step, we begin to define Scope of Work. Then, we approach the Work Breakdown Structure to divide the scope of work into work package. After that, we write the job description and job specification of each work package. Finally, we calculate the workload of CIPD for all three blocks.

The Scope of Work (**see in Appendix B**) can be identified from *Technical Scope Document* (TSD) that is the contract document of Ratchaburi Combined Cycle Project. TSD describes a functionally complete project. The design and supply must be in accordance with this document. Also, the contractors shall provide all equipment and services associated with the detailed design and engineering. In fact, the scope of work indicates the details of the activities in the framework that identified in the situation analysis. For Ratchaburi Combined Cycle Project, the TSD covers the contents in 7 parts as follows.

Part1 General Requirement
- General
- Design Description
- Scope
- Design Criteria

Part2 System Definition
- Civil and Structural Systems
- Mechanical Systems
- Electrical Systems
- Instrumentation and Control Systems

Part3 Major Equipment Specifications
- Structural Equipment
- Mechanical Equipment
- Electrical Equipment
- Instrumentation and Control equipment

Part4 Component Design Specifications
- Civil, Structural & Architectural Components
- Mechanical Components
- Electrical Components
- Instrumentation and Control Components

Part5 Quality Assurance Requirement
- Responsibilities of Contractor

- Responsibilities of EGAT

Part6 Plant Startup, Acceptance and Guarantees

- Startup
- Test on Site
- Factory Tests
- Training
- Performance Monitoring Program
- Equipment Manuals

Part7 Drawing Control

- Scope
- Project Design Drawing
- Vendor Documents
- Drawing Review by EGAT
- Certification of Documents
- Drawing Issued for Construction
- As-Built Drawing
- Transmittal of Records to EGAT

Then, we can approach ***Work Breakdown Structure*** (WBS) to present the overall scope of work (**Figure 3.5**). Control Instrument Project Department is in charge of installation and tests the control systems for three Combined Cycle Blocks. There are three subprojects in each block i.e. *Combustion Turbine Generator A* (CTG A), *Combustion Turbine Generator B* (CTG B) and *Steam Turbine Generator* (STG). The framework of the subprojects is the same, which they are described the details in the situation analysis.

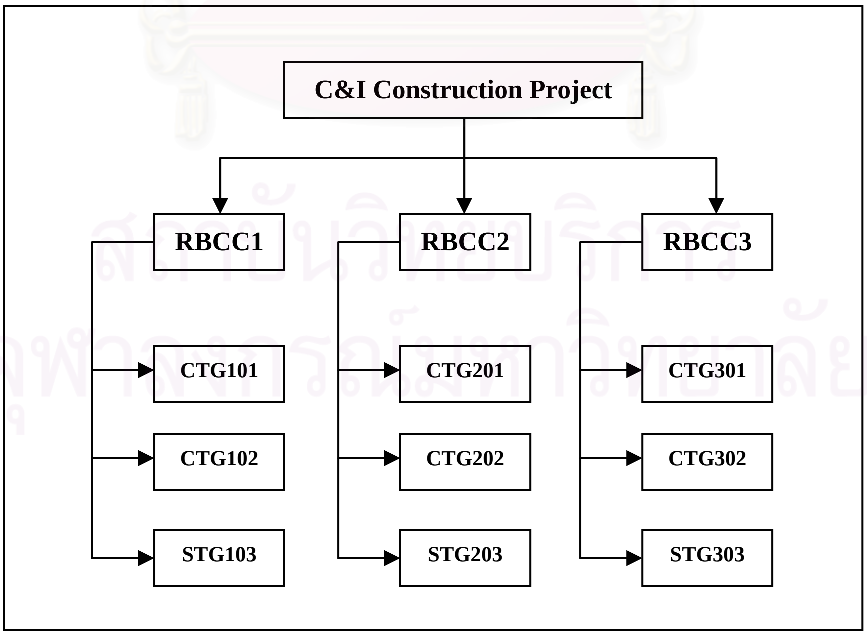


Figure 3.5 Work Breakdown Structure of Control Instrument Project Department

The ***Job Description*** explains work functions of organization. The work to be performed must be defined in sufficient detail to allow the participants to complete the work with a minimum need for further instructions. According to WBS, Control Instrument Project Department conducts the same main functions for 9 subprojects. Therefore, we can concentrate only one subproject in the detail of job description (**Appendix C)** and then extend to others.

The ***Job Specification*** describes the skills and qualities a human resource in order to do the task on the job description. The requirements detailed in a job specification should be the minimum standards required for a human resource to be able to perform the job. Writing the job specification of CIPD, we collect the data by interviewing the head of each section. We can sum up the job specification of CIPD in **Appendix D**.

The ***Workload*** provides the total man-hour of each task that is classified by main activities. Calculating workload, we multiply the quantity of work by man-hour per unit. The quantity of work can be identified by the scope of work from previous section. In this study, the man-hour per unit is obtained by interviewing the relevant people. Its values may have some mistakes. In addition, the amount of work may be not accurate. Thus, the total man-hour is approximate value based on the judgement of interviewee. Refer to **Table 3.3,** the workload of block1 comprises of Gas Turbine A, Gas Turbine B and Steam Turbine. The gas turbine A and gas turbine B are 10,310 man-hrs per each. The steam turbine is 12,613 man-hrs. In practice, the all gas turbine units are the same quality of work, as well as the all steam turbine units are the same. Thus, we can look at one block and extend to the other blocks.

Table 3.3 Workload per Block for Combined Cycle Plant Project

Ratchaburi Combined Cycle Project						
Task	Quantity	Unit	Man-Hour/Unit	Total Man-Hour	Duration [day]	Man
1.Gas Turbine A				10,310	935	133
Calibrate & install instrument	650	Set	0.6	390	30	13
Adjust control valve	68	Set	4	272	30	9
Install control cabinet	5	Set	20	100	5	20
Inspect panel & enclosure installation	23	Set	16	368	100	4
Install stainless tube	4,200	Metre	0.5	2,100	120	18
Install tray & conduit	3,700	Metre	0.5	1,850	120	15
Inspect cable laying	33,000	Metre	0.02	660	120	6
Terminate cable	490	Point	2	980	60	16
Test instrument loop	245	Loop	4	980	60	16
Test control function	30	System	15	450	90	5
Test & Commissioning	45	Procedure	48	2,160	200	11
2.Gas Turbine B				10,310	935	133
The details are similar to Gas Turbine A						
3.Steam Turbine				12,613	1,210	130
Calibrate & install instrument	1,047	Set	0.6	628	45	14
Adjust control valve	105	Set	4	420	45	9
Install control cabinet	10	Set	20	200	10	20
Inspect panel & enclosure installation	33	Set	10	330	150	2
Install stainless tube	5,400	Metre	0.5	2,700	150	18
Install tray & conduit	4,500	Metre	0.5	2,250	150	15
Inspect cable laying	48,000	Metre	0.02	960	150	6
Terminate cable	720	Point	2	1,440	90	16
Test instrument loop	360	Loop	4	1,440	90	16
Test control function	33	System	15	495	90	6
Test & Commissioning	50	Procedure	35	1,750	240	7

STEP 3. Supply Analysis

Supply analysis deals with identifying present organizational competencies and analyzing staff demographics and trend. For Control Instrument Project Department, we focus supply analysis on *Turnover Rate* (TR) and *Absenteeism Rate* (AR) that are presented in **Table 3.4**. These factors are estimated loss of working hours for current human resource. Both of them are based on the CIPD database in past two years (1998-1999). In this study, both rates are useful to only monitor the trend of human resource. If they are higher than 10%, the project managers must find out the cause of those high rates and resolve them. In the last, the current human resource of CIPD in the end of September 1999 can be presented in **Table 3.5**.

Table 3.4 Turnover rate and Absenteeism rate for CIPD

	1998 (as of 30 Sep 98)	**1999** (as of 30 Sep 99)	**Average Percentage (%)**
Turnover Rate (TR)	3.62 %	4.53 %	4.08 %
Absenteeism Rate (AR)	5.04 %	6.20 %	5.62 %

Note:

$$\textbf{Turnover Rate} = \frac{\textbf{Leavers per period}}{\textbf{Average number employed during that period}} \times 100\%$$

$$\textbf{Absenteeism Rate (TR)} = \frac{\textbf{Loss hours per period}}{\textbf{Total hours during that period}} \times 100\%$$

Table 3.5 Human Resource Supply of CIPD (as of 30 Sep 99)

Group	Position	Number of Employees	Percentage
1.C&I Department	❑ Chief of Department ❑ Consultant Engineer ❑ C&I Support ❑ C&I Employee	1 1 5 2 **9**	**7.2 %**
2. Mechanical C&I Section	❑ Head of Section ❑ Mechanical Engineer ❑ Mechanical Technician ❑ Mechanical Skilled Labor ❑ Mechanical Employee	1 2 22 4 20 **49**	**39.2 %**
3. Electrical C&I Section	❑ Head of ECI ❑ Electrical Engineer ❑ Electrical Technician ❑ Electrical Skilled Labor ❑ Electrical Employee	1 5 15 2 20 **43**	**34.4 %**
4. Information Section	❑ Head of INF ❑ Information Engineer ❑ Information Technician ❑ Information Employee	1 3 10 10 **24**	**19.2 %**
Total EGAT' Employees		**73**	**58.4 %**
Total Contracted Employees		**52**	**41.6 %**
Grand Total		**125**	**100 %**

STEP 4. Gap Analysis

Gap Analysis is the process of comparing the future needs with the present human resource in order to identify competency gaps and surpluses. The most information is provided by the previous analysis. This analysis, we will apply Microsoft Project to help us identifying the gap. Before beginning gap analysis, we need to create CIPD schedule and identify its milestones based on situation analysis, then assign the human resources performing each task in the schedule. Finally, we can view human resource gap and human resource workload with *Workload Report, Peak Units Report and Overallocation Report of Microsoft Project.*

- ***Create schedule***: According to situation analysis, the project schedule can be used as guidance for creating a schedule for CIPD as shown in **Appendix E**. The schedule comprises of main tasks, duration and milestones. The main tasks required to complete a project and the duration are integrated from workload in the demand analysis. On the schedule, they are listed in a sequence of performing. As defining a schedule, we should also identify the milestones. The milestone represents an event or condition that indicates the completion of related tasks or phase of project. Milestones help us to arrange tasks into logical groups or sequences. We can also use them to mark the progress of the project. This project, milestones usually are Initial Synchronization and Commercial Operation. The initial synchronization marks the specific date in schedule when the control systems are available for test and commission phase. The commercial operation is an official date that the Combined Cycle Plant is passed the approval and then synchronized to the master system.

- ***Assign human resource***: After establishing the schedule, we use the information of demand analysis and supply analysis to assign the human resource. Using Microsoft Project, we can quickly assign human resources to tasks and accurately track the human resource costs. Any information about a human resource such as costs, available time, can be stored in the Ms Project. We can also track the different rates per human resource to reflect varied charges for different types of work. This information can be used to incorporate future rate changes such as pay increases. In addition, we can better track the amount of work on task, the cost of work and the progress of the project. By assigning human resource, we can enter the human resource information into Ms Project in several different locations. The most common locations are the *Assign Resources* dialog box and the *Resource Sheet* (**see in Table 3.6**). In the Assign Resource dialog box, we can enter human resource names and assign human resource to tasks. On the Resource Sheet, we can enter human resource names as well as details information such as maximum units and costs. The most information assigned in Ms Project is transferred from the supply analysis and situation analysis. Actually, the Resource Sheet indicates the current competency supply of CPID that is a snapshot of 30 Sep 1999. In Grant Chart of Ms Project, we then can assign the human resource to tasks in order to identify the human resource needs that can be presented in Task Usage.

- ***View human resource gap and workload***: Viewing workloads helps to identify the gap of human resources. Using Ms Project, the gap can be obtained by viewing human resource that is overallocated and underallocated. A human resource is overallocated when it is assigned more work than it can complete in its schedule working hours. The Ms Project determines overallocation based on the work and duration values for assigned tasks, the maximum number of units available for the human resource, and the calendar used by the human resource. In Resource View, the resource text is highlighted in red and a leveling indicator is displayed for overallocated human resources. By viewing gap, we can use the *Resource Usage* view and the *Resource Allocation* view to identify and resolve the human resource allocations. We can also use the *Resource Graph*, which displays the percentage of human resource usage in a bar chart format. Typically, The gap information helps to resolve human resource conflicts within a schedule, which it can be obtained from Peak Units, Overallocation and Availability Report (**see in Table 3.7,3.8,3.9 respectively**).

STEP 5. Solution Analysis

Solution Analysis is the process of preparing the strategic plans for building the human resource needed in the future in order to close gaps and decrease surplus in competencies.

- ***Resolve human resource gap***: The human resource gap occurs when a human resource is overallocated or underallocated on a task or the project. Before starting the project, all human resource gaps should be resolved so that the schedule accurately reflects the human resources and work required to completing all tasks. In fact, we always consider the overallocation more than underallocation. The overallocation can be resolved automatically or manually. By resolving automatically, the Ms Project examines overallocation by looking at task dependencies, slack time, dates, priorities and constraints. Then, it determines whether a task can be delayed or split to resolve a human resource conflicts. Automatic leveling might not always be enough to completely resolve all human resource conflicts in a project. Thus, other scheduling techniques can be used to manually resolve the overallocations. In this analysis, we will consider two strategies as follows.

- Increase human resource

According to Overallocation Report of Microsoft Project, we have to subtract the maximum of overtime hours from the overallocation hours. In this study, the maximum overtime hours are limited at 50 hours per person per month. After that, we select the highest remained overalocation in order to calculate the maximum units of human resource. Then, the maximum unit is entered to Resource Sheet of Microsoft Project. Before increasing the maximum units of a human resource, be sure that the extra units are available to the project and determine the impact on the cost of the project. In this study, we assume that

- The EGAT's employees are limited. We can increase the human resource by hiring the contracted employees.
- Skilled labor can be allocated across sections.
- Technician can develop to assist Engineer by on-job Training.
- The contracted employees can develop to assist the Technician by on-job training.

- Add overtime

After we increase the maximum units of human resource, we view the overallocation again. If the overallocation is still existed, we can assign them to the overtime work. Before assigning overtime work, determine the impact on the cost of the project. The overtime plan is shown in **Table 3.10**.

- ***Establish human resource plan***:

Set a baseline plan

After a project schedule is created and the human resource conflicts have been resolved, the current schedule represents the best plan. By this reason, we have to set the schedule as a baseline plan. A baseline is a record taken at a specific time in the project. When a baseline is set, the dates, times and other critical pieces of data are stored and do not change. A baseline is useful for comparing the planned schedule with later versions of the schedule to see what changes have occurred.

- ***Prepare human resource plan***

As previous solution, the human resource plan can be established in term of human resource schedule, human resource budget and action plan. The human resource schedule provides the view of increasing and decreasing the number of human resource (**see in Table 3.11**). Consequently, the action plan explains more detail of the human resource schedule as shown in **Table 3.12**. Then, we calculate the human resource budget (**see in Table 3.13**) based on the number of human resource in schedule and the overtime plan.

STEP 6. Plan Evaluation

Plan evaluation involves a periodic and systematic review of human resource plan. The plan must be reviewed the validity of its objective and assumptions. If the objectives and assumptions are changed, the effective adjustments are required.

- ***Define tracking progress***

Both actual work and actual cost values can be tracked in the time-phased fields in the Task Usage and Resource Usage views. By entering information for a particular day, the project is kept up-to-date on a daily basis by resource task assignments. Tracking actual data in this way is helpful when a task assignment has been contoured. It is also useful when a resource is one of multiple resource assigned to a task, and that resource performs less scheduled work on the task than the other resources. The frequency of updates depends on the control needed over the project. If progress is tracked more often, it is easier to identify problems and take corrective action.

- ***Compare the baseline to actual data***

The project baseline provides the basis for comparing costs, work, and dates for all tasks and resources. By comparing the project progress to the baseline, the project can be monitored to ensure tasks are on schedule, resources are completing their work, and costs are not exceeding the budget. Project baselines and actual data can be viewed graphically in charts or numerically in tables.

Table 3.6 Human Resource Supply and Cost
Control Instrument Project Department
Fiscal Year 2000

ID	Resource Name	Initials	Group	Max. Units	Std. Rate	Ovt. Rate	Cost/Use	Accrue At	Base Calendar	Code
1	Chief-C&I Division	Chief	Admin	1	฿4,435.64/day	฿426.10/hr	฿0.00	Prorated	CI Calendar	
2	Consultant Engineer	Consult	Admin	1	฿3,371.62/day	฿313.23/hr	฿0.00	Prorated	CI Calendar	
3	C&I Officer	Officer	Admin	5	฿2,662.48/day	฿184.04/hr	฿0.00	Prorated	CI Calendar	
4	CI Employee	CEMP	Admin	2	฿248.10/day	฿30.00/hr	฿0.00	Prorated	Emp Calendar	
5	Head-MCI Section	HMCI	MCI	1	฿3,243.55/day	฿272.98/hr	฿0.00	Prorated	CI Calendar	
6	**M Engineer**	**MENG**	**MCI**	**2**	**฿2,812.30/day**	**฿184.04/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
7	**M Technician**	**MTEC**	**MCI**	**22**	**฿2,857.27/day**	**฿184.04/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
8	**M Skilled Labor**	**MSKL**	**MCI**	**4**	**฿1,434.37/day**	**฿117.42/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
9	**M Employee**	**MEMP**	**MCI**	**20**	**฿248.10/day**	**฿30.00/hr**	**฿0.00**	**Prorated**	**Emp Calendar**	
10	Head-ECI Section	HECI	ECI	1	฿3,243.55/day	฿272.98/hr	฿0.00	Prorated	CI Calendar	
11	**E Engineer**	**EENG**	**ECI**	**5**	**฿2,812.30/day**	**฿184.04/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
12	**E Technician**	**ETEC**	**ECI**	**15**	**฿2,857.27/day**	**฿184.04/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
13	**E Skilled Labor**	**ESKL**	**ECI**	**2**	**฿1,434.37/day**	**฿117.42/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
14	**E Employee**	**EEMP**	**ECI**	**20**	**฿248.10/day**	**฿30.00/hr**	**฿0.00**	**Prorated**	**Emp Calendar**	
15	Head-INF Section	HINF	INF	1	฿3,243.55/day	฿272.98/hr	฿0.00	Prorated	CI Calendar	
16	**I Engineer**	**IENG**	**INF**	**3**	**฿2,812.30/day**	**฿184.04/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
17	**I Technician**	**ITEC**	**INF**	**10**	**฿2,857.27/day**	**฿184.04/hr**	**฿0.00**	**Prorated**	**CI Calendar**	
18	I Skilled Labor	ISKL	INF	0	฿1,434.37/day	฿117.42/hr	฿0.00	Prorated	CI Calendar	
19	**I Employee**	**IEMP**	**INF**	**10**	**฿248.10/day**	**฿30.00/hr**	**฿0.00**	**Prorated**	**Emp Calendar**	

Table 3.7 Human Resource Peak Units
Control Instrument Project Department
Fiscal Year 2000

	Oct '99	Nov '99	Dec '99	Jan '00	Feb '00	Mar '00	Apr '00	May '00	Jun '00	Jul '00	Aug '00	Sep '00	Total
Chief-C&I Division	1	1	1	1	1	1	1	1	1	1	1	1	12
Consultant Engineer	1	1	1	1	1	1	1	1	1	1	1	1	12
C&I Officer	5	5	5	5	5	5	5	5	5	5	5	5	60
CI Employee	2	2	2	2	2	2	2	2	2	2	2	2	24
Head-MCI Section	1	1	1	1	1	1	1	1	1	1	1	1	12
M Engineer	1	2	3	3	1	1	3	4	3	1	2	2	26
M Technician	5	15	15	13	9	9	17	22	11	7	11	11	145
M Skilled Labor	2	2	2	2	2	2	2	4	2	2	2	2	26
M Employee		6	14	10	10		10	20	10	10	4	4	98
Head-ECI Section	1	1	1	1	1	1	1	1	1	1	1	1	12
E Engineer	3	3	4	4	4	6	7	8	6	6	7	7	65
E Technician	20	14	22	25	27	32	38	37	17	20	25	22	299
E Skilled Labor	2	2	4	4	4	4	2	4	4	2	2	2	36
E Employee	29	29	31	41	35	19	26	34	36	35	21	29	365
Head-INF Section	1	1	1	1	1	1	1	1	1	1	1	1	12
I Engineer	3	3	3	3	4	6	7	8	6	6	7	7	63
I Technician	7	7	8	10	9	10	12	13	12	10	9	11	118
I Skilled Labor													
I Employee	8	8	9	17	11	10	12	12	12	8	8	16	131
Total	92	103	127	144	128	111	148	178	131	119	110	125	1,516

Table 3.8 Human Resource Overallocation

Control Instrument Project Department

Fiscal Year 2000

	Oct '99	Nov '99	Dec '99	Jan '00	Feb '00	Mar '00	Apr '00	May '00	Jun '00	Jul '00	Aug '00	Sep '00	Total
Chief-C&I Division													
Consultant Engineer													
C&I Officer													
CI Employee													
Head-MCI Section													
M Engineer			100 hrs					284 hrs					384 hrs
M Technician													
M Skilled Labor													
M Employee													
Head-ECI Section													
E Engineer							316 hrs	427.09 hrs	2 hrs	168 hrs	216 hrs	336 hrs	1,465.09 hr
E Technician	312 hrs		500.49 hrs	434.13 hrs	1,200 hrs	2,596 hrs	3,080 hrs	2,567.12 hrs		594.75 hrs	950 hrs	224.13 hrs	12,458.62 hrs
E Skilled Labor			80 hrs	336 hrs	336 hrs	264 hrs		128 hrs	8 hrs				1,152 hrs
E Employee	160.15 hrs	1,416.01 hr	1,318.01 hr	2,879.33 hrs	1,283.04 hr		540.15 hrs	1,776.15 hr	2,684.01 hrs	1,752.63 hr		12.04 hrs	13,821.51 hrs
Head-INF Section													
I Engineer					96 hrs	344 hrs	636 hrs	795.09 hrs	354 hrs	504 hrs	584 hrs	672 hrs	3,985.09 hrs
I Technician							312 hrs	433.09 hrs	68 hrs				813.09 hrs
I Skilled Labor													
I Employee				352 hrs			360 hrs	328 hrs				72 hrs	1,112 hrs
Total	472.15 hrs	1,416.01 hr	1,998.5 hr	4,001.46 hrs	2,915.04 hrs	3,204 hrs	5,244.15 hrs	6,738.55 hrs	3,116.01 hrs	3,019.38 hrs	1,750 hrs	1,316.17 hr	35,191.4 hrs

Table 3.9 Human Resource Availability
Control Instrument Project Department
Fiscal Year 2000

	Oct '99	Nov '99	Dec '99	Jan '00	Feb '00	Mar '00	Apr '00	May '00	Jun '00	Jul '00	Aug '00	Sep '00	Total
Chief-C&I Division													
Consultant Engineer													
C&I Officer													
CI Employee													
Head-MCI Section													
M Engineer	168 hrs	80 hrs		26 hrs	168 hrs	184 hrs	104 hrs		26 hrs	168 hrs	72 hrs		996 hrs
M Technician	2,856 hrs	2,032 hrs	1,812 hrs	1,660 hrs	2,184 hrs	2,512 hrs	2,384 hrs	804 hrs	2,372 hrs	2,520 hrs	2,312 hrs	2,148 hrs	25,596 hrs
M Skilled Labor	336 hrs	352 hrs	488 hrs	336 hrs	336 hrs	368 hrs	320 hrs	168 hrs	352 hrs	336 hrs	368 hrs	336 hrs	4,096 hrs
M Employee	4,160 hrs	3,488 hrs	1,952.86 hr	2,080 hrs	2,535.22 hrs	4,320 hrs	3,664 hrs	816.86 hrs	2,080 hrs	3,495.22 hrs	3,808 hrs	4,042 hrs	36,442.15 hrs
Head-ECI Section													
E Engineer	408 hrs	372 hrs	288 hrs	186.18 hrs	240 hrs	24 hrs							1,518.18 hr
E Technician		752 hrs							702 hrs				1,454 hrs
E Skilled Labor	176 hrs												176 hrs
E Employee						1,431.85 hr					704 hrs		2,135.85 hrs
Head-INF Section													
I Engineer	72 hrs	20 hrs	64 hrs										156 hrs
I Technician	552 hrs	664 hrs	592 hrs	257.87 hrs	480 hrs	288 hrs				232 hrs	488 hrs	153.87 hrs	3,707.74 hrs
I Skilled Labor													
I Employee	448 hrs	712 hrs	552 hrs		243.61 hrs	208 hrs			64 hrs	672 hrs	800 hrs		3,699.61 hrs
Total	9,176 hrs	8,472 hrs	5,748.86 hrs	4,546.05 hrs	6,186.83 hrs	9,335.85 hrs	6,472 hrs	1,788.86 hr	5,596 hrs	7,423.22 hrs	8,552 hrs	6,679.87 hrs	79,977.53 hrs

Table 3.10 Human Resource Overtime Plan

Control Instrument Project Department
Fiscal Year 2000

	Oct '99	Nov '99	Dec '99	Jan '00	Feb '00	Mar '00	Apr '00	May '00	Jun '00	Jul '00	Aug '00	Sep '00	Total
Chief-C&I Division													
Consultant Engineer													
C&I Officer													
CI Employee													
Head-MCI Section													
M Engineer			100 hrs					284 hrs					384 hrs
M Technician													
M Skilled Labor													
M Employee													
Head-ECI Section													
E Engineer							316 hrs	427.09 hrs	2 hrs	168 hrs	216 hrs	336 hrs	1,465.09 hr
E Technician	312 hrs		500.49 hrs	434.13 hrs	1,200 hrs	2,596 hrs	3,080 hrs	2,567.12 hrs		594.75 hrs	950 hrs	224.13 hrs	12,458.62 hrs
E Skilled Labor			80 hrs	336 hrs	336 hrs	264 hrs		128 hrs	8 hrs				1,152 hrs
E Employee													
Head-INF Section													
I Engineer							316 hrs	427.09 hrs	2 hrs	168 hrs	216 hrs	336 hrs	1,465.09 hr
I Technician							312 hrs	433.09 hrs	68 hrs				813.09 hrs
I Skilled Labor													
I Employee													
Total	312 hrs		680.49 hrs	770.13 hrs	1,536 hrs	2,860 hrs	4,024 hrs	4,266.39 hrs	80 hrs	930.75 hrs	1,382 hrs	896.13 hrs	17,737.89 hrs

Table 3.11 Human Resource Utilization in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00
Admin	*Chief -C&I Division*	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin	*Consultant Engineer*	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin	*C&I Officer*	5	5	5	5	5	5	5	5	5	5	5	5	5
Admin	*C& I Employee*	2	2	2	2	2	2	2	2	2	2	2	2	2
MCI	*Head-MCI Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
MCI	*M Engineer*	2	2	2	2	2	2	2	2	2	2	2	2	2
MCI	*M Technician*	22	22	22	22	22	22	22	22	22	22	22	22	22
MCI	*M Skilled Labor*	4	4	4	4	4	4	4	4	4	4	4	4	4
MCI	*M Employee*	20	20	20	20	20	20	20	20	20	20	20	20	20
ECI	*Head-ECI Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
ECI	*E Engineer*	5	5	5	5	5	5	5	5	5	5	5	5	5
ECI	*E Technician*	15	15	15	15	15	15	15	15	15	15	15	15	15
ECI	*E Skilled Labor*	2	2	2	3	3	3	3	3	3	3	3	3	3
ECI	*E Employee*	20	35	35	35	45	45	45	45	45	45	45	45	45
INF	*Head-INF Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
INF	*I Engineer*	3	3	3	3	3	3	3	3	3	3	3	3	3
INF	*I Technician*	10	10	10	10	10	10	10	10	10	10	10	10	10
INF	*I Skilled Labor*	0	0	0	0	0	0	0	0	0	0	0	0	0
INF	*I Employee*	10	10	10	10	12	12	12	12	12	12	12	12	12
Total EGAT's employee		73	73	73	74	74	74	74	74	74	74	74	74	74
Total tempolaty employee		52	67	67	67	79	79	79	79	79	79	79	79	79
Grand Total C&I		125	140	140	141	153	153	153	153	153	153	153	153	153

Table 3.12 Human Resource Action Plan in Fiscal Year 2000
Control Instrument Project Department

Date	Action Plan	Responsibility
1 Oct 99	• Hire 15 E.Employees. • Train 5 E.Employees to assist E.Technician.	ECI ECI
1 Dec 00	• Allocate one M.Skilled labor to assist at ECI for 5 months. • Hire 1 E.Skilled labor for one month.	MCI, ECI ECI
1 Jan 00	• Hire 10 E employees. • Train 10 E.Employees to assist E.Technician. • Hire 2 I employees. • Train 2 I.Employees to assist I Technician. • Train 2 I.Technicians to assist I Engineer.	ECI ECI ECI INF INF INF

Table 3.13 Human Resource Budget in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Budget
Admin	*Chief -C&I Division [Bath]*	106,455.36	111,524.66	116,593.97	11,524.66	106,455.36	116,593.97	106,455.36	116,593.97	111,524.66	106,455.36	116,593.97	110,891.00	1,237,662.30
Admin	*Consultant Engineer [Bath]*	80,918.88	84,772.16	88,625.44	84,772.16	80,918.88	88,625.44	80,918.88	88,625.44	84,772.16	80,918.88	88,625.44	84,290.50	1,016,784.26
Admin	*C&I Officer [Bath]*	319,497.60	334,711.77	349,925.94	334,711.77	319,497.60	349,925.94	319,497.60	349,925.94	334,711.77	319,497.60	349,925.94	332,810.00	4,014,639.47
Admin	*C& I Employee [Bath]*	14,744.23	14,744.23	15,311.31	14,744.23	14,177.14	15,311.31	14,177.14	15,311.31	14,744.23	14,744.23	15,311.31	14,673.34	177,994.01
MCI	*Head-MCI Section [Bath]*	77,845.20	81,552.11	85,259.03	81,552.11	77,845.20	85,259.03	77,845.20	85,259.03	81,552.11	77,845.20	85,259.03	81,088.75	978,162.00
MCI	*M Engineer [Bath]*	134,990.40	141,418.51	147,846.63	141,418.51	134,990.40	147,846.63	134,990.40	147,846.63	141,418.51	134,990.40	147,846.63	140,615.00	1,696,218.65
MCI	*M Technician [Bath]*	1,508,638.56	1,580,478.49	1,652,318.42	1,580,478.49	1,508,638.56	1,652,318.42	1,508,638.56	1,652,318.42	1,580,478.49	1,508,638.56	1,652,318.42	1,571,498.50	18,956,761.89
MCI	*M Skilled Labor [Bath]*	137,699.52	144,256.64	150,813.76	144,256.64	137,699.52	150,813.76	137,699.52	150,813.76	144,256.64	137,699.52	150,813.76	143,437.00	1,730,260.04
MCI	*M Employee [Bath]*	147,442.29	147,442.29	153,113.14	147,442.29	141,771.43	153,113.14	141,771.43	153,113.14	147,442.29	147,442.29	153,113.14	146,733.43	1,779,940.30
ECI	*Head-ECI Section [Bath]*	74,601.65	81,552.11	85,259.03	81,552.11	77,845.20	85,259.03	77,845.20	85,259.03	81,552.11	77,845.20	85,259.03	81,088.75	974,918.45
ECI	*E Engineer [Bath]*	323,414.50	353,546.29	369,616.57	353,546.29	337,476.00	369,616.57	337,476.00	369,616.57	353,546.29	337,476.00	369,616.57	351,537.50	4,226,485.15
ECI	*E Technician [Bath]*	985,758.15	1,077,598.97	1,126,580.74	1,077,598.97	1,028,617.20	1,126,580.74	1,028,617.20	1,126,580.74	1,077,598.97	1,028,617.20	1,126,580.74	1,071,476.25	12,882,205.87
ECI	*E Skilled Labor [Bath]*	65,981.02	72,128.32	75,406.88	72,128.32	68,849.76	75,406.88	68,849.76	75,406.88	72,128.32	68,849.76	75,406.88	71,718.50	862,261.28
ECI	*E Employee [Bath]*	253,062.00	258,024.00	267,948.00	339,117.26	326,074.29	352,160.23	326,074.29	352,160.23	339,117.26	339,117.26	352,160.23	337,486.89	3,842,501.94
INF	*Head-INF Section [Bath]*	77,845.20	81,552.11	85,259.03	81,552.11	77,845.20	85,259.03	77,845.20	85,259.03	81,552.11	77,845.20	85,259.03	81,088.75	978,162.00
INF	*I Engineer [Bath]*	202,485.60	212,127.77	221,769.94	212,127.77	202,485.60	221,769.94	202,485.60	221,769.94	212,127.77	202,485.60	221,769.94	210,922.50	2,544,327.97
INF	*I Technician [Bath]*	685,744.80	718,399.31	751,053.83	718,399.31	685,744.80	751,053.83	685,744.80	751,053.83	718,399.31	685,744.80	751,053.83	714,317.50	8,616,709.95
INF	*I Skilled Labor [Bath]*													
INF	*I Employee [Bath]*	73,721.14	73,721.14	76,556.57	88,465.37	85,062.85	91,867.88	85,062.85	91,867.88	88,465.37	88,465.37	91,867.88	88,040.05	1,023,164.35
Total Cost [Bath]		5,270,846.10	5,569,550.88	5,819,258.23	5,565,388.37	5,411,994.99	5,918,781.77	5,411,994.99	5,918,781.77	5,665,388.37	5,434,678.43	5,918,781.77	5,633,714.21	67,539,159.88
Total Overtime [Bath]		0.00	0.00	42,731.32	64,187.26	19,726.56	148,527.84	450,912.96	693,759.34	43,851.18	61,837.44	79,505.28	123,674.88	1,728,714.06
Grand Total C&I [Bath]		5,270,846.10	5,569,550.88	5,861,989.55	5,629,575.63	5,431,721.55	6,067,309.61	5,862,907.95	6,612,541.11	5,709,239.55	5,496,515.87	5,998,287.05	5,757,389.09	**69,267,873.94**

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter will explain the results and discussions of development the human resource planning for Control Instrument Project Department. First, we present the results of existing method, the results of proposed method and the results of development. Then, we explain the results of existing method application in term of human resource utilization and human resource budget. After that, we present the proposed method application, which includes human resource utilization, human resource workload, human resource budget, action plan and evaluation. Finally, we discuss the results by comparing the existing method and the proposed method in three main subjects: human resource planning, human resource plan, action plan and evaluation, workload analysis, workforce analysis and budget estimating.

4.1 The Results of Existing Method

The existing method is a simple method of human resource planning. It consists three main steps: Analyzing, Forecasting and Planning.

In the first step, the analyzing involves examining the current state of project schedule, scope of work and human resource cost. The project schedule indicates the activity duration and its milestone. Then, the scope of work can be planed along the project schedule. In order to estimate the HR budget, the HR cost has to be classified into the specific cost types. In this project, there are two main types of human resource cost: Standard Rate and Overtime Rate. The standard rate includes Average salary, Site allowance, Electricity allowance, Providence allowance, Skill premium and Fringe Benefit. The overtime rate is extra working hour, which it is different rate for different positions. When the standard rate and overtime rate are determined explicitly, the budget can be calculated by multiplying both rates to the number of human resource required in those periods.

In the next step, the analyzed data were used for forecasting the human resource utilization with the planners' experiences. Although the work is the same quantity and condition, the attained value of HR utilization may be varied. Again, the HR budget is calculated from the utilization. If the utilization is untrue, the budget is incorrect, too.

Finally, the plan is established on the human resource utilization and human resource budget. The accuracy of both plan depend on the analyzing and forecasting. The advantage of this method is quick to plan the human resource. However, the error is still high and the progress tracking is not defined explicitly.

4.2 The Results of Proposed Method

The proposed method is a systematic method that comprises of six steps: Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis, Solution Analysis and Evaluation.

This method begin with analyzing the current situation of project schedule, department structure, human resource framework and human resource cost. We can summarize as below.

Situation Analysis	Results
• Project schedule	• Duration and milestone
• Department Structure	• Current structure
• HR Framework	• HR characteristics
• HR Cost	• Details of HR cost

- The project schedule provides the duration and milestone of the activities that are defined in the scope of work. The project schedule may be changed because of the uncertainty of the project. In fact, it will be revised by the Coordination Project Department. If the project schedule is often changed, the demand and supply analysis may be high error. In order to keep the forecasting accuracy, the demand and supply analysis have to change according to the project schedule.
- The department structure is also a necessary factor for human resource planning. This analysis help to concern the current department structure. If the structure is changed, the human resource planning is arranged in accordance with the structure. The department structure is approved by the project director. In practice, it is changed hardly.
- In this study, the HR framework is included in the situation analysis, too. The HR framework represents the characteristics of the department both functions and positions. It can be used as a guidance for human resource planning for each work. Generally, the chief of department determine the HR framework, which it is consistent to the department structure. The framework is varied to the project depending on the scope of work, technology, process, structure and so on.
- Calculating the HR budget, the HR cost has to be broken down into standard rate and overtime rate. In this study, the details of both rates are similar to the HR cost in the existing method. Both rates are important to enter in Microsoft Project calculating the HR budget. If the estimating method in Table 3.1 is changed, both rate will be also changed.

Then, the future demand of human resource is forecasted in term of human resource workload and human resource competency. The demand analysis is based on the Technical Scope Document and Job Analysis. The results are concluded as below.

Demand Analysis	Results
• Technical Scope Document (TSD)	• Scope of Work • Work Breakdown Structure (WBS)
• Job Analysis	• Job Description • Job Specification • Workload (man-hour)

- Technical Scope Document is the contract document of the project, which it describes a functionally complete project. It also explains the design and supply of the project. Consequently, the scope of work can be identified from this document. The scope of work indicates the system package, the responsibility and suppliers of each sub-project. In each sub-project, the activities are based on the HR framework that is established in the situation analysis. Then, the Work Breakdown Structure is approached to show the overall scope of work. In practice, the WBS depend on the determination of the scope of work. It may be different, if it is applied to the other projects.
- In order to determine the workload, the job analysis is used for identifying the job description and job specification. The job description explains the functions that defined in the HR framework of situation analysis. The job description includes the job title, the duties to be performed, the distinguishing characteristics of the job, environmental conditions, and the authority and responsibilities of the jobholder. The job specification defines the minimum acceptable qualifications to perform the job successfully. It identifies the knowledge, skills, education, experience, certification and ability to do the job effectively. The workload shows the man-hour of task that classified in job description. Its value is calculated by multiplying the quantity of work with the man-hour per unit. The quantity of work can be extracted from the scope of work and relevant drawing. Again, the man-hour per unit is collected by interviewing the involved people. This value is not a standard man-hour for the job. It depends on the judgement of each interviewee. Thus, the calculated workload is only used for this project. Applying to the different project, the workload can be estimated in the similar way. Its value can be adjusted to the job information.

After that, the supply analysis is performed in order to identify the present organizational competency and staff trend. It can be summarized as below.

Supply Analysis	Results
• Staff competency	• Group, position, number of HR, percentage of each group
• Staff trend	• Turnover rate • Absenteeism rate

- The staff competency includes the current status of work group, work position, number of human resource and the percentage of each group. It depend on the department structure and HR framework.
- In this study, the staff trend is considered in two main rates: Turnover rate and Absenteeism rate. The turnover rate indicates the average percentage of people leaving over a period. The absenteeism rate is the average percentage of loss hours over a period of time. According to the database of CIPD during 1998 and 1999, the turnover rate and the absenteeism rate are 4.1% and 5.6% respectively. Those vales are not too high. Thus, in this study is not concluded this effect in the planning. If those values are higher than 10%, the manager should find out the cause of those rate and resolve them.

Then, the gap analysis provides the future of competency shortage and surpluses. Most information of this step is obtained from previous analysis. The gap analysis uses Microsoft Project to help to calculate the gap or overallocation.

Gap Analysis	Results
• By using Microsoft Project to analyze the gap between demand and supply.	• Workload Report • Utilization Report • Cost Report • Gap or Overallocation Report

The outputs from this analysis are resolved in the solution analysis, which applies the organizational strategies to close the gap. In this study, we consider only three strategies: Hiring the temporary employees, Increasing the overtime and Providing on-job training.

Solution Analysis	Results
• By using Microsoft Project to help resolving the gap. - Increase HR - Add overtime - Provide training	• Action plan - HR utilization plan - HR workload plan - HR budget plan

In the final step, the evaluation is identified the periodic and systematic review of human resource plan in order to ensure the validity of plan's objectives and assumptions.

Evaluation	Results
• Periodic review	• Monthly, yearly
• Systematic review - HR utilization - HR workload - HR cost	• Microsoft Project - Resource usage - Task usage - Cost uasage

4.3 The Results of Development

The proposed method provides the development of human resource planning in term of human resource utilization, human resource workload and human resource budget.

Human Resource Workload

In the existing method, the human resource workload is not defined in the human resource plan. However, the proposed method includes the human resource workload in human resource plan. The workload is calculated by Microsoft Project, which based on the assignment of human resource to the task in the project schedule. The value of workload plan is slightly higher than the calculated workload because the human resource assignment can't be often changed to the actual workload. Although, there is no job in a period, we have to keep the same assignment of human resource.

Human Resource Utilization

With regard to the existing method, the human resource utilization is estimated by the planners' experiences. The utilization is often not consistent to the workload. In this study, the utilization of the existing method is always higher than the proposed method through the fiscal year. In the other hand, the utilization of the proposed method is calculated by Microsoft Project, which based on the human resource workload that is also calculated by Microsoft Project. Thus, the human resource utilization is always in accordance with the human resource workload. In this method, we ensure that human resource utilization is appropriate estimation.

Human Resource Budget

The human resource budget of the existing method is estimated from the plan of human resource utilization. The budget includes the total human resource cost and total overtime cost. The total human resource cost is the sum of standard rate multiplying to people and 22 days. The overtime rate is the sum of overtime rate multiplying to 60% of people and 50 hours.

However, the budget calculation of the proposed method is different from that of the existing method. Calculating the total human resource cost, we use Microsoft Project help us to calculate, which its value depends on the working calendar. The days may more than 22 days or less than 22 days because they vary by the actual working day defined in the calendar. For calculating overtime, the proposed method depends on the hours in overtime plan generated by Microsoft Project. The overtime cost is the sum of overtime rate multiplying the hours in overtime plan. When comparing to the existing method, the proposed method can reduce the budget.

4.4 The Results of Existing Application

The results of existing application include the human resource utilization and human resource budget as below.

4.4.1 Human Resource Utilization, **Table 4.1**

The human resource plan includes the human resource name and the number of human resource assigned to each activity in the project schedule during 1 Oct 1999 and 30 Sep 2000.

4.2.2 Human Resource Budget, **Table 4.2**

The human resource budget details the quantities of money expended for each human resource during fiscal year 2000.

Table 4.1 Human Resource Utilization in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00
Admin	*Chief -C&I Division*	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin	*Consultant Engineer*	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin	*C&I Officer*	5	5	5	5	5	5	5	5	5	5	5	5	5
Admin	*C& I Employee*	2	2	2	2	2	2	2	2	2	2	2	2	2
MCI	*Head-MCI Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
MCI	*M Engineer*	2	2	2	2	2	2	2	2	2	2	2	2	2
MCI	*M Technician*	22	22	22	22	22	22	22	22	22	22	22	22	22
MCI	*M Skilled Labor*	4	4	4	4	4	4	4	4	4	4	4	4	4
MCI	*M Employee*	20	20	20	20	20	20	20	20	20	20	20	20	20
ECI	*Head-ECI Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
ECI	*E Engineer*	5	5	5	5	5	5	5	5	5	5	5	5	5
ECI	*E Technician*	15	15	15	15	15	15	15	25	25	25	25	25	25
ECI	*E Skilled Labor*	2	2	2	2	2	2	2	2	2	2	2	2	2
ECI	*E Employee*	60	60	60	60	60	60	60	60	60	60	60	60	60
INF	*Head-INF Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
INF	*I Engineer*	3	3	3	3	3	3	3	3	3	3	3	3	3
INF	*I Technician*	10	10	10	10	10	10	10	10	10	10	10	10	10
INF	*I Skilled Labor*													
INF	*I Employee*	10	10	10	20	20	20	20	20	20	20	20	20	20
Total EGAT's employee		73	73	73	73	73	73	73	83	83	83	83	83	83
Total temporaly employee		92	92	92	102	102	102	102	102	102	102	102	102	102
Grand Total C&I		165	165	165	175	175	175	175	185	185	185	185	185	185

Table 4.2 Human Resource Budget in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Budget
Admin	*Chief -C&I Division [Bath]*	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	97,584.08	1,171,008.96
Admin	*Consultant Engineer [Bath]*	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	74,175.64	890,107.68
Admin	*C&I Officer [Bath]*	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	292,872.80	3,514,473.60
Admin	*C& I Employee [Bath]*	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	10,916.40	130,996.80
MCI	*Head-MCI Section [Bath]*	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	856,297.20
MCI	*M Engineer [Bath]*	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	123,741.20	1,484,894.40
MCI	*M Technician [Bath]*	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	1,382,918.68	16,595,024.16
MCI	*M Skilled Labor [Bath]*	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	126,224.56	1,514,694.72
MCI	*M Employee [Bath]*	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	1,309,968.00
ECI	*Head-ECI Section [Bath]*	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	856,297.20
ECI	*E Engineer [Bath]*	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	309,353.00	3,712,236.00
ECI	*E Technician [Bath]*	942,899.10	942,899.10	942,899.10	942,899.10	942,899.10	942,899.10	1,571,498.50	1,571,498.50	1,571,498.50	1,571,498.50	1,571,498.50	1,571,498.50	15,086,385.60
ECI	*E Skilled Labor [Bath]*	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	63,112.28	757,347.36
ECI	*E Employee [Bath]*	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	327,492.00	3,929,904.00
INF	*Head-INF Section [Bath]*	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	71,358.10	856,297.20
INF	*I Engineer [Bath]*	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	185,611.80	2,227,341.60
INF	*I Technician [Bath]*	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	628,599.40	7,543,192.80
INF	*I Skilled Labor [Bath]*													
INF	*I Employee [Bath]*	54,582.00	54,582.00	54,582.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	109,164.00	1,146,222.00
Total Cost [Bath]		4,943,321.24	4,943,321.24	4,943,321.24	4,997,903.24	4,997,903.24	4,997,903.24	5,626,502.64	5,626,502.64	5,626,502.64	5,626,502.64	5,626,502.64	5,626,502.64	63,582,689.28
Total Overtime [Bath]		569,614.50	569,614.50	569,614.50	578,614.50	578,614.50	578,614.50	661,771.50	661,771.50	661,771.50	661,771.50	661,771.50	661,771.50	7,415,316.00
Grand Total C&I [Bath]		5,512,935.74	5,512,935.74	5,512,935.74	5,576,517.74	5,576,517.74	5,576,517.74	6,288,274.14	6,288,274.14	6,288,274.14	6,288,274.14	6,288,274.14	6,288,274.14	**70,998,005.28**

4.5 The Results of Proposed Method Application

In order to plan the human resource, the collected data of fiscal year 2000 is analyzed through six steps of the planning model described in Chapter 3. After that, we can conclude the results as follows.

4.5.1 Human Resource Plan, **Table 4.3**

The human resource plan includes the human resource name and the number of human resource assigned to each activity on the project schedule during 1 Oct 1999 and 30 Sep 2000. It also shows the sum of human resource in each month.

4.5.2 Human Resource Workload, **Table 4.4**

The human resource workload contains the human resource name and the quantities of work hours required completing the tasks on the schedule during 1 Oct 1999 and 30 Sep 2000.

4.5.3 Human Resource Budget, **Table 4.5**

The human resource budget details the quantities of money expended for each human resource during fiscal year 2000.

4.5.4 Action Plan, **Table 4.6**

The action plan summarizes the main activities performed during fiscal year 2000 so that the human resource plan can be effective. It presents the date, action plan and responsibility.

4.5.5 Evaluation Plan

The evaluation plan defines how to track the progress and when to evaluate the plan in order to concern the validity of plan. **Table 4.7**, the tracking progress is prepared for recording and reporting the actual work hours and actual costs. Again, the evaluation determines the period of examining the plan. In this planning, we will record the actual work hours and actual costs every day and evaluate the plan every month.

Table 4.3 Human Resource Utilization in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00
Admin	*Chief -C&I Division*	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin	*Consultant Engineer*	1	1	1	1	1	1	1	1	1	1	1	1	1
Admin	*C&I Officer*	5	5	5	5	5	5	5	5	5	5	5	5	5
Admin	*C& I Employee*	2	2	2	2	2	2	2	2	2	2	2	2	2
MCI	*Head-MCI Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
MCI	*M Engineer*	2	2	2	2	2	2	2	2	2	2	2	2	2
MCI	*M Technician*	22	22	22	22	22	22	22	22	22	22	22	22	22
MCI	*M Skilled Labor*	4	4	4	4	4	4	4	4	4	4	4	4	4
MCI	*M Employee*	20	20	20	20	20	20	20	20	20	20	20	20	20
ECI	*Head-ECI Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
ECI	*E Engineer*	5	5	5	5	5	5	5	5	5	5	5	5	5
ECI	*E Technician*	15	15	15	15	15	15	15	15	15	15	15	15	15
ECI	*E Skilled Labor*	2	2	2	2	2	2	2	2	2	2	2	2	2
ECI	*E Employee*	20	35	35	35	46	46	46	46	46	46	46	46	46
INF	*Head-INF Section*	1	1	1	1	1	1	1	1	1	1	1	1	1
INF	*I Engineer*	3	3	3	3	3	3	3	3	3	3	3	3	3
INF	*I Technician*	10	10	10	10	10	10	10	10	10	10	10	10	10
INF	*I Skilled Labor*	0	0	0	0	0	0	0	0	0	0	0	0	0
INF	*I Employee*	10	10	10	10	12	12	12	12	12	12	12	12	12
Total EGAT's employee		73	73	73	73	73	73	73	73	73	73	73	73	73
Total temporary employee		52	67	67	67	80	80	80	80	80	80	80	80	80
Grand Total C&I		125	140	140	140	153	153	153	153	153	153	153	153	153

Table 4.4 Human Resource Workload in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Total
Admin	*Chief -C&I Division [hours]*	168	176	184	176	168	184	168	184	176	168	184	175	2,111
Admin	*Consultant Engineer [hours]*	168	176	184	176	168	184	168	184	176	168	184	175	2,111
Admin	*C&I Officer [hours]*	840	880	920	880	840	920	840	920	880	840	920	875	10,555
Admin	*C& I Employee [hours]*	416	416	432	416	400	432	400	432	416	416	432	414	5,022
MCI	*Head-MCI Section [hours]*	168	176	184	176	168	184	168	184	176	168	184	175	2,111
MCI	*M Engineer [hours]*	336	352	368	352	336	368	336	368	352	336	368	350	4,222
MCI	*M Technician [hours]*	3,696	3,872	4,048	3,872	3,696	4,048	3,696	4,048	3,872	3,696	4,048	3,850	46,442
MCI	*M Skilled Labor [hours]*	672	704	736	704	672	736	672	736	704	672	736	700	8,444
MCI	*M Employee [hours]*	4,160	4,160	4,320	4,160	4,000	4,320	4,000	4,320	4,160	4,160	4,320	4,140	50,220
ECI	*Head-ECI Section [hours]*	161	176	184	176	168	184	168	184	176	168	184	175	2,104
ECI	*E Engineer [hours]*	805	880	920	880	840	920	840	920	880	840	920	875	10,520
ECI	*E Technician [hours]*	2,415	2,640	2,760	2,640	2,520	2,760	2,520	2,760	2,640	2,520	2,760	2,625	31,560
ECI	*E Skilled Labor [hours]*	322	352	368	352	336	368	336	368	352	336	368	350	4,208
ECI	*E Employee [hours]*	7,140	7,280	7,560	9,568	9,200	9,936	9,200	9,936	9,568	9,568	9,936	9,522	108,414
INF	*Head-INF Section [hours]*	168	176	184	176	168	184	168	184	176	168	184	175	2,111
INF	*I Engineer [hours]*	504	528	552	528	504	552	504	552	528	504	552	525	6,333
INF	*I Technician [hours]*	1,680	1,760	1,840	1,760	1,680	1,840	1,680	1,840	1,760	1,680	1,840	1,750	21,110
INF	*I Skilled Labor [hours]*													
INF	*I Employee [hours]*	2,080	2,080	2,160	2,496	2,400	2,592	2,400	2,592	2,496	2,496	2,592	2,484	28,868
Total Hours		**25,899**	**26,784**	**27,904**	**29,488**	**28,264**	**30,712**	**28,264**	**30,712**	**29,488**	**28,904**	**30,712**	**29,335**	**346,466**

Table 4.5 Human Resource Budget in Fiscal Year 2000

Control Instrument Project Department

Group	Position	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Budget
Admin	*Chief -C&I Division [Bath]*	106,455.36	111,524.66	116,593.97	11,524.66	106,455.36	116,593.97	106,455.36	116,593.97	111,524.66	106,455.36	116,593.97	110,891.00	1,237,662.30
Admin	*Consultant Engineer [Bath]*	80,918.88	84,772.16	88,625.44	84,772.16	80,918.88	88,625.44	80,918.88	88,625.44	84,772.16	80,918.88	88,625.44	84,290.50	1,016,784.26
Admin	*C&I Officer [Bath]*	319,497.60	334,711.77	349,925.94	334,711.77	319,497.60	349,925.94	319,497.60	349,925.94	334,711.77	319,497.60	349,925.94	332,810.00	4,014,639.47
Admin	*C& I Employee [Bath]*	14,744.23	14,744.23	15,311.31	14,744.23	14,177.14	15,311.31	14,177.14	15,311.31	14,744.23	14,744.23	15,311.31	14,673.34	177,994.01
MCI	*Head-MCI Section [Bath]*	77,845.20	81,552.11	85,259.03	81,552.11	77,845.20	85,259.03	77,845.20	85,259.03	81,552.11	77,845.20	85,259.03	81,088.75	978,162.00
MCI	*M Engineer [Bath]*	134,990.40	141,418.51	147,846.63	141,418.51	134,990.40	147,846.63	134,990.40	147,846.63	141,418.51	134,990.40	147,846.63	140,615.00	1,696,218.65
MCI	*M Technician [Bath]*	1,508,638.56	1,580,478.49	1,652,318.42	1,580,478.49	1,508,638.56	1,652,318.42	1,508,638.56	1,652,318.42	1,580,478.49	1,508,638.56	1,652,318.42	1,571,498.50	18,956,761.89
MCI	*M Skilled Labor [Bath]*	137,699.52	144,256.64	150,813.76	144,256.64	137,699.52	150,813.76	137,699.52	150,813.76	144,256.64	137,699.52	150,813.76	143,437.00	1,730,260.04
MCI	*M Employee [Bath]*	147,442.29	147,442.29	153,113.14	147,442.29	141,771.43	153,113.14	141,771.43	153,113.14	147,442.29	147,442.29	153,113.14	146,733.43	1,779,940.30
ECI	*Head-ECI Section [Bath]*	74,601.65	81,552.11	85,259.03	81,552.11	77,845.20	85,259.03	77,845.20	85,259.03	81,552.11	77,845.20	85,259.03	81,088.75	974,918.45
ECI	*E Engineer [Bath]*	323,414.50	353,546.29	369,616.57	353,546.29	337,476.00	369,616.57	337,476.00	369,616.57	353,546.29	337,476.00	369,616.57	351,537.50	4,226,485.15
ECI	*E Technician [Bath]*	985,758.15	1,077,598.97	1,126,580.74	1,077,598.97	1,028,617.20	1,126,580.74	1,028,617.20	1,126,580.74	1,077,598.97	1,028,617.20	1,126,580.74	1,071,476.25	12,882,205.87
ECI	*E Skilled Labor [Bath]*	65,981.02	72,128.32	75,406.88	72,128.32	68,849.76	75,406.88	68,849.76	75,406.88	72,128.32	68,849.76	75,406.88	71,718.50	862,261.28
ECI	*E Employee [Bath]*	253,062.00	258,024.00	267,948.00	339,117.26	326,074.29	352,160.23	326,074.29	352,160.23	339,117.26	339,117.26	352,160.23	337,486.89	3,842,501.94
INF	*Head-INF Section [Bath]*	77,845.20	81,552.11	85,259.03	81,552.11	77,845.20	85,259.03	77,845.20	85,259.03	81,552.11	77,845.20	85,259.03	81,088.75	978,162.00
INF	*I Engineer [Bath]*	202,485.60	212,127.77	221,769.94	212,127.77	202,485.60	221,769.94	202,485.60	221,769.94	212,127.77	202,485.60	221,769.94	210,922.50	2,544,327.97
INF	*I Technician [Bath]*	685,744.80	718,399.31	751,053.83	718,399.31	685,744.80	751,053.83	685,744.80	751,053.83	718,399.31	685,744.80	751,053.83	714,317.50	8,616,709.95
INF	*I Skilled Labor [Bath]*													
INF	*I Employee [Bath]*	73,721.14	73,721.14	76,556.57	88,465.37	85,062.85	91,867.88	85,062.85	91,867.88	88,465.37	88,465.37	91,867.88	88,040.05	1,023,164.35
Total Cost [Bath]		5,270,846.10	5,569,550.88	5,819,258.23	5,565,388.37	5,411,994.99	5,918,781.77	5,411,994.99	5,918,781.77	5,665,388.37	5,434,678.43	5,918,781.77	5,633,714.21	67,539,159.88
Total Overtime [Bath]		0.00	0.00	42,731.32	64,187.26	19,726.56	148,527.84	450,912.96	693,759.34	43,851.18	61,837.44	79,505.28	123,674.88	1,728,714.06
Grand Total C&I [Bath]		5,270,846.10	5,569,550.88	5,861,989.55	5,629,575.63	5,431,721.55	6,067,309.61	5,862,907.95	6,612,541.11	5,709,239.55	5,496,515.87	5,998,287.05	5,757,389.09	**69,267,873.94**

Table 4.6 Human Resource Action Plan in Fiscal Year 2000
Control Instrument Project Department

Date	Action Plan	Responsibility
1 Oct 99	• Hire 15 E.Employees. • Train 5 E.Employees to assist E.Technician.	ECI ECI
1 Dec 00	• Allocate one M.Skilled labor to assist at ECI for 5 months. • Hire 1 E.Skilled labor for one month.	MCI, ECI ECI
1 Jan 00	• Hire 10 E employees. • Train 10 E.Employees to assist E.Technician. • Hire 2 I employees. • Train 2 I.Employees to assist I Technician. • Train 2 I.Technicians to assist I Engineer.	ECI ECI ECI INF INF INF

Table 4.7 Example Form of Tracking Progress
Control Instrument Project Department

ID	Task Name	Details	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Total
1		Work													
		Act. Work													
		Act. Cost													
2		Work													
		Act. Work													
		Act. Cost													
3		Work													
		Act. Work													
		Act. Cost													

4.6The Discussion of Results

In this section, we discuss the results by comparing the existing method and the proposed method in three main subjects: human resource planning, human resource plan, action plan and evaluation, workload analysis, workforce analysis and budget estimating.

4.6.1 Human Resource Planning

In this discussing, the contents are based on the framework of human resource process, which consists of four steps: *Analyzing, Forecasting, Planning and Implementing* as shown in **Table 4.8**.

Table 4.8 Comparison of Existing Method and Proposed Method

Framework	**Existing Method**	**Proposed Method**
Analyzing	• Project Schedule • HR Cost • Scope of Work	• Project Schedule • CIPD Structure • HR Framework • HR Cost • Scope of Work • Work Breakdown Structure • Job Description • Job Specification • Workload • Turnover Rate • Absenteeism Rate
Forecasting	• Number of HR ** estimated by experience*	• Number of HR • HR Workload (hours) • HR Gap • HR Surplus ** estimated by Microsoft Project*
Planning	• HR Plan • HR Budget	• HR Plan • HR Budget • Action Plan: hire temporary employee, add overtime, on-job training
Implementing		• Progress Tracking • Evaluation

The existing method is a simple approach that is required the analyzed data less than the proposed method (**see in Table 4.8**). In practice, the heads of section involve in analyzing and forecasting of the human resource. They use the relevant data to plan the human resource as possible as they can obtain in that time. Their estimations often depend on various experiences. By those reasons, the human resource plan of each section may be failed and incredible. Again, the results are issued to the Chief of Department in order to be concluded in a master plan and be calculated the budget. Actually, the master plan is only aimed to estimate the budget in a fiscal year. Therefore, there is no action plan and no activity in the implementing step. After planning, they rarely review those plans. When a problem is occurred, the solving is often late because of no supporting plan. Consequently, the human resource cost may higher than the estimation cost.

In the other hand, the proposed method is a systematic process that is required more data to analyzing and forecasting (**see in Table 4.8**). In this study, we use Microsoft Project as a tool helping us to forecast the human resource need of future and analyze the gap of demand and supply. According to the planing, we can define the action plan that is consistent to the human resource utilization in order to achieve the project's goal. In the last step of proposed method, we identify the process for continuous monitoring and plan evaluation. Thus, we can ensure that the planning is accuracy and credibility. Furthermore, we can increase the efficiency of human resource allocation because the plan is explicitly defined the point of human resource movement. As a generic-planning method, it can be also applied to other departments.

4.6.2 Human Resource Plan

In this part, the discussions cover the comparing of plan components in human resource utilization, human resource workload and human resource budget.

Figure 4.1 shows the comparison of human resource utilization. Microsoft Project generates the actual utilization of human resource across the month. Its peak is occurred in May 2000. When comparing to the actual utilization, the existing method provides the over estimation of human resource utilization through the fiscal year 2000. The total average utilization of the existing method is about 40.5%. Also, the estimation of human resource workload and budget is higher than the actual requirement. Its percentages presented in **Figure 4.2 and 4.3** are 74.1% and 20.0% respectively. If we calculate the over budget, it is high to 11.9 million bath. By the results, we realize that the traditional plan may not be consistent to the actual work. They always estimate the plan by their experiences. In addition, the plan is not defined the action plan. They would not know the transition point of human resource. Thus, they could not make the decision on the allocation. Also, the tracking progress and plan evaluation of human resource are not determined. So, they would not have the historical information for analyzing in the future.

However, the human resource planning is developed as a systematic method in which the problem is occurred. Refer to graph in **Figure 4.1**, the proposed method can minimize the utilization of human resource, the workload and the budget. The values of utilization are higher than the actual requirement, except in May 2000. The total average of human resource utilization is higher than the actual requirement about 18.5%, which its values are still lower than those of existing method. The result indicates that the proposed method can reduce the over estimation to 22.0%, when compared to 40.5% of the existing method. In the same way, the proposed method can decrease the estimation of workload and budget to 45.4% and 17.4% respectively. When comparing to the existing method, the proposed method can reduce the variance to 28.6% of workload and 3% of budget. It means that the budget is minimized to 1.7 million bath, but it still covers the budget need. The results show that the proposed method can minimize not only human resource utilization, human resource workload but also the human resource budget. In the proposed method, the action plan and evaluation are also determined. The action plan presents the point of activity that is performed through the period of plan. It reminds the participants to do the activity explaining in the action plan. In addition, the proposed method indicates the evaluation including the progress tracking and evaluation period. The participants can know how to record the progress and when to evaluate the plan. By those reasons, we can sure that the proposed method is effective to implement in Control Instrument Project Department and others.

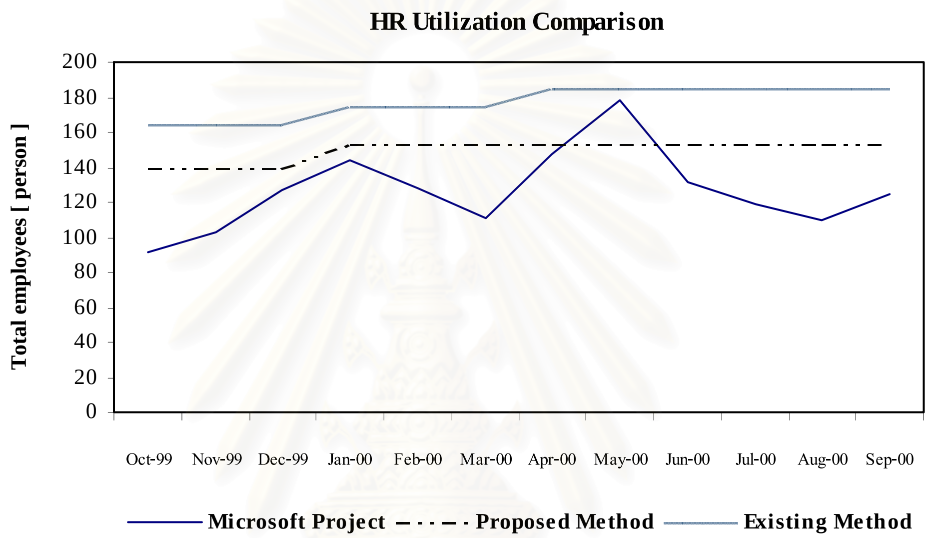


Figure 4.1 The Comparison of Human Resource Utilization

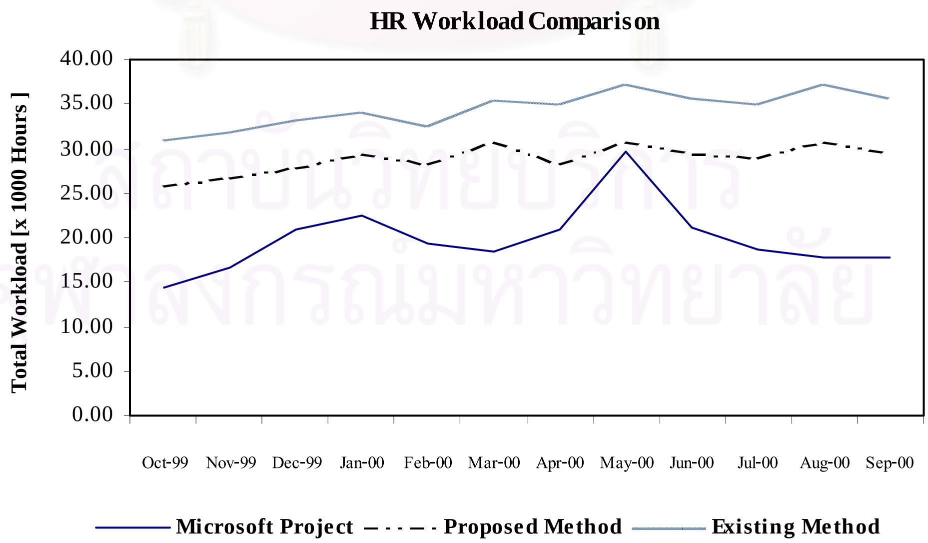


Figure 4.2 The Comparison of Human Resource Workload

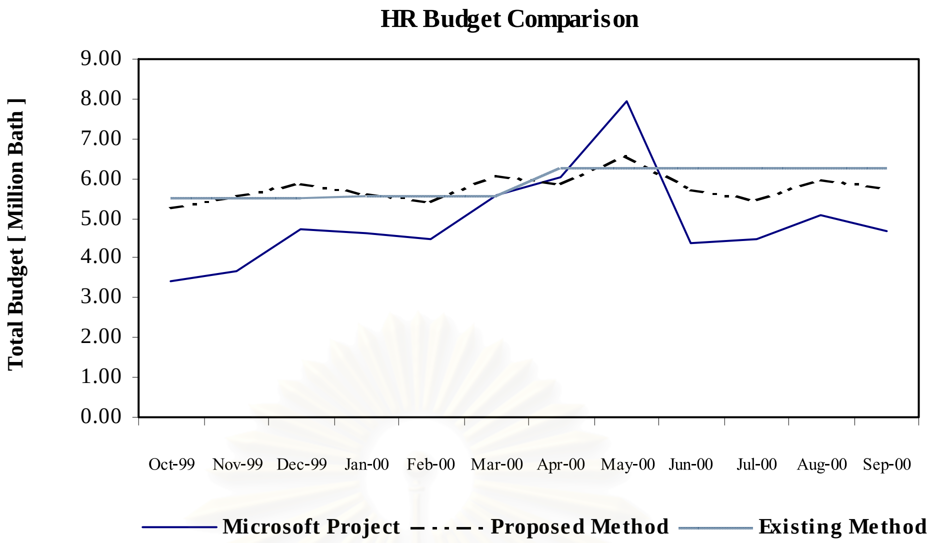


Figure 4.3 The Comparison of Human Resource Budget

4.6.3 Action plan and Evaluation

Regarding to **Table 4.8**, the action plan and evaluation are not explained in the existing method. The planers assume that everyone knows what action to be done along the plan. Again, the evaluation is not necessary to review because they think that they can use their experience to solve the future changes. In the results, they face the difficulty to solve the problems because of limited time or budget. If they define the action plan and proper evaluate the plan, they can conduct the project efficiently and effectively.

In contrast, the proposed method provides the action plan and evaluation in the last part of the plan. Regarding to the proposed method, we establish the action based on the four key strategies: hire employees, add overtime, internal allocation and on-job training. We can summary into the **Table 4.9** below.

Table 4.9 Action Plan of Control Instrument Project Department in Fiscal Year 2000

Date	Action Plan	Responsibility
1 Oct 99	• Hire 15 E.Employees. • Train 5 E.Employees to assist E.Technician.	ECI ECI
1 Dec 00	• Allocate one M.Skilled labor to assist at ECI for 5 months. • Hire 1 E.Skilled labor for one month.	MCI, ECI ECI
1 Jan 00	• Hire 10 E employees. • Train 10 E.Employees to assist E.Technician. • Hire 2 I employees. • Train 2 I.Employees to assist I Technician. • Train 2 I.Technicians to assist I Engineer.	ECI ECI ECI INF INF INF

4.6.4 Workload Analysis

The workload of existing method is estimated from the analyzed data of project schedule and scope of work. If those data are changed in the future, the estimated workload is not available. In addition, there is no tool for estimating the workload. The planners use their experiences to estimating the workload. Thus, the estimated workload is varied to the planner experiences. Although the work is the same, the workload may be different.

In contrast, the proposed method examines more data than the existing method. It also uses Microsoft Project as a tool to calculating the workload. In this method, the workload depends on the job analysis that provides the job description and the job specification. The workload presents in man-hour. Its value is calculated by multiplying the quantity of work with the man-hour per unit. The quantity of work can be extracted from the scope of work and relevant drawing. Again, the man-hour per unit is collected by interviewing the involved people. This value is not a standard man-hour for the job. It depends on the judgement of each interviewee. Thus, the calculated workload is only used for this project. Applying to the different project, the workload should be estimated in the similar way. Its value should be adjusted to the job information.

4.6.5 Workforce Analysis

According to the existing method, the workforce is estimated by the planners' experiences. The workforce is often not consistent to the workload. In this study, the workforce of the existing method is always higher than the proposed method through the fiscal year.

In the other hand, the workforce of the proposed method is calculated by Microsoft Project, which based on the human resource workload that is also calculated by Microsoft Project. Thus, the workforce is always in accordance with the human resource workload. In this method, we ensure that workforce is appropriate estimation.

4.6.6 Budget Estimating

The human resource budget of the existing method is estimated from the plan of human resource utilization. The budget includes the total human resource cost and total overtime cost. The total human resource cost is the sum of standard rate multiplying to people and 22 days. The overtime rate is the sum of overtime rate multiplying to 60% of people and 50 hours.

However, the budget calculation of the proposed method is different from that of the existing method. Calculating the total human resource cost, we use Microsoft Project help us to calculate, which its value depends on the working calendar. The days may more than 22 days or less than 22 days because they vary by the actual working day defined in the calendar. For calculating overtime, the proposed method depends on the hours in overtime plan generated by Microsoft Project. The overtime cost is the sum of overtime rate multiplying the hours in overtime plan. When comparing to the existing method, the proposed method can reduce the budget.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Control Instrument Project Department is a construction unit of Ratchaburi Power Plant Construction Project. Its structure comprises of three main sections: Mechanical C&I Section, Electrical C&I Section and Information Section. The department responsibility is to set up the control system of Combined Cycle Plant Project. The human resource is very important for this department. To date, CIPD don’t have a proper method to plan the human resource.

This thesis aims to develop a systematic method of human resource planning for Control Instrument project department by using Microsoft Project as a management tool. The proposed method can help the project managers to ensure that they can achieve the project goal through the efficient utilization of human resource. The development addresses in three main areas: Workload Planning, Utilization Planning and Budget Planning.

The methodologies were initiated to survey the literature of human resource planning from various sources such as text, journals, internet and etc. Then, the specific areas of development are determined. After that, the relevant data are collected and arranged in required form. In next step, we have proposed a systematic method of human resource planning, which this method is based on the workforce planning model that is developed by Department of Health and Human Services (HHS). The main components of the model include Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis and Evaluation. The development covers analyzing the current human resource, identifying organizational goals and human resource competencies needed to achieve them, comparing the current competencies to those needed in the future, then developing plans to transition from current human resource to the future human resource. In this study, we use Microsoft Project as tool to forecasting the demand and analyzing the gap.

The results can be concluded in the existing method, the proposed method, the development and the application.

Existing Method

The existing method is a simple method of human resource planning. It consists three main steps: Analyzing, Forecasting and Planning. In the first step, the analyzing involves in examining the current state of project schedule, scope of work and human resource cost. In the next step, the analyzed data were used for forecasting the human resource utilization with the planners’ experiences so that the budget of human resource can be estimated from the predicted utilization. Finally, the plan is establish on the human resource utilization and human resource budget. The advantage of this method is quick to plan the human resource. However, the error is still high and the progress tracking is not defined explicitly.

Proposed Method

The proposed method is a systematic method that comprises of six steps: Situation Analysis, Demand Analysis, Supply Analysis, Gap Analysis, Solution Analysis and Evaluation.

1. Situation Analysis: The situation analysis involve examining the current situation of project schedule, department structure, human resource framework and human resource cost.

- The project schedule provides the duration and milestone of the activities that are defined in the scope of work. The project schedule may be changed because of the uncertainty of the project. In fact, it will be revised by the Coordination Project Department. If the project schedule is often changed, the demand and supply analysis may be high error. In order to keep the forecasting accuracy, the demand and supply analysis have to change according to the project schedule.

- The department structure is also a necessary factor for human resource planning. This analysis help to concern the current department structure. If the structure is changed, the human resource planning is arranged in accordance with the structure. The department structure is approved by the project director. In practice, it is changed hardly.

- In this study, the HR framework is included in the situation analysis, too. The HR framework represents the characteristics of the department both functions and positions. It can be used as guidance for human resource planning for each work. Generally, the chief of department determines the HR framework, which it is consistent to the department structure. The framework is varied to the project depending on the scope of work, technology, process, structure and so on.

- Calculating the HR budget, the HR cost has to be broken down into standard rate and overtime rate. In this study, the details of both rates are similar to the HR cost in the existing method. Both rates are important to enter in Microsoft Project calculating the HR budget. If the estimating method in Table 3.1 is changed, both rates will be also changed.

2. Demand Analysis: The future demand of human resource is forecasted in term of human resource workload and human resource competency. The demand analysis is based on the Technical Scope Document and Job Analysis.

- Technical Scope Document is the contract document of the project, which it describes a functionally complete project. It also explains the design and supply of the project. Consequently, the scope of work can be identified from this document. The scope of work indicates the system package, the responsibility and suppliers of each sub-project. In each sub-project, the activities are based on the HR framework that is established in the situation analysis. Then, the Work Breakdown Structure is approached to show the overall scope of work. In practice, the WBS depends on the determination of the scope of work. It may be different, if it is applied to the other projects.

- In order to determine the workload, the job analysis is used for identifying the job description and job specification. The job description explains the functions that defined in the HR framework of situation analysis. The job description includes the job title, the duties to be performed, the distinguishing characteristics of the job, environmental conditions, and the authority and responsibilities of the jobholder. The job specification defines the minimum acceptable qualifications to perform the job successfully. It identifies the knowledge, skills, education, experience, certification and ability to do the job effectively. The workload shows the man-hour of task that classified in job description. Its value is calculated by multiplying the quantity of work with the man-hour per unit. The quantity of work can be extracted from the scope of work and relevant drawing. Again, the man-hour per unit is collected by interviewing the involved people. This value is not a standard man-hour for the job. It depends on the judgement of each interviewee. Thus, the calculated workload is only used for this project. Applying to the different project, the workload can be estimated in the similar way. Its value can be adjusted to the job information.

3. Supply Analysis: The supply analysis is performed in order to identify the present organizational competency and staff trend. It can be summarized as below.

- The staff competency includes the current status of work group, work position, number of human resource and the percentage of each group. It depends on the department structure and HR framework.

- In this study, the staff trend is considered in two main rates: Turnover rate and Absenteeism rate. The turnover rate indicates the average percentage of people leaving over a period. The absenteeism rate is the average percentage of loss hours over a period of time. According to the database of CIPD during 1998 and 1999, the turnover rate and the absenteeism rate are 4.1% and 5.6% respectively. Those vales are not too high. Thus, in this study is not concluded this effect in the planning. If those values are higher than 10%, the manager should find out the cause of those rates and resolve them.

4. Gap Analysis: The gap analysis provides the future of competency shortage and surpluses. Most information of this step is obtained from previous analysis. The gap analysis uses Microsoft Project to help to calculate the gap or overallocation.

5. Solution Analysis: The outputs from this analysis are resolved in the solution analysis, which applies the organizational strategies to close the gap. In this study, we consider only three strategies: Hiring the temporary employees, Increasing the overtime and Providing on-job training.

6. Action plan and evaluation: In the final step, the evaluation is identified the periodic and systematic review of human resource plan in order to ensure the validity of plan’s objectives and assumptions.

Development

The proposed method provides the development of human resource planning in term of human resource utilization, human resource workload and human resource budget.

In the existing method, the human resource workload is not defined in the human resource plan. However, the proposed method includes the human resource workload in human resource plan. The workload is calculated by Microsoft Project, which based on the assignment of human resource to the task in the project schedule. The value of workload plan is slightly higher than the calculated workload because the human resource assignment can't be often changed to the actual workload. Although, there is no job in a period, we have to keep the same assignment of human resource.

With regard to the existing method, the human resource utilization is estimated by the planners' experiences. The utilization is often not consistent to the workload. In this study, the utilization of the existing method is always higher than the proposed method through the fiscal year. In the other hand, the utilization of the proposed method is calculated by Microsoft Project, which based on the human resource workload that is also calculated by Microsoft Project. Thus, the human resource utilization is always in accordance with the human resource workload. In this method, we ensure that human resource utilization is appropriate estimation.

The human resource budget of the existing method is estimated from the plan of human resource utilization. The budget includes the total human resource cost and total overtime cost. The total human resource cost is the sum of standard rate multiplying to people and 22 days. The overtime rate is the sum of overtime rate multiplying to 60% of people and 50 hours. However, the budget calculation of the proposed method is different from that of the existing method. Calculating the total human resource cost, we use Microsoft Project help us to calculate, which its value depends on the working calendar. The days may more than 22 days or less than 22 days because they vary by the actual working day defined in the calendar. For calculating overtime, the proposed method depends on the hours in overtime plan generated by Microsoft Project. The overtime cost is the sum of overtime rate multiplying the hours in overtime plan. When comparing to the existing method, the proposed method can reduce the budget.

In order to evaluate the proposed method, we compare it to the existing method in fiscal year 2000 covering 1 Oct 99 and 30 Sep 00. Then, we discuss the results on three main subjects: Human resource planning, Human resource plan, Action plan and evaluation, Workload analysis, Workforce analysis and Budget estimating.

Human Resource Planning

The existing method is a simple approach that is required the analyzed data less than the proposed method. The estimations often depend on various experiences of the planner. By the reasons, the human resource plan may be failed and incredible. In fact, the human resource plan is only aimed to estimate the budget in a fiscal year. Therefore, there is no action plan supporting the planning. After planning, they rarely review those plans. When a problem is occurred, the solving is often late because of no supporting plan. Consequently, the human resource cost may higher than the estimation cost.

In the other hand, the proposed method is a systematic process that is required more data to analyzing and forecasting. Microsoft Project is used as a tool helping to forecast the human resource need of future and analyze the gap of demand and supply. According to the planing, we can define the action plan that is consistent to the human resource utilization in order to achieve the project's goal. In the last step of proposed method, we identify the process for continuous monitoring and plan evaluation. Thus, we can ensure that the planning is accuracy and credibility. Furthermore, we can increase the efficiency of human resource allocation because the plan is explicitly defined the point of human resource movement. As a generic-planning method, it can be also applied to other departments.

Human Resource Plan

When comparing to the actual utilization, the existing method provides the over estimation of human resource utilization through the fiscal year 2000. The total average utilization of the existing method is about 40.5%. Also, the estimation of human resource workload and budget is higher than the actual requirement. Its percentages are 74.1% and 20.0% respectively. By the results, we realize that the traditional plan may not be consistent to the actual work. They always estimate the plan by their experiences. In addition, the plan is not defined the action plan. They would not know the transition point of human resource. Thus, they could not make the decision on the allocation. Also, the tracking progress and plan evaluation of human resource are not determined. So, they would not have the historical information for analyzing in the future.

However, the human resource planning is developed as a systematic method in which the problem is occurred. The proposed method can minimize the utilization of human resource, the workload and the budget. The total average of human resource utilization is higher than the actual requirement about 18.5%, which its values are still lower than those of existing method. The result indicates that the proposed method can reduce the over estimation to 22.0%, when compared to 40.5% of the existing method. In the same way, the proposed method can decrease the estimation of workload and budget to 45.4% and 17.4% respectively. When comparing to the existing method, the proposed method can reduce the variance to 28.6% of workload and 3% of budget. It means that the budget is minimized to 1.7 million bath, but it still covers the budget need. The results show that the proposed method can minimize not only human resource utilization, human resource workload but also the human resource budget. In the proposed method, the action plan and evaluation are also determined. The action plan presents the point of activity that is performed through the period of plan. It reminds the participants to do the activity explaining in the action plan. In addition, the proposed method indicates the evaluation including the progress tracking and evaluation period. The participants can know how to record the progress and when to evaluate the plan. By those reasons, we can sure that the proposed method is effective to implement in Control Instrument Project Department and others.

Action plan and evaluation

The action plan and evaluation are not explained in the existing method. The planers assume that everyone knows what action to be done along the plan. Again, the evaluation is not necessary to review because they think that they can use their experience to solve the future changes. In the results, they face the difficulty to solve the problems because of limited time or budget. If they define the action plan and proper evaluate the plan, they can conduct the project efficiently and effectively.

In contrast, the proposed method provides the action plan and evaluation in the last part of the plan. Regarding to the proposed method, we establish the action based on the four key strategies: hire employees, add overtime, internal allocation and on-job training.

Workload analysis

The workload of existing method is estimated from the analyzed data of project schedule and scope of work. If those data are changed in the future, the estimated workload is not available. In addition, there is no tool for estimating the workload. The planners use their experiences to estimating the workload. Thus, the estimated workload is varied to the planner experiences. Although the work is the same, the workload may be different.

In contrast, the proposed method examines more data than the existing method. It also uses Microsoft Project as a tool to calculating the workload. In this method, the workload depends on the job analysis that provides the job description and the job specification. The workload presents in man-hour. Its value is calculated by multiplying the quantity of work with the man-hour per unit. The quantity of work can be extracted from the scope of work and relevant drawing. Again, the man-hour per unit is collected by interviewing the involved people. This value is not a standard man-hour for the job. It depends on the judgement of each interviewee. Thus, the calculated workload is only used for this project. Applying to the different project, the workload should be estimated in the similar way. Its value should be adjusted to the job information.

Workforce analysis

According to the existing method, the workforce is estimated by the planners' experiences. The workforce is often not consistent to the workload. In this study, the workforce of the existing method is always higher than the proposed method through the fiscal year.

In the other hand, the workforce of the proposed method is calculated by Microsoft Project, which based on the human resource workload that is also calculated by Microsoft Project. Thus, the workforce is always in accordance with the human resource workload. In this method, we ensure that workforce is appropriate estimation.

Budget Estimating

The human resource budget of the existing method is estimated from the plan of human resource utilization. The budget includes the total human resource cost and total overtime cost. The total human resource cost is the sum of standard rate multiplying to people and 22 days. The overtime rate is the sum of overtime rate multiplying to 60% of people and 50 hours.

However, the budget calculation of the proposed method is different from that of the existing method. Calculating the total human resource cost, we use Microsoft Project help us to calculate, which its value depends on the working calendar. The days may more than 22 days or less than 22 days because they vary by the actual working day defined in the calendar. For calculating overtime, the proposed method depends on the hours in overtime plan generated by Microsoft Project. The overtime cost is the sum of overtime rate multiplying the hours in overtime plan. When comparing to the existing method, the proposed method can reduce the budget.

The results indicate that the proposed method can improve analyzing, forecasting, planning and implementing of the existing method. In addition, the comparing results provide that the proposed method can minimized the utilization of human resource, the workload and budget to 22%, 29% and 3% respectively. In the other word, we can minimize the budget to 1.7 million bath per fiscal year, while the budget still covers the actual cost. In addition, the proposed method can be applied to the other project departments, which its assumptions have to revise in accordance with the data analysis.

5.2 Recommendation

Although, the results of model can minimize the utilization of human resource, workload and budget, the following recommendation are made:

5.2.1 Application of Proposed Method

We can apply this method to other departments. The data analysis can be varied to assumptions of department. The assumption validity depends on the data analysis and forecasting technique. If we used the proposed method to planning human resource for the other project, the assumptions should be reviewed significantly. The assumptions should be made explicit so that the forecasts can be judged against them.

5.2.2 Forecasting Techniques

This study involves estimating human resource utilization through the use of workload factors. The job analysis is used identifying the job description and job specification. The number of job to be completed is then estimated and converted into total man-hours. After that, those data are entered to Microsoft Project that helps to calculating the workload in accordance with the project schedule. Actually, the total man-hours are not the standard value for each job depending on the judgement of each interviewee. Thus, the workload forecasting should be improved by studying more details of job and determining the standard for a job. The factors considered choosing the appropriate techniques are as follows.

- Time should be consistent to the overall planning timeframe.
- Data should reflect actual organizational operations.
- Assumptions may differ from organization to organization.
- The more accurate an organization needs the forecasting, the more cost an organization have to spend on it.
- It is necessary for data to be available and timeless.

5.2.3 Estimating Workload

Estimating workload, the proposed method use the job analysis providing job description and job specification. The job description depends on the HR framework that is defined in the situation analysis. The HR framework may differ from project to project. Again, the job specification defines the minimum qualification in accordance with the job description. In practice, the minimum qualifications always depend on the judgement of the planners. In results, the workload is varied to the planner judgement, too. In this study, Microsoft Project is used to present workload in man-hour, which its value is calculated by multiplying the quantity of work with the man-hour per unit. The quantity of work can be extracted from the scope of work and relevant drawing. Again, the man-hour per unit is collected by interviewing the involved people. This value is not a standard man-hour for the job. It depends on the judgement of each interviewee. Thus, the calculated workload is only used for this project. Applying to the different project, the workload should be estimated in the similar way. Then, its value should be adjusted to the job information.

5.2.4 Uncertainty

In this study, we assume that the uncertainty includes in the project schedule. If the project schedule is changed, the HR workload is also changed respectively. In addition, the project schedule effects to the human resource utilization and human resource budget. Before planning the human resource, the project schedule should be considered significantly about the risk analysis. Then, the plan should be defined the way to reduce the uncertainty.

5.2.5 Database Development

Data of human resource demographics and personnel transaction are essential to human resource planning. The demographic data provides necessary baseline for current human resource. Its data includes occupation, grade level, organizational structure, race/nation origin, gender, age, length of service, retirement eligibility and so on. In similar, the personnel data can provide the trend of human resource. Consequently, organization can develop valuable information on any areas at a given point in the future by projecting from baseline. By those reasons, we should develop the database not only human resource demographics but also personnel transaction.

5.2.6 Competency Assessment

Competencies are a set of behaviors involving skills, knowledge, abilities and personal attributes. They are critical to achievement of organization. Thus, we should develop a competency model to guide the organization achieving the goals. The model should include two key elements: Skill Analysis and Job Analysis.

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APPENDICES

APPENDIX A

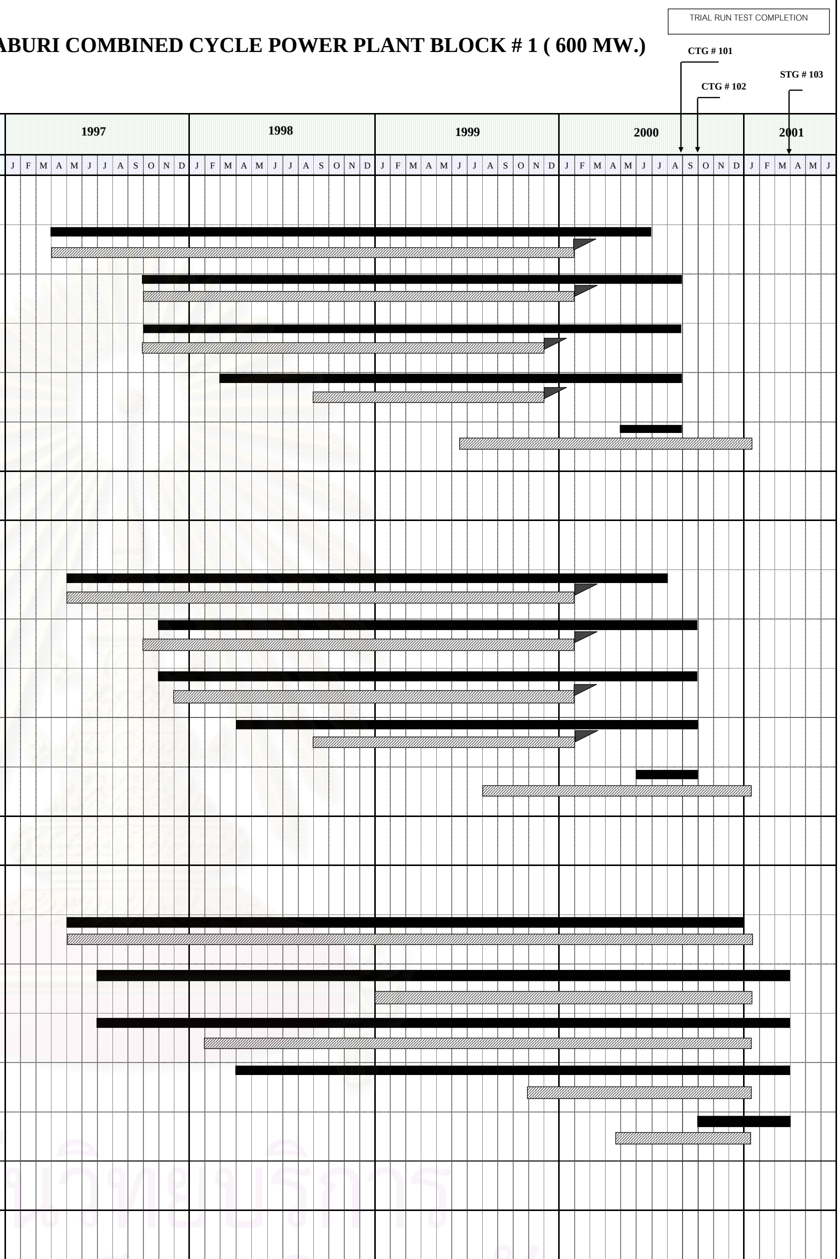
PROJECT SCHEDULE

RATCHABURI COMBINED CYCLE PLANT PROJECT

BLOCK 1, BLOCK 2 AND BLOCK 3

Appendix A-1

PACKAGE II : RATCHABURI COMBINED CYCLE POWER PLANT BLOCK # 1 (600 MW.)



DESCRIPTION	% OF TOTAL PROJECT	% PROGRESS WORK UP TO Jan. 15,2001 SCH.	ACTUAL	STATUS
1. CTG # 101				
- CIVIL WORK	5.00	100.00	100.00	0.00
- MECHANICAL WORK	8.50	100.00	100.00	0.00
- ELECTRICAL WORK	5.50	100.00	100.00	0.00
- CONTROL & INSTRUMENT WORK	2.50	100.00	100.00	0.00
- TEST & COMMISSIONING	1.50	100.00	97.50	-2.50
TOTAL OF CTG # 101	23.00	100.00	99.84	-0.16
2. CTG # 102				
- CIVIL WORK	5.00	100.00	100.00	0.00
- MECHANICAL WORK	8.50	100.00	100.00	0.00
- ELECTRICAL WORK	5.50	100.00	100.00	0.00
- CONTROL & INSTRUMENT WORK	2.50	100.00	100.00	0.00
- TEST & COMMISSIONING	1.50	100.00	97.80	-2.20
TOTAL OF CTG # 102	23.00	100.00	99.86	-0.14
3.1 STG # 1	(54.00)			
- CIVIL WORK	14.00	100.00	98.00	-2.00
- MECHANICAL WORK	17.80	95.50	98.35	2.85
- ELECTRICAL WORK	11.20	95.50	99.55	4.05
- CONTROL & INSTRUMENT WORK	7.50	95.50	94.00	-1.50
- TEST & COMMISSIONING	3.50	32.50	37.00	4.50
TOTAL OF STG #1	54.00	92.59	93.93	1.34
TOTAL OF BLOCK 1	100	96.00	96.65	0.65

Year / Month	J	F	M	A	M	J	J	A	S	O	N	D
1997 COMULATIVE TOTAL PROJECT WORK SCHEDULED				0.20	0.78	1.26	2.03	2.80	3.62	4.97	6.60	8.03
1997 COMULATIVE TOTAL PROJECT WORK FINISHED				0.29	0.85	1.30	1.43	1.90	2.46	3.60	5.60	6.35
1998 COMULATIVE TOTAL PROJECT WORK SCHEDULED	9.51	11.04	13.02	15.28	17.59	19.90	22.25	24.62	27.04	29.39	31.64	34.02
1998 COMULATIVE TOTAL PROJECT WORK FINISHED	7.78	9.00	10.75	11.71	14.40	14.40	20.68	22.85	26.74	29.62	33.36	35.40
1999 COMULATIVE TOTAL PROJECT WORK SCHEDULED	36.55	39.08	41.65	44.07	46.46	48.87	51.28	53.67	56.06	58.45	60.84	63.37
1999 COMULATIVE TOTAL PROJECT WORK FINISHED	38.71	42.52	45.45	46.58	48.00	49.77	57.55	59.86	64.99	67.97	72.10	73.40
2000 COMULATIVE TOTAL PROJECT WORK SCHEDULED	66.02	68.72	71.56	73.99	76.66	79.44	82.72	86.22	88.78	90.93	93.24	95.19
2000 COMULATIVE TOTAL PROJECT WORK FINISHED	74.49	76.68	78.28	80.56	83.00	86.89	89.22	90.96	92.32	94.33	95.86	96.45
2001 COMULATIVE TOTAL PROJECT WORK SCHEDULED	96.81	98.59	100.00									
2001 COMULATIVE TOTAL PROJECT WORK FINISHED	96.65											

REMARK : COMMERACIAL OPERATION DATE

CTG101 : August 2000

CTG 102 : September 2000

STG 103 : March 2544

Appendix A-2

PACKAGE II : RATCHABURI COMBINED CYCLE POWER PLANT BLOCK # 2 (600 MW.)

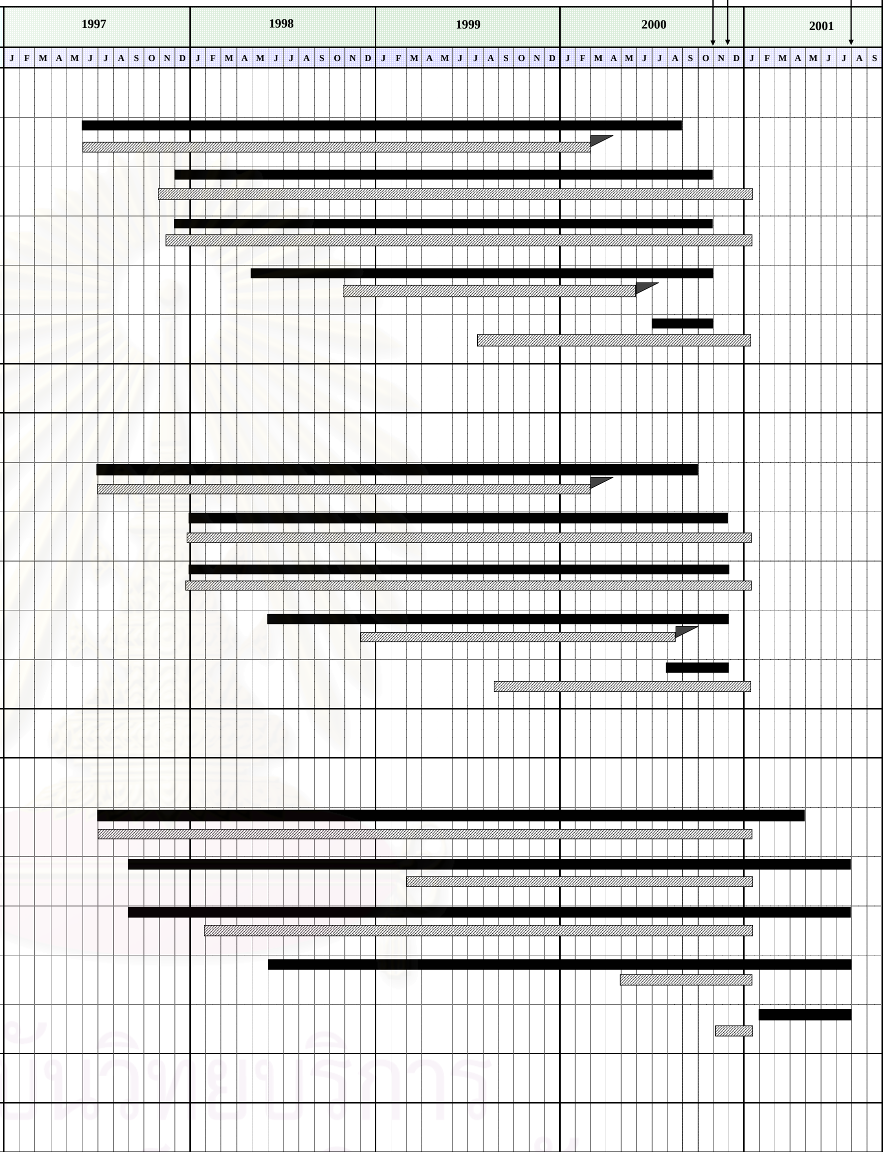
TRIAL RUN TEST COMPLETION

CTG # 201

CTG # 202

STG # 203

DESCRIPTION	% OF TOTAL PROJECT	% PROGRESS WORK UP TO Jan.15,2001 SCH.	ACTUAL	STATUS
1. CTG # 201				
- CIVIL WORK	5.00	100.00	100.00	0.00
- MECHANICAL WORK	8.50	100.00	99.57	-0.43
- ELECTRICAL WORK	5.50	100.00	99.10	-0.90
- CONTROL & INSTRUMENT WORK	2.50	100.00	100.00	0.00
- TEST & COMMISSIONING	1.50	100.00	89.00	-11.00
TOTAL OF CTG # 201	**23.00**	**100.00**	**98.91**	**-1.09**
2. CTG # 202				
- CIVIL WORK	5.00	100.00	100.00	0.00
- MECHANICAL WORK	8.50	100.00	99.57	-0.43
- ELECTRICAL WORK	5.50	100.00	99.55	-0.45
- CONTROL & INSTRUMENT WORK	2.50	100.00	100.00	0.00
- TEST & COMMISSIONING	1.50	100.00	74.00	-26.00
TOTAL OF CTG # 202	**23.00**	**100.00**	**98.04**	**-1.96**
3.1 STG # 2	**(54.00)**			
- CIVIL WORK	14.00	98.25	97.00	-1.25
- MECHANICAL WORK	17.80	87.50	93.40	5.90
- ELECTRICAL WORK	11.20	87.50	83.70	-3.80
- CONTROL & INSTRUMENT WORK	7.50	87.50	88.00	0.50
- TEST & COMMISSIONING	3.50	0.00	10.00	10.00
TOTAL OF STG #2	**54.00**	**84.62**	**86.17**	**1.55**
TOTAL OF BLOCK 2	**100**	**91.69**	**91.83**	**0.14**



Year	Month	COMULATIVE TOTAL PROJECT WORK SCHEDULED	COMULATIVE TOTAL PROJECT WORK FINISHED
1997	J		
1997	F		
1997	M		
1997	A		
1997	M		
1997	J	0.20	0.15
1997	J	0.78	0.30
1997	A	1.26	0.60
1997	S	2.03	1.40
1997	O	2.80	2.20
1997	N	3.62	3.08
1997	D	4.97	3.85
1998	J	6.60	4.41
1998	F	8.03	5.14
1998	M	9.51	5.86
1998	A	11.04	6.56
1998	M	12.94	7.25
1998	J	15.03	8.03
1998	J	17.17	14.45
1998	A	19.31	15.38
1998	S	21.49	17.61
1998	O	23.69	19.68
1998	N	25.94	22.88
1998	D	28.12	24.76
1999	J	30.20	27.95
1999	F	32.33	30.97
1999	M	34.52	33.96
1999	A	36.70	35.33
1999	M	39.02	36.44
1999	J	41.27	37.91
1999	J	43.57	43.41
1999	A	45.98	45.20
1999	S	48.31	48.21
1999	O	50.53	50.33
1999	N	52.75	53.87
1999	D	54.97	55.95
2000	J	57.19	58.13
2000	F	59.55	61.97
2000	M	62.28	64.16
2000	A	65.57	66.24
2000	M	69.43	68.52
2000	J	73.05	71.28
2000	J	76.49	72.13
2000	A	79.44	74.04
2000	S	82.72	77.55
2000	O	86.22	80.75
2000	N	88.78	87.17
2000	D	90.75	90.79
2001	J	92.64	91.83
2001	F	94.35	
2001	M	95.87	
2001	A	96.65	
2001	M	97.54	
2001	J	98.76	
2001	J	100.00	
2001	A		
2001	S		

REMARK : COMMERACIAL OPERATION DATE

CTG 201 : October 2000

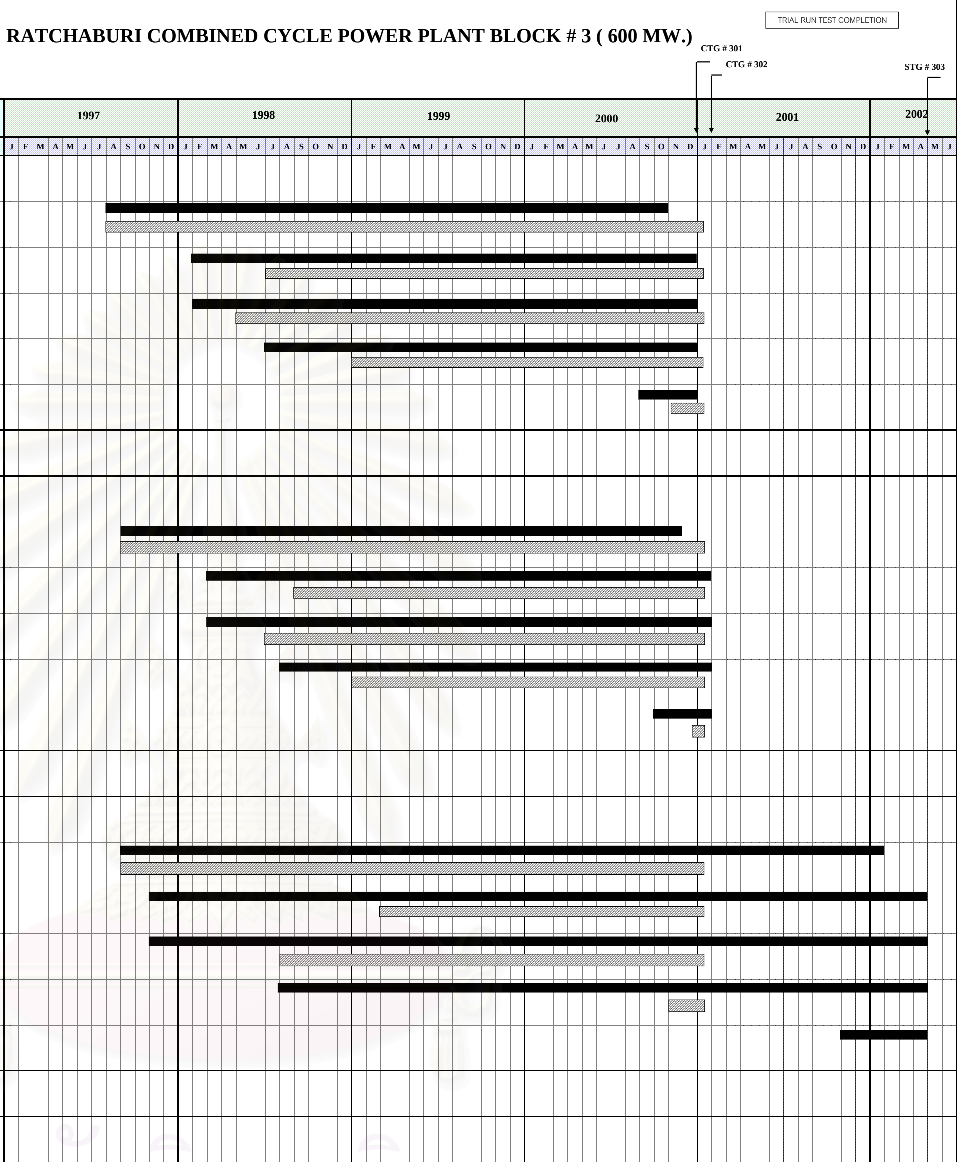
CTG 202 : November 2000

STG 203 : July 2001

Appendix A-3

PACKAGE II : RATCHABURI COMBINED CYCLE POWER PLANT BLOCK # 3 (600 MW.)

DESCRIPTION	% OF TOTAL PROJECT	% PROGRESS WORK UP TO Jan.15,2001 SCH.	ACTUAL	STATUS
1. CTG # 301				
- CIVIL WORK	5.00	100.00	99.90	-0.10
- MECHANICAL WORK	8.50	100.00	94.84	-5.16
- ELECTRICAL WORK	5.50	100.00	96.65	-3.35
- CONTROL & INSTRUMENT WORK	2.50	100.00	99.60	-0.40
- TEST & COMMISSIONING	1.50	100.00	17.00	-83.00
TOTAL OF CTG # 301	23.00	100.00	91.81	-8.19
2. CTG # 302				
- CIVIL WORK	5.00	100.00	99.85	-0.15
- MECHANICAL WORK	8.50	99.50	94.32	-5.18
- ELECTRICAL WORK	5.50	99.00	96.10	-2.90
- CONTROL & INSTRUMENT WORK	2.50	99.00	99.10	0.10
- TEST & COMMISSIONING	1.50	85.00	8.00	-77.00
TOTAL OF CTG # 302	23.00	98.50	90.84	-7.66
3.1 STG # 3	(54.00)			
- CIVIL WORK	14.00	89.00	94.50	5.50
- MECHANICAL WORK	17.80	65.00	44.61	-20.39
- ELECTRICAL WORK	11.20	57.00	53.96	-3.04
- CONTROL & INSTRUMENT WORK	7.50	46.50	5.00	-41.50
- TEST & COMMISSIONING	3.50	0.00	0.00	
TOTAL OF STG #3	54.00	62.79	51.09	-11.70
TOTAL OF BLOCK 3	100	79.56	69.60	-9.96



	Year	J	F	M	A	M	J	J	A	S	O	N	D
COMULATIVE TOTAL PROJECT WORK SCHEDULED	1997								0.20	0.78	1.26	2.03	2.80
	1998	3.62	4.86	6.32	7.64	9.01	10.43	11.94	13.44	14.98	16.54	18.08	19.63
	1999	21.35	23.02	24.68	26.36	28.04	29.73	31.54	33.49	35.49	37.61	39.63	41.61
	2000	43.71	45.85	47.86	50.16	53.29	57.61	61.94	66.27	69.84	72.88	75.90	78.67
	2001	80.45	81.53	82.74	84.02	85.57	87.36	89.14	90.86	92.57	94.10	95.45	96.23
	2002	96.83	97.54	98.76	100.00								
COMULATIVE TOTAL PROJECT WORK FINISHED	1997								0.16	0.50	1.00	1.20	1.59
	1998	2.28	2.40	2.59	3.66	4.35	4.92	8.82	10.38	11.26	13.06	15.21	17.74
	1999	21.17	22.67	26.17	27.33	28.93	31.30	34.22	36.07	37.82	39.52	42.56	43.02
	2000	43.55	44.96	45.92	46.82	50.29	53.22	55.20	59.64	61.79	63.26	66.51	68.44
	2001	69.60											

REMARK : COMMERACIAL OPERATION DATE

CTG 301 : December 2000

CTG 302 : January 2001

STG 303 : April 2002

APPENDIX B

SCOPE OF WORK

CONTROL INSTRUMENT PROJECT DEPARTMENT

Appendix B-1

Scope of Work

Control Instrument Division

No	Scope of Work		Responsibility			Supplier	Remarks
			MCI	ECI	INF		
1	**Gas Turbine A**						
	ML0411	Alignment checks	o	o		GE	
	ML0415	Control Devices Turbine	o	o		GE	
	ML0416	Lube Oil System	o	o		GE	
	ML0417	Cooling + Sealing Air System	o	o		GE	
	ML0418	Trip Oil System	o	o		GE	
	ML0419	Control Air System	o	o		GE	
	ML0420	Cooling Water System	o	o		GE	
	ML0421	Starting System	o	o		GE	
	ML0422	Gas Fuel System	o	o		GE	
	ML0424	Liquid Fuel System	o	o		GE	
	ML0425	Atomizing Air System	o	o		GE	
	ML0426	Fire Protection System	o	o		GE	
	ML0434	Hydraulic Supply System	o	o		GE	
	ML0436	Heat Ventilation System	o	o		GE	
	ML0440-1	Load Equipment	o	o		GE	
	ML0440-2	Seal Oil	o	o		GE	
	ML0440-3	H2 / CO2	o	o		GE	
	ML0440-4	Gen Core Monitor	o	o		GE	
	ML0440-5	Gen Winding Vib.	o	o		GE	
	ML0442	Turbine & Compressor Washing System	o	o		GE	
	ML0461	Water Wash Unit 1A & 1B	o	o		GE	
	ML0462	Water Injection System	o	o		GE	
	ML0469	Inlet Guide Vane System	o	o		GE	
	ML0471	Inlet + Exhaust System	o	o		GE	
	ML0474	Hazardous Gas Detection	o	o		GE	
	ML0477	Fuel Purge System	o	o		GE	
	ML0492	Performance Monitor	o	o		GE	
	ML0700	Combustor Installation	o	o		GE	
	MLA111	Generator Terminal Enclosure & NGR	o	o		GE	
	MLA124-1	Mark V		o		GE	
	MLA124-2	GCP				GE	
	MLA140	Start up/Excitation Transformer				GE	
	MLA153	BAC (Bus Accessory Compartment)				GE	
	MLA155	EX2000 (Static Voltage Regulator)				GE	
	MLA157	LCI (Load Commutated Inverter)				GE	
	WSC / SW1	Service Water System,Common & Block No.1	o		o	REOL	
	WWA / WW1	Chemical Waste Disposal, Block No. 1	o		o	REOL	
	WWA / WWC	Sewage System, Common(All Blocks)	o		o	REOL	
	WWC / OW	Oily Waste Disposal, Common(All Blocks)	o		o	REOL	
	WWC / OW1	Oily Waste Disposal, Common & Block No.1	o		o	REOL	
	Total gas turbine systems for each section		**34**	**30**	**5**		
2	**Gas Turbine B**						
	The scope of Gas Turbine B is similar to Gas Turbine A						
3	**Steam Turbine**						
	TGA / ST1	Steam Turbine Block No.1	o	o		GE	
	TGB / ST1	Steam Turbine Generator Block No.1	o	o		GE	
	TGB /BAC1	BAC				GE	
	TGB / GTE1	Generator Terminal Enclosure & NGR				GE	
	TGB / EX1	EX2000				GE	
	TGB / GCP1	GCP				GE	
	TGC / ST1	Steam Turbine Package Block No.1	o	o		GE	
	TGD / LO1	Steam Turbine Lube/Hydraulics, Block No.1	o	o		GE	
	TGD / LO4	Lube Oil Conditioning (Common)	o	o		GE	
	TGD / LO4A	Lube Oil Conditioning Block No.1	o	o		GE	
	TGE / ST1	ST.Gen. Cooling & Purge Block No.1	o	o		GE	
	TGF/ST1	Mark V	o	o		GE	
	TGG / ST1	Steam Turbine Hydrogen Seal Oil	o	o		GE	
	TGH/ST1	EHC	o	o		GE	
	SGA / BP1A	Bypass Damper HRSG 1A	o	o	o	REOL	
	SGA / BP1B	Bypass Damper HRSG 1B	o	o	o	REOL	

Appendix B-2

Scope of Work

Control Instrument Division

No	Scope of Work		Responsibility			Supplier	Remarks
			MCI	ECI	INF		
	CAA / SA1C	Service Air STG-1				REOL	
	CAB / IA1C	Instrument Air System STG-1	o	o	o	REOL	
	CAD / BD1C	IPB Duct Dry Air				REOL	
	CFPA / FP1C	Fire Prot.(CO2)Steam Turbine Block No. 1&2				REOL	
	COA / CC1	DCIS Combined Cycle Block No.1		o	o	REOL	
	ECB / CC1-1	Closed Cooling Water Block No.1	o	o	o	REOL	
	ECB / CC1	Closed Cooling Water Block No.1	o	o	o	REOL	
	EED / CATH 1/2/3	Cathodic Protection System Block No.1				REOL	
	EED / CATH 4	Cathodic Protection System Common Areas				REOL	
	FWA / BF1	Boiler Feedwater (Common) Block No.1	o	o	o	REOL	
	FWC / CD1-1	Condensate Block No.1(PMA flushing)	o	o	o	REOL	
	FWC / CD1	Condensate Block No.1	o	o	o	REOL	
	FWE / CF1	Chemical Feed (Common System)	o	o	o	REOL	
	FWF / CD1	Condensate Make Up System Block No.1	o	o	o	REOL	
	GTU / EE5A-3	416 V Switchgear Block No. 1 (SUS-31/41)				REOL	
	GTU / EE5A-4	416 V Switchgear Block No. 1 (SUS-32/42)				REOL	
	GTU / EE7A-4	416 V MCCs Block No. 1(311, 411, 314, 414)				REOL	
	GTU / EE7A-5	416 V MCCs Block No. 1(312, 313, 412, 413)				REOL	
	GTU / EE7A-6	416 V MCCs Block No. 1(321, 421)				REOL	
	GTU / ST1	ST Gen Transf 1 and ST Main Aux Transf 1				REOL	
	HRB / VA1	Vacuum System Block No.1	o	o	o	REOL	
	HRC / CT1	Cooling Tower Block No.1	o	o	o	REOL	
	HRC / CW1	Circulating Water System, Block No.1	o	o	o	REOL	
	HRE / CF1	Circulating Water Chemical Feed Block No.1	o	o	o	REOL	
	HRF / TC1	Condenser Tube Cleaning Block No.1	o	o	o	REOL	
	PMA / CC	Chemical Cleaning Block No.1	o	o	o	REOL	
	PMB / NS1	Shutdown Corrosion Protection GT Block No.1	o	o	o	REOL	
	PMB / NS1C	Shutdown Corrosion Protection Block No.1	o	o	o	REOL	
	SAC / SS1	Sampling and Analysis Block No.1	o	o	o	REOL	
	SCA / HV1	HVAC Turbine Building Block No.1				REOL	
	SCC / AC1	HVAC Control Building Block No.1&2				REOL	
	SGA / EG1A	Exhaust Gas HRSG 01A	o	o	o	REOL	
	SGA / EG1B	Exhaust Gas HRSG 01B	o	o	o	REOL	
	SGA / EM1	Emission Monitoring (Common) Block No.1	o	o	o	REOL	
	SGA / HP1A	High Pressure Steam HRSG 01A	o	o	o	REOL	
	SGA / HP1B	High Pressure Steam HRSG 01B	o	o	o	REOL	
	SGA / IP1A	IP/Reheat Steam HRSG 01A	o	o	o	REOL	
	SGA / IP1B	IP/Reheat Steam HRSG 01B	o	o	o	REOL	
	SGA / LP1A	Low Pressure Steam HRSG 01A	o	o	o	REOL	
	SGA / LP1B	Low Pressure Steam HRSG 01B	o	o	o	REOL	
	SGF / BD1A	Boiler Blowdown HRSG 01A	o	o	o	REOL	
	SGF / BD1B	Boiler Blowdown HRSG 01B	o	o	o	REOL	
	SGG / HP1	High Pressure Steam System Block No. 1	o	o	o	REOL	
	SGJ / IP1	Intermediate Pressure Steam Block No. 1	o	o	o	REOL	
	SGK / SB1	Steam Blowout Block No.1	o	o	o	REOL	
	SGL / LP1	Low Pressure Steam Block No.1	o	o	o	REOL	
	TEF / MD1	Miscellaneous Drains (Common) Block No.1	o	o	o	REOL	
	SGA / BP1A	Bypass Damper HRSG 1A	o	o	o	REOL	
	SGA / BP1B	Bypass Damper HRSG 1B	o	o	o	REOL	
	WWA / WWC	Sewage System, Common(All Blocks)	o	o	o	REOL	
Total steam turbine systems for each section			**48**	**49**	**39**		

APPENDIX C

JOB DESCRIPTION

CONTROL INSTRUMENT PROJECT DEPARTMENT

Job Description
Control Instrument Project Department

1. Calibrate & install instrument

The instrument calibration and installation shall follow completion of site preparation and precede the control cable laying. The instrument shall be calibrated and installed in accordance with the specifications in section 4.4.5, *Field-Mounted Instruments*.

- Flow: Process flows shall be measured by differential pressure instruments close-coupled across square edged, orifice plates mounted between orifice flanges.
- Level: Service conditions shall be used to determine the primary level sensing elements, i.e., differential type, displacer type, or ball float type. Connections for level shall be used flange rating in accordance with the piping specifications.
- Pressure: Direct-connected instruments shall have welded spiral bourdon, helix, diaphragm elements or bellows-type elements depending upon the service requirements. Pressure elements shall be capable of withstanding intermittent over-ranging to 1.3 times the maximum scale reading without shifting calibration more than 0.5% of the scale range. Pressure and sample connections on process lines and vessels shall be in accordance with the requirements of the piping specifications.
- Temperature: The primary elements for temperature service shall consist of thermocouples, or RTDs depending upon the service applications. Thermocouples shall generally be used. Where precise temperature measurement is required such as flow compensation, RTD shall be used. Thermocouples shall normally have stainless steel sheath. Thermometers shall be for separable socket type (well) installation. The well shall fit the stem to provide for maximum heat transfer rate. Bimetallic type thermometers shall not be furnished for use at temperatures below 0 C. Provision shall be made for external adjustment of thermometer pointer without removing it from the shaftt. Thermocouple calibrations shall conform to the ISA "Temperature Measurement Thermocouples," with cold junction reference at 0 C.
- Transmitter: All of the transmitters shall be SMART transmitters in line of the standard models specified, complete with SMART FAMILY interface unit. SMART FAMILY shall be ROSEMOUNT, FOXBORO or acceptable equal.

2. Adjust control valve

The control valve adjustment shall follow completion of site preparation and precede the control cable laying. The control valve shall be adjusted in accordance with the specifications in section 4.4.6, *Control Valve and MOVs*. Control valve end connections shall be flanged or welded for sizes 25 mm and larger and threaded for sizes 20 mm and smaller. All control valves with stainless steel bodies shall be flanged. Valves with carbon steel bodies can alternatively have welded connections. The rating and flange facing of carbon steel globe valves shall conform to the specification of the pipelines in which they are installed, except that the rating of flanged carbon steel valves 150 mm NPS and smaller shall not be less than ANSI class 300.

Valve size shall be based on pressure drop at process flow conditions which will be determined by the Contractor during the detailed design phase. All control valves shall be sized to operate from 10 to 90% opening for the given condition. Valves shall be at least three levels of removable trim and delivered with the median trim installed. Control valve body material shall be carbon steel and trim material shall be type 310 stainless steel unless fluid service conditions require other materials. Other alloys shall be used if required by corrosion or temperature conditions. Control valve body material shall be in accordance with the piping specifications. In cases where pressure drops are in excess of 6.9 bar or erosion is expected, hardened trim is to be used. Plain extension bonnets shall be used on services with temperatures of 0 C and below. Extension bonnets shall be used on high-temperature services when required.

3. Install control cabinet

The control cabinet installation shall follow completion of control room and service air, and precede the control cable terminating. The control cabinets shall be installed in accordance with the specifications in section 4.3.8, *Boxes and Cabinets*. The control cabinets shall be rigidly mounted. Mounting on concrete shall be by concrete anchors. Mounting on steel shall be by drilled and taped screw holes, or by special support channels weld to the steel or by both. The control cabinets shall be leveled and fastened to the mounting surface with not less than 6 mm air space.

4. Inspect panel & enclosure installation

The panel & enclosure installation shall follow completion of site preparation and precede the control cable laying. The panel & enclosure installation shall be inspected in accordance with the specifications in section 4.3.8, *Boxes and Cabinets*. The panel and enclosure shall be rigidly mounted. Mounting on concrete shall be by concrete anchors. Mounting on steel shall be by drilled and taped screw holes, or by special support channels weld to the steel or by both. The panel and enclosure shall be leveled and fastened to the mounting surface with not less than 6 mm air space.

5. Install stainless tube

The stainless tube installation shall follow completion of site preparation and precede the instrument in service. The stainless tube shall be installed in accordance with the specifications in section 1.4.2, *Mechanical Design Criteria*.

- Instrument impluse line pressure connections to process piping root valves for all pressure indicators, pressure switches, pressure transmitters, etc. shall be 25 mm (1") socket weld for all piping design pressures and temperaturees except for station air which is 20 mm (3/4")
- Temperature connections to process piping temperature indicators, temperature controllers, temperature switches, temperature detectors and temperature testwells shall be as follows.

a) HP, IP and RH steam	40 mm (1-1/2") Weld-in geometry
b) LP steam	32 mm (1-1/4") Socket Weld
c) Boiler feedwater	32 mm (1-1/4") Socket Weld

- Temperature connections to air and flue gas duct draft/pressure measurement transmitters, temperature switches, thermocouple and temperature testwells shall be as follows.

a) Duct temperature	25 m (1") NPT
b) Duct draft/pressure	25 m (1") NPT

- Temperature connections to all other systems shall be 20 mm (3/4") NPT.
- Flow transmitter process connections and piping through the root valves shall be 25 mm (1") for all piping except orifice flanges where 15 mm (1/2") piping and valves shall be used.
- Level switch connections and piping through root valves shall be 25 mm (1").
- Level controllers and level transmitters of the displacement type shall have connections and piping through root valves of 50 mm (2").
- Level controllers and level transmitters of the differential pressure type shall have connections and piping through root valves of 25 mm (1").
- Instrument water and condensate pipe columns at tanks and pressure vessels shall be 65 mm (2-1/2") minimum.

6. Install cable tray & conduit

The cable tray and conduit installation shall follow completion of site preparation and precede the control cable laying. The cable tray and conduit shall be furnished and installed in accordance with the specifications in section 4.3.6, *Conduit Design*. The conduit shall include all fitting, supports, all flexible conduit and materials required for a complete system.

- Field routed conduit shall not interfere with the future installation or maintenance of any dimensioned equipment, building steel, cable tray, HVAC duct, prerouted piping, etc.
- All conduit shall be installed the tee condulet fitting with a drain before the conduit enters the boxes or equipment. The drain shall be installed in the lowest tee outlet.
- Metal conduit shall be joined by threaded conduit coupling with the conduit ends butted. The use of running threads will not be permitted.
- The plane of all conduit ends shall be square with the centerline. The end of all conduits shall be reamed to remove all rough edges and burrs.

- Conduit shall be securely fastened to all boxes and cabinets by locknuts both inside and outside.
- Liquidtight flexible conduit inserts shall be installed in all conduit runs, which are supported by both building steel and by structure subject to vibration or thermal expansion. They shall not be longer than 750 mm.
- Each conduit shall be supported within 300 mm of junction boxes and fitting. Support spacing along conduit runs shall be as follows.

Conduit Size	Max. Distance Between Supports
13 mm - 32 mm	1.5 meters
38 mm - larger	3 meters

- Conduit clamps shall be bolted to building steel using drilled and tapped screw holes. Support channels for three or more conduit shall be welded to building steel or bolted using drilled and tapped screw holes.

7. Inspect control cable laying

The control cable laying shall follow completion of tray and conduit installation and precede the control cable termination. The control cable laying shall be inspected in accordance with the specifications in section 4.3.11, *Cable and Conductors*.

Insulated cable, conductors, and conductor accessories shall be furnished in quantities sufficient for a complete installation. Cable reels shall be transported, stored and handled in a manner which will prevent physical damage to the cable. Cable reels shall be stored on a hard surface or timber to prevent contact between cable insulation and earth due to sinking of the reel. Impact damage between reels shall be prevented by aligning reels flange to flange or by using guards across flanges. During storage, the ends of all cable rated 3.3 kV and above shall be protected with end caps.

8. Terminate control cable

The control cable termination shall follow completion of control cable laying and precede the instrument loop test. The control cable shall be terminated in accordance with the specifications in section 4.3.11, *Cable and Conductors*.

- Terminating a conductor shall include installing cable termination kits for shielded cable, attaching the conductor at its designated location, and insulating the entire connection where specified or required by the application.
- All conductors shall be multi-stranded of at least seven strands with a minimum conductor cross-sectional area of 1.5 mmฒ.
- Wiring insulation for connections to earth shall be colored green or green/yellow.
- Both ends of all wires shall be fitted with bootlace ferrules and cable markers fitted of the Grafoplast or an approved equivalent.
- All 400/230 V ac wiring shall be in black insulating plastic sleeving segregated from all other wiring.

9. Test instrument loop

The instrument loop testing shall follow completion of control cable termination and precede the control function test. The instrument loop shall be tested in accordance with the specifications in section 6.1.6, *Calibration, Test and Preoperation Checkout*.

The Contractor's instrument test engineer shall calibrate onsite and functionally loop check all instrumentation and instrument loops. This shall include Combustion Turbine systems, HRSG systems, Steam Turbine Generator systems, Circulating Water system, and balance of plant systems including skid-mounted factory tested systems.

10. Test control function

The control function testing shall follow completion of instrument loop testing and precede the commissioning test. The control function shall be tested in accordance with the specifications in section 6.1.6, *Calibration, Test and Preoperation Checkout*.

Appendix C

The Contractor shall test and fine tune all analog and digital control loops and systems as systems. Calibration and loop test data shall be recorded on instrument device calibration sheets and instrument loop calibration data sheets. The Contractor shall provide the calibration set points and issue revised set points to meet field conditions. Errors found during or after system startup shall be corrected by the Contractor prior to performance testing.

Instruments shall be calibrated and re-calibrated as required to ensure all instruments and control loops are functioning as designed at the time of plant turnover to EGAT. All test instruments used for calibration shall be certified by the National Bureau of Standards or equal within 3 months prior to their use.

11. Test & Commissioning

The test and commissioning shall follow completion of control function testing and precede the commercial date. The commissioning shall be tested in accordance with the specifications in section 6.2.2, *Acceptance Tests and Guarantee*.

- Combustion Turbine Generator

  The Contractor shall, at his expense, make unit repairs and modifications as necessary to bring each item listed in title combustion turbine performance test into compliance with the proposal guarantees except the net heat rate and output capacity (capability). In case the net output and net heat rate at continuous (base) rating do not meet the guaranteed values, the Contractor shall be penalized according to condition specified in Section *PENALTIES FOR FAILURE TO MEET PERFORMANCE GUARANTEES* of the General Condition and the Contractor shall not be allowed to make any modification to correct the output and heat rate. Subsequent to those modifications, the performance tests shall be repeated at the Contractor's expense, where expenses shall include all charges incurred during retesting except EGAT-furnished energy and fuel and EGAT's normal operating personnel.

  Combustion turbine generator alterations and modifications shall be completed in a manner that is convenient to EGAT. The procedure and schedule for alterations and modifications shall be subject to review and approval by EGAT/Engineer, and such corrective measures shall be completed within 90 days following the initial performance test.

  The Contractor shall have the right to review EGAT's test data, test calculations, test corrections and test results.

- Combine Cycle

  Acceptance tests will be performed which shall be binding on the parties to this Contract to determine compliance with guarantees. The contractor shall, at his expenses make unit repairs and modifications as necessary to bring each item into compliance with the performance guarantees except the net heat rate and output capacity (capability) of the Combustion Turbine. Should the equipment fail to meet the guarantees, modifications shall be made under the procedure given in the *GENERAL CONDITIONS Article GC. 26, entitled WARRANTY and GC.47 entitled PENALTIES FOR FAILURE TO MEET PERFORMANCE GUARANTEES*. Subsequent to the acceptance test, an operational Demonstration test as described in 6.2.3 shall be performed as part of the combined cycle block demonstration test. All equipment must operate successfully, to the satisfaction of EGAT, during the period to fulfill this portion of the guarantees.

  Acceptance tests shall be conducted within 90 days after initial operation and will be a condition precedent to final payment. If acceptance testing has not been performed within the specified time period, EGAT will release the retention if all other conditions specified in the *GENERAL CONDITIONS* article entitled Final Payment have been met by the Contractor. Failure by EGAT to conduct the acceptance tests within the specified time period shall not release the Contractor from the requirements of this article for compliance with the guarantees, testing, retesting, and corrective action.

The tests will be conducted at approximately the design conditions specified herein. Proper corrections will be made in the calculation of results to account for variations from the specified design conditions.

Sufficient test connections shall be recommended by the Contractor for the acceptance tests outlined. If the performance tests indicate that a piece of equipment fails to comply with the performance guarantee, the Contractor shall modify the equipment or recommend modification to be performed by EGAT, as required to obtain the guaranteed performance. All costs incurred by these modifications shall be the responsibility of the Contractor.

APPENDIX D

JOB SPECIFICATION

CONTROL INSTRUMENT PROJECT DEPARTMENT

Job Specification
Control Instrument Project Department

1. Calibrate & install instrument

- Engineer or Technician
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence

2. Adjust control valve

- Engineer or Technician
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence
- Ability to coordinate with others

3. Install control cabinet

- Technician or equivalent experience
- More than 1 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence

4. Inspect panel & enclosure installation

- Technician or equivalent experience
- More than 1 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence
- Ability to coordinate with others
- Ability to inspect each completion of contractor

5. Install stainless tube

- Technician or equivalent experience
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence
- Ability to coordinate with others

6. Install cable tray & conduit

- Technician or equivalent experience
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence
- Ability to coordinate with others

Appendix D

7. Inspect control cable laying

- Technician or equivalent experience
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to write reports and correspondence
- Ability to coordinate with others
- Ability to inspect each completion of contractor

8. Terminate control cable

- Engineer or Technician or equivalent experience
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to use relevant tools
- Ability to write reports and correspondence
- Ability to coordinate with others
- Ability to solve problem

9. Test instrument loop

- Engineer or Technician or equivalent experience
- More than 2 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret procedure manuals and drawing
- Ability to use relevant tools and electrical measurement
- Ability to write reports and correspondence
- Ability to coordinate with others
- Ability to analyze and solve problem

10. Test control function

- Engineer or Technician or equivalent experience
- More than 3 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret control process, procedure manuals and drawing
- Ability to use relevant tools and electrical measurement
- Ability to write reports and correspondence
- Ability to coordinate with others
- Ability to analyze and solve problem

11. Test & Commissioning

- Engineer or Technician
- More than 3 year experiences
- Ability to perform each essential duty satisfactory
- Ability to read and interpret control process, procedure manuals and drawing
- Ability to use relevant tools and electrical measurement
- Ability to write reports and correspondence
- Ability to coordinate with others
- Ability to analyze and solve problem

Appendix D

APPENDIX E

PROJECT SCHEDULE

CONTROL INSTRUMENT PROJECT DEPARTMENT

Control Instrumrnt Project Department

Fiscal Year 2000

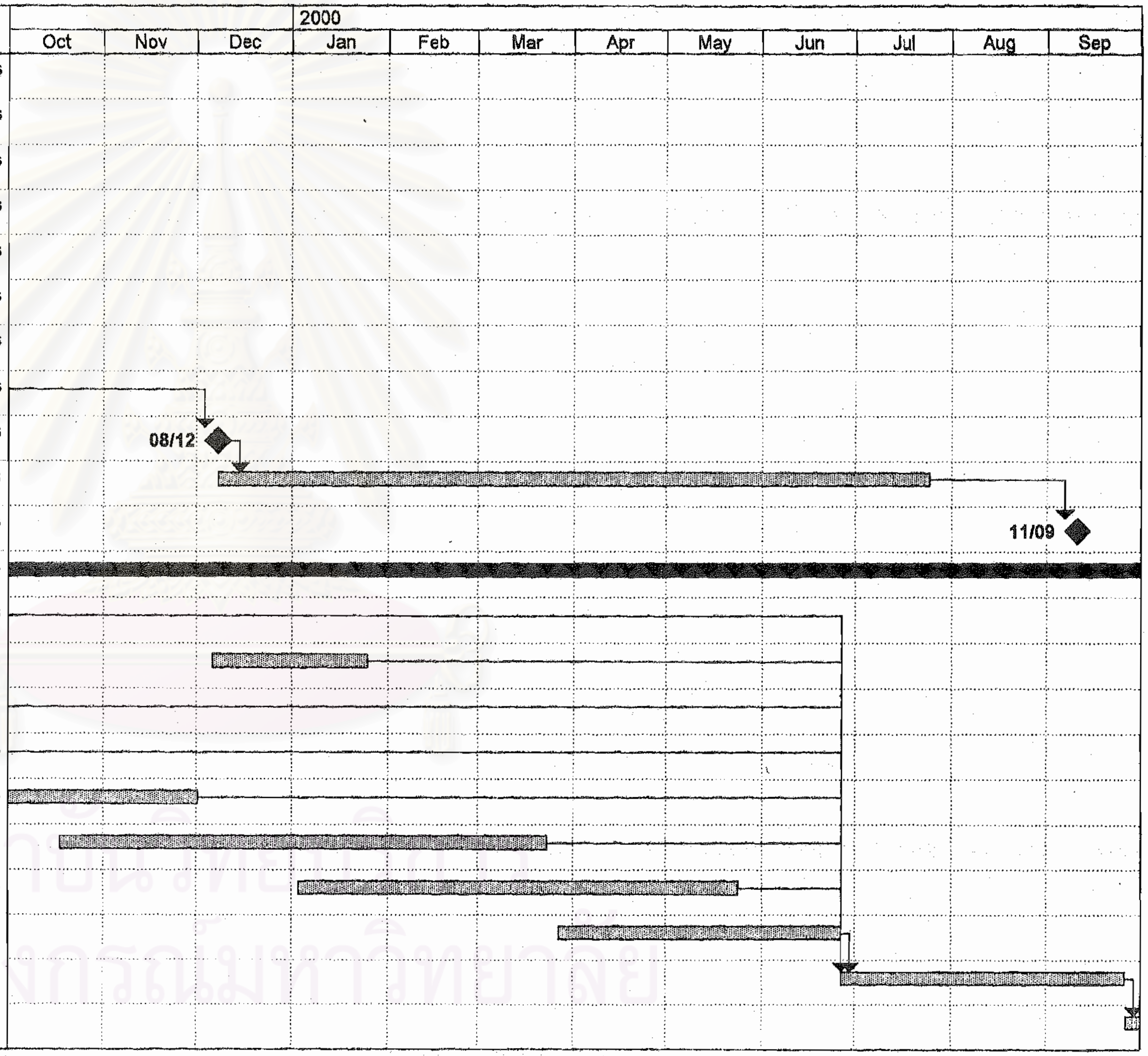
ID	Task Name	Duration
1	**Administration**	**1734.43 days**
2	C&I Division	2082 days
3	MCI Section	1734.43 days
4	ECI Section	1734.43 days
5	INF Section	1734.43 days
6	**CTG 101**	**764.57 days**
7	101 Calibrate & install instrument	30 days
8	101 Adjust control valve	30 days
9	101 Install control cabinet	5 days
10	101 Inspect panel & enclosure intallation	100 days
11	101 Install stainless tube	120 days
12	101 Install tray & conduit	120 days
13	101 Inspect cable laying	120 days
14	101 Terminate cable	60 days
15	101 Test instrument loop	60 days
16	101 Test control function	90 days
17	101 Initial Synchronization	0 days
18	101 Test & Commissioning	200 days
19	101 Commercial Operation	0 days
20	**CTG 102**	**661.71 days**
21	102 Calibrate & install instrument	30 days
22	102 Adjust control valve	30 days

Appendix E-1

Control Instrumrnt Project Department

Fiscal Year 2000

ID	Task Name	Duration
23	102 Install control cabinet	5 days
24	102 Inspect panel & enclosure intallation	100 days
25	102 Install stainless tube	120 days
26	102 Install tray & conduit	120 days
27	102 Inspect cable laying	120 days
28	102 Terminate cable	60 days
29	102 Test instrument loop	60 days
30	102 Test control function	90 days
31	102 Initial Synchronization	0 days
32	102 Test & Commissioning	200 days
33	102 Commercial Operation	0 days
34	**STG 103**	**744.68 days**
35	103 Calibrate & install instrument	45 days
36	103 Adjust control valve	45 days
37	103 Install control cabinet	10 days
38	103 Inspect panel & enclosure intallation	110 days
39	103 Install stainless tube	140 days
40	103 Install tray & conduit	140 days
41	103 Inspect cable laying	140 days
42	103 Terminate cable	90 days
43	103 Test instrument loop	90 days
44	103 Test control function	100 days

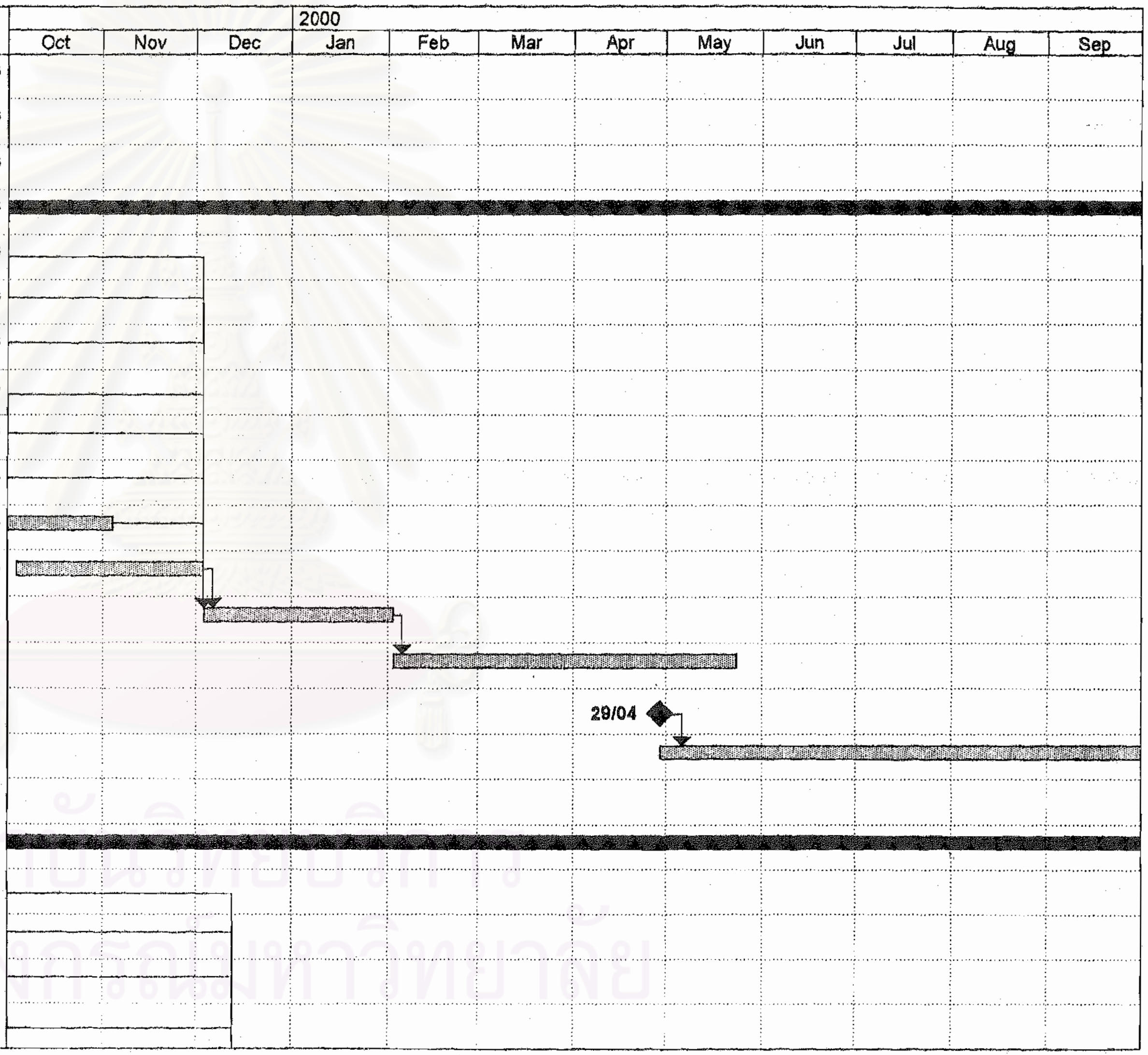


Appendix E-2

Control Instrumrnt Project Department

Fiscal Year 2000

ID	Task Name	Duration
45	103 Initial Synchronization	0 days
46	103 Test & Commissioning	240 days
47	103 Commercial Operation	0 days
48	**CTG 201**	**698.29 days**
49	201 Calibrate & install instrument	30 days
50	201 Adjust control valve	30 days
51	201 Install control cabinet	5 days
52	201 Inspect panel & enclosure intallation	100 days
53	201 Install stainless tube	120 days
54	201 Install tray & conduit	120 days
55	201 Inspect cable laying	120 days
56	201 Terminate cable	60 days
57	201 Test instrument loop	60 days
58	201 Test control function	90 days
59	201 Initial Synchronization	0 days
60	201 Test & Commissioning	200 days
61	201 Commercial Operation	0 days
62	**CTG 202**	**734.86 days**
63	202 Calibrate & install instrument	30 days
64	202 Adjust control valve	30 days
65	202 Install control cabinet	5 days
66	202 Inspect panel & enclosure intallation	100 days

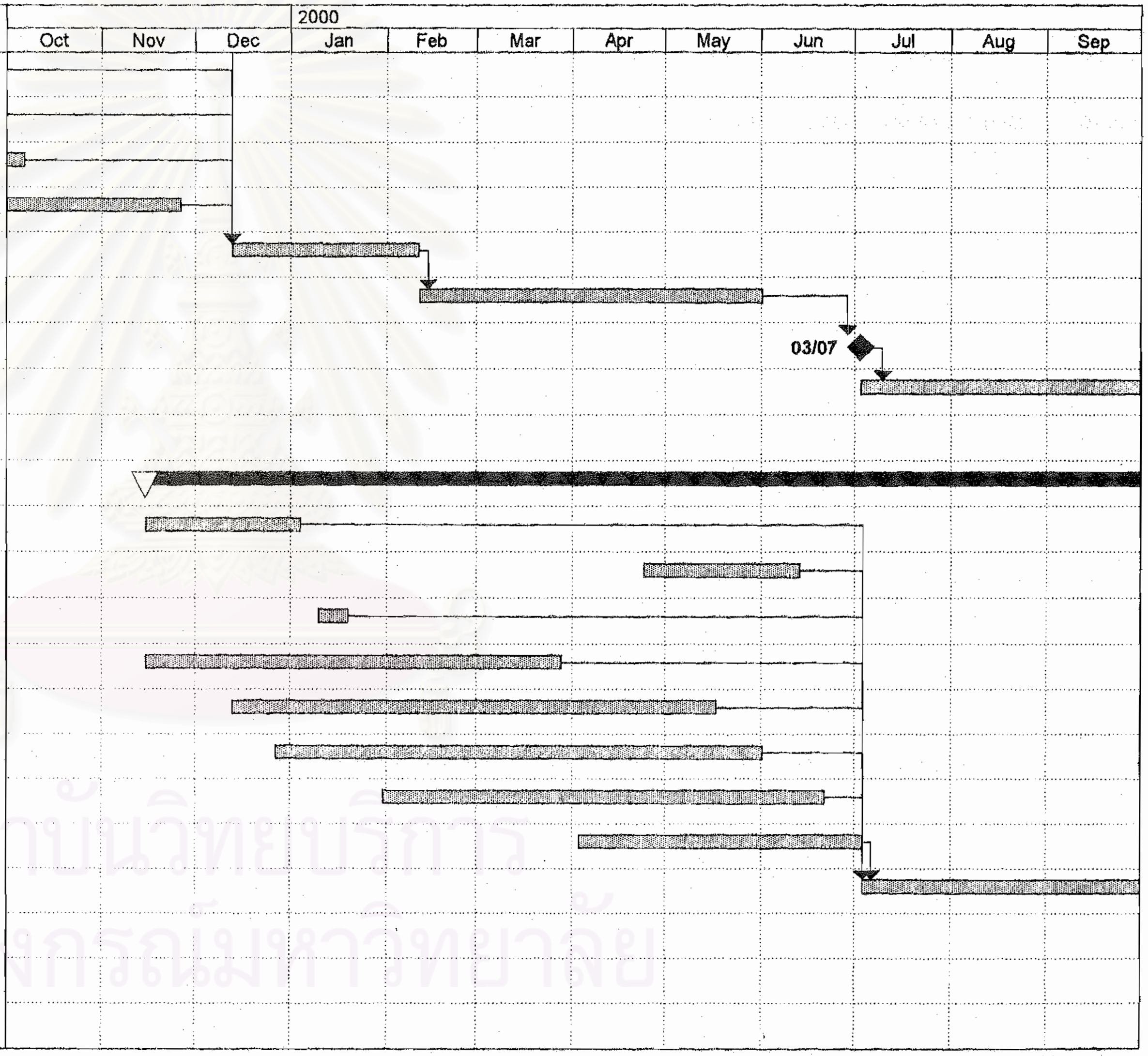


Appendix E-3

Control Instrumrnt Project Department

Fiscal Year 2000

ID	Task Name	Duration
67	202 Install stainless tube	120 days
68	202 Install tray & conduit	120 days
69	202 Inspect cable laying	120 days
70	202 Terminate cable	60 days
71	202 Test instrument loop	60 days
72	202 Test control function	90 days
73	202 Initial Synchronization	0 days
74	202 Test & Commissioning	200 days
75	202 Commercial Operation	0 days
76	**STG 203**	**748.43 days**
77	203 Calibrate & install instrument	45 days
78	203 Adjust control valve	45 days
79	203 Install control cabinet	10 days
80	203 Inspect panel & enclosure intallation	110 days
81	203 Install stainless tube	140 days
82	203 Install tray & conduit	140 days
83	203 Inspect cable laying	140 days
84	203 Terminate cable	90 days
85	203 Test instrument loop	90 days
86	203 Test control function	100 days
87	203 Initial Synchronization	0 days
88	203 Test & Commissioning	240 days

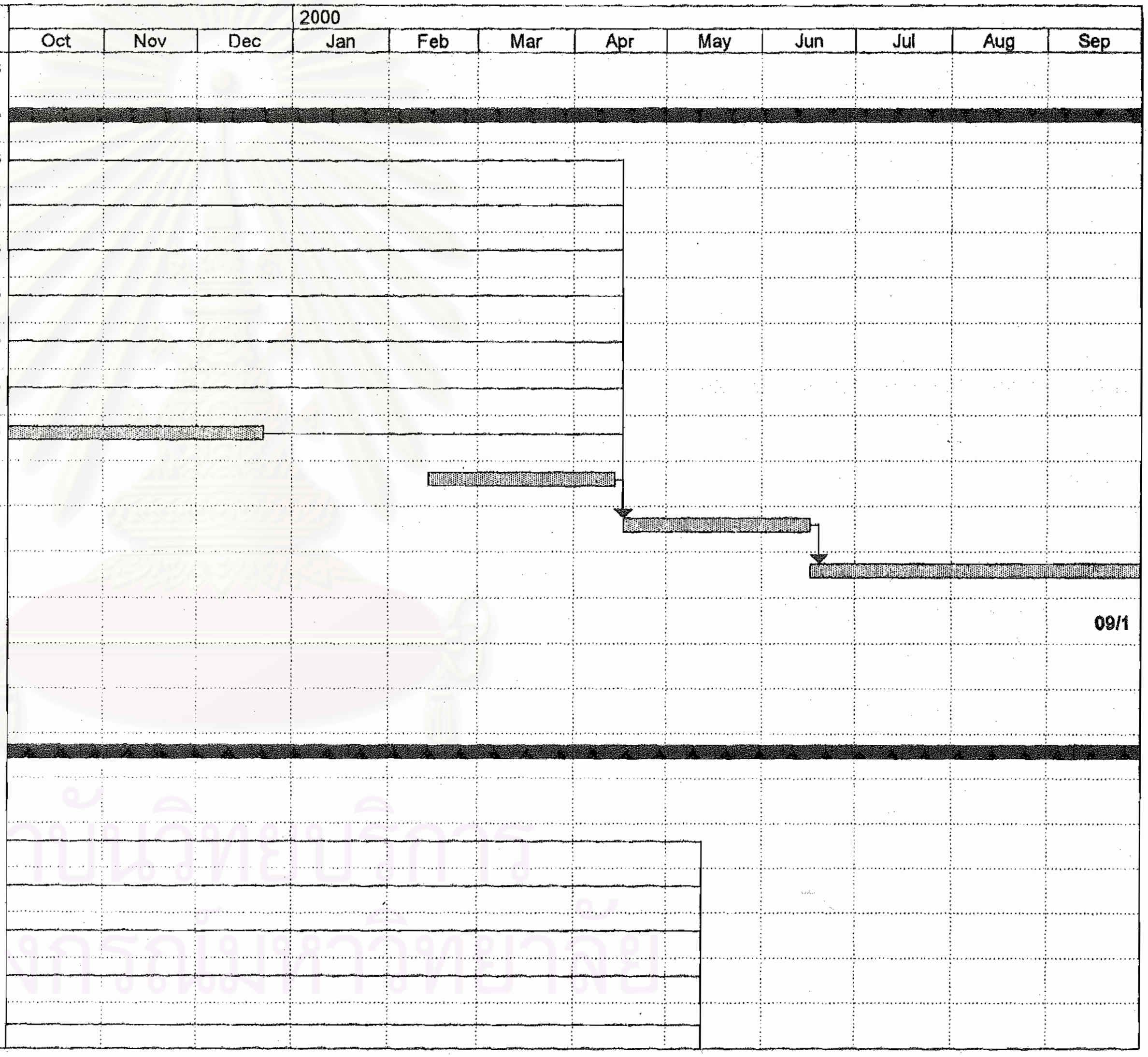


Appendix E-4

Control Instrumrnt Project Department

Fiscal Year 2000

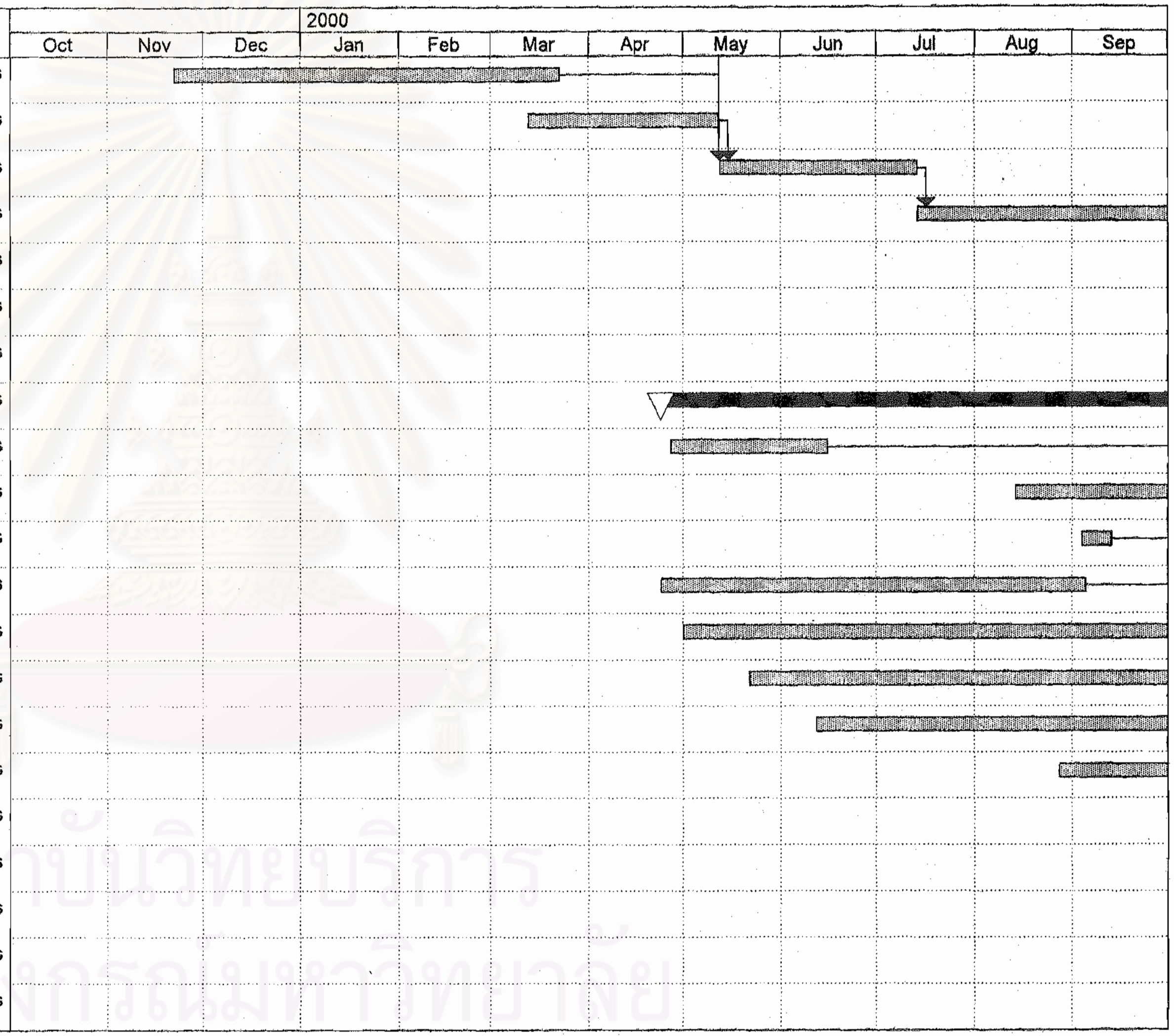
ID	Task Name	Duration
89	203 Commercial Operation	0 days
90	**CTG 301**	**828.43 days**
91	301 Calibrate & install instrument	30 days
92	301 Adjust control valve	30 days
93	301 Install control cabinet	5 days
94	301 Inspect panel & enclosure intallation	100 days
95	301 Install stainless tube	120 days
96	301 Install tray & conduit	120 days
97	301 Inspect cable laying	120 days
98	301 Terminate cable	60 days
99	301 Test instrument loop	60 days
100	301 Test control function	90 days
101	301 Initial Synchronization	0 days
102	301 Test & Commissioning	200 days
103	301 Commercial Operation	0 days
104	**CTG 302**	**1171.29 days**
105	302 Calibrate & install instrument	30 days
106	302 Adjust control valve	30 days
107	302 Install control cabinet	5 days
108	302 Inspect panel & enclosure intallation	100 days
109	302 Install stainless tube	120 days
110	302 Install tray & conduit	120 days



Control Instrumrnt Project Department

Fiscal Year 2000

ID	Task Name	Duration
111	302 Inspect cable laying	120 days
112	302 Terminate cable	60 days
113	302 Test instrument loop	61.14 days
114	302 Test control function	90 days
115	302 Initial Synchronization	0 days
116	302 Test & Commissioning	200 days
117	302 Commercial Operation	0 days
118	**STG 303**	**702.71 days**
119	303 Calibrate & install instrument	45 days
120	303 Adjust control valve	45 days
121	303 Install control cabinet	10 days
122	303 Inspect panel & enclosure intallation	110 days
123	303 Install stainless tube	140 days
124	303 Install tray & conduit	140 days
125	303 Inspect cable laying	140 days
126	303 Terminate cable	90 days
127	303 Test instrument loop	90.14 days
128	303 Test control function	100 days
129	303 Initial Synchronization	0 days
130	303 Test & Commissioning	240 days
131	303 Commercial Operation	0 days



BIOGRAPHY

Chatchai Mawong was born on June 8, 1969 in Chiangmai, Thailand. He graduated from Chiangmai University with a Bachelor degree in Electrical Engineering since 1991. Then, he studied for Master of Engineering in Engineering Management and Master of Science in Engineering Business Management at The Regional Centre for Manufacturing Systems Engineering, Chulalongkorn University in 1998.

He has been working at Control Instrument Project Department of Electricity Generating Authority of Thailand (EGAT) since 1991. Today, he is a senior engineer position.