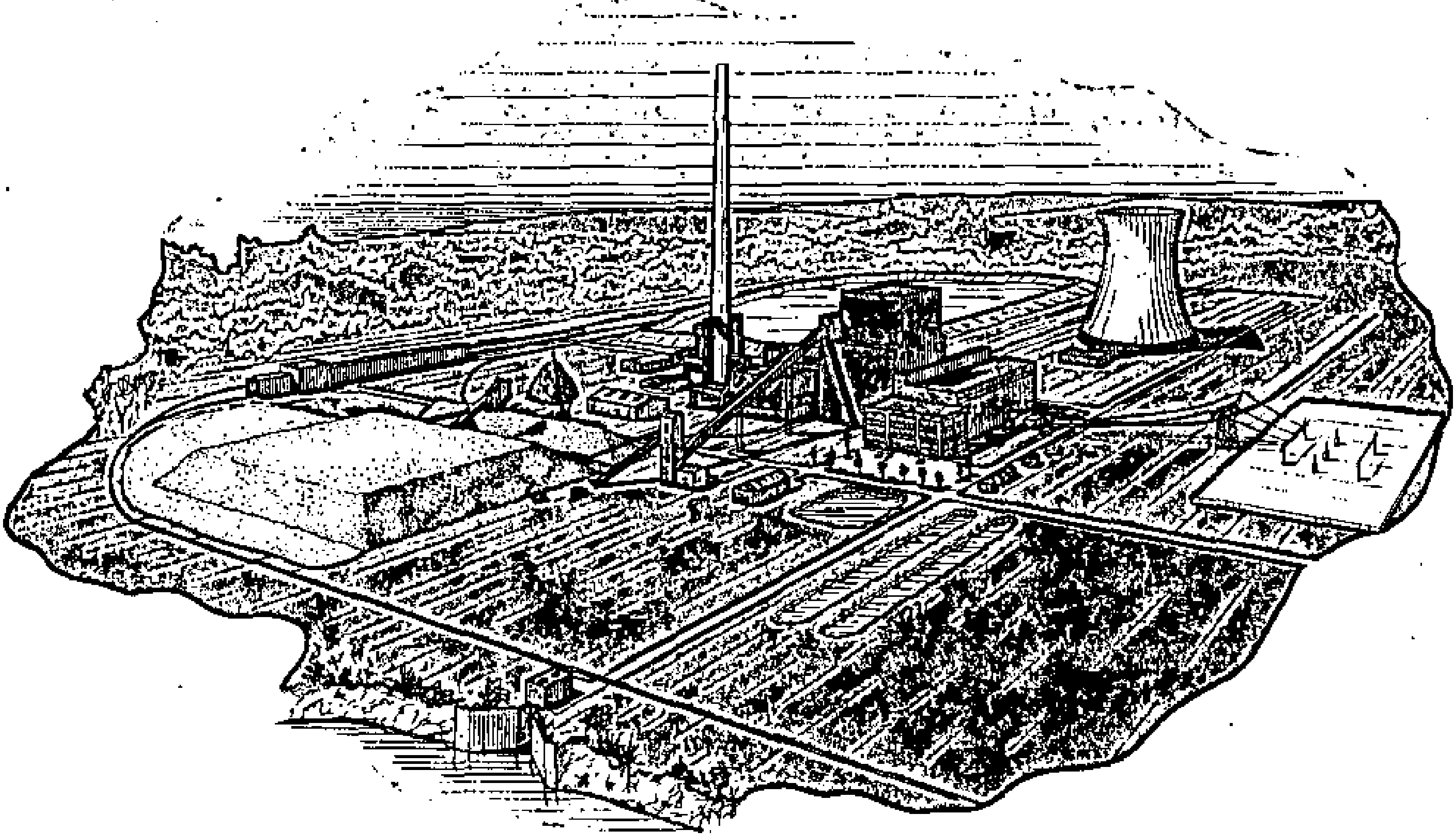
MANAGING INDUSTRIAL PROJECTS
A Performance Oriented Approach

AGENDA

Thursday, October 23, 1980

Day One

Time	Topic Description	Instructor
8:30- 8:45AM	Introductory Remarks	Smith
8:45-10:15	Overview & Case Problem #1	Smith
10:15-10:30	Break	
10:30-12:00PM	Work Definition & Case Problem #2	Gilbreath
12:00- 1:30	Luncheon	
1:30- 3:00	Risk Analysis and Selective Control & Case Problem #3	Smith
3:00- 3:15	Break	
3:15- 5:30	Responsibility Assignment and Control Account Establishment & Case Problem #4	Osborn
5:30- 7:00	Informal Reception	



HUMPHREYS & ASSOCIATES

ARTHUR ANDERSEN & CO.

MANAGING INDUSTRIAL PROJECTS
A Performance Oriented Approach

AGENDA

Friday, October 24, 1980

Day Two

Time	Topic Description	Instructor
8:30- 9:15AM	Contract Administration	Gilbreath
9:15-10:15	Estimating, Scheduling and Performance Budgeting	Osborn
10:15-10:30	Break	
10:30-11:00	Estimating, Scheduling and Performance Budgeting	Osborn
11:00-12:00PM	Measuring Accomplishment & Case Problems #5 & #6	Gilbreath
12:00- 1:30	Luncheon	
1:30- 2:15	Accumulating Actual Data	Smith
2:15- 3:15	Comparing Planned and Actual Performance & Case Problem #7	Osborn
3:15- 3:30	Break	
3:30- 5:00	Comparing Planned and Actual Performance & Case Problem #8	Osborn
5:30- 7:00	Informal Reception	

MANAGING INDUSTRIAL PROJECTS
A Performance Oriented Approach

AGENDA

Saturday, October 25, 1980

Day Three

Time	Topic	Description	Instructor
8:30-10:00AM		Reporting and Analysis & Case Problem #9	Osborn
10:00-10:15		Break	
10:15-11:15		Reporting and Analysis & Case Problem #10	Osborn
11:15-12:15PM		Change Control	Gilbreath
12:15- 1:15		Luncheon	
1:15- 2:00		Implementation	Smith
2:00- 2:45		Automation Considerations	Smith
2:45- 3:00		Summary	Smith

OVERVIEW

ulp
UTILITY
LIGHT &
POWER
CO.

September 28, 1981

To: President
Vice President, Finance
Vice President, Power Generation
Vice President, Operations

Gentlemen:

Enclosed for your information is a copy of ULPCo.'s Pioneer Unit I progress report for the month ending July 31, 1981.

Sincerely,

D. A. Wilson
Pioneer I Project Manager

DAW:bcr

Enclosures

September 28, 1981

(1)

To: President
Vice President, Finance
Vice President, Power Generation
Vice President, Operations

Gentlemen:

Enclosed for your information is a copy of ULPCo.'s Pioneer Unit I progress report for the month ending July 31, 1981.

Sincerely,

D. A. Wilson /bcr

D. A. Wilson
Pioneer I Project Manager

DAW:bcr

Enclosures

I. SUMMARY OF PROJECT STATUS

In general, construction progress on Pioneer I was satisfactory with the project now approximately 34.7% complete. However, critical path items have continued to fall behind schedule due to difficulty in receiving vendor prints on critical equipment and congested placements for reinforcing bars and structural steel on major buildings. The recovery schedule following the carpenters strike in May is being implemented and with manpower levels improving, at least a partial recovery of schedule slippage can be expected by the end of the year. Detailed status of construction is shown on Figure 1 (attached).

(2)

The proposed ownership reallocations have been proceeding very slowly and may result in a revision to the completion date. The biggest hurdle has been the reluctance of the state PUC to grant approval. These hearings have dragged out for over a year and, unfortunately show no indication of a faster conclusion.

(3) Dewatering activities have slowed the installation of circulating water pipe to a point where this work is virtually stopped. A lack of chemical additives for the disposal water has forced a cessation of the wellpoint process and flooded open pipetrenches.

(4) In order to expedite production of "issued for construction" drawings by the project engineering consultant, WAYLO associates, authority has been granted for WAYLO to increase the level of temporary designers and drafters to 85.

The Pioneer Trails nature park has been a very busy attraction this summer. Over 200 visitors frequented the temporary information center, bringing the total to date to over 4,000. Several civic and educational groups have indicated a desire to sponsor group tours of the proposed wildlife preserve north of the plant site.

Soil testing for the ash disposal area is proceeding according to schedule. Preliminary results show the possibility of a clay liner to prevent seepage from both ponds.

II. LICENSING

Hearings are proceeding with the DNR regarding the impact of the railroad spur (corridor C) on the proposal Pioneer Trails Wildlife Preserve. Railine Consultants, Inc. have been retained to develop conceptual plans for proceeding with alternate access routes from the North-South line.

Preliminary findings from both the DNR and the Corps of Engineers are imminent concerning our applications for waivers for the make-up water intake pumping station.

III. ENGINEERING-DESIGN

5 Approximately 71.2% of the basic engineering design is completed, 82% of equipment is on order and contracts have been let for 93% of the construction work, the latter based upon dollar value.

Specific, detailed engineering progress is given below:

6

	Total Number	Completed
Equipment Specifications	306	272
System Descriptions	74	65
WAYLO Drawings	3,986	2,771
Procurements	217	178

There were no significant changes in the required quantities of material during this month.

7 A total of 92 unresolved Design Change Notices (DCN's) are pending.

8 Our field non-nuclear quality assurance program continued to be effective in its inspection and reporting efforts. Significant nonconformance reports issued during July involved: undetermined quantity of honeycomb cavities in the turbine pedestal, storage security, document control and weld inspection. These have been investigated and corrective action is being planned.

IV. CONSTRUCTION

Construction difficulties continue for items on the critical path, and during July three-and-one-half weeks of added slippage in schedule occurred. Difficulties are primarily in circulating water piping, condenser erection, control room, cooling tower vendor selection, rebar fabrication and placement and miscellaneous steel installation.

Structural steel erection for the turbine building has slowed due to modifications required in detailing of vendor shop drawings. Efforts are underway to resolve these delays; however, the complexity of the needed design and general congestion of the work areas is making a solution very difficult. This is a critical problem as we have scheduled the turbine building to be enclosed before arrival of winter to permit installation of turbine-generator equipment.

9 The recovery from the carpenters' strike in May was slower than expected and shortages of carpenters and pipefitters hindered the buildup in manpower. Although a shortage of pipefitters now exists, the rest of the manpower problems have been resolved and only startup work on some building piping is now being affected.

Some of the construction highlights during July included the delivery of the turbine generators, completion of the chimney foundation, and expansion of the construction parking area.

The summary below shows the status of major buildings:

(10)

Item	Current Status	Change Since Last Report
Control Room	17 weeks behind	lost three weeks
*Turbine Bldg.	36 weeks behind	lost eight weeks
Boiler House	20 weeks behind	lost two weeks
*Cooling Tower	28 weeks behind	lost four weeks
Crusher House	3 weeks behind	gained one-half week
Precipitator	19 weeks behind	lost two weeks

*(Critical Path Items)

(11)

A summary of the total construction work completed as of July 31, 1981 follows:

Direct Manhours Estimated	Direct Manhours Earned	Percent Complete	Change Since Last Report
7,195,506	1,417,703	19.7	+ 4.02%

Note: Under the manhour productivity evaluation plan instituted at the site, the percentage complete of each task is based on physical evaluation of progress. These figures are based upon the January 1981 construction estimate, but have been adjusted to exclude all indirect craft manhours.

(12)

Peak Force During this Period (July 18, 1981)

	Day	Night	Total
WAYLO	190	6	196
Contractors	1,050	875	1,925

(13)

Construction Equipment Commitments

Type	Committed	On Hand
Construction Cranes	16	15
Earth Moving Equipment	24	20
Air Compressors	18	18
Concrete Trucks	11	11
Rented Cranes	4	3

(14) A summary of major construction packages and their status is listed below:

Package #1 (Excavation)

The excavation contractor is substantially complete. Work is continuing on the office building extension.

Package #2 (Site Services)

(15) Dewatering has been temporarily halted.

Package #5 (Structural Steel Vendor)

Shipments of structural steel are continuing.

Package #6 (Superstructure)

Work on the north and west walls of the turbine building continues. Began installation of boiler house stairs and grating. Miscellaneous steel in control room and flue gas ducts to elevation 48 feet is in progress.

Package #7 (Coal Handling)

Erection of conveyors is continuing. Receipt of crusher equipment continues. Work on primary crushers has begun. Redesign of bunkers continues.

Package #9 (Cooling Tower)

(16) First draft of procurement specification is in progress at WAYLO.

Package #10 (Electrical #1)

Subgrade grounding work continues. Construction parking lot extension lighting has begun.

Package #17 (Piping)

(17) Yard piping work has been stopped due to a shortage of pipefitters.

V. FINANCIAL

(18) The project is currently preparing a revised Cash Requirements Estimate. This estimate will not be available until the first quarter of next year at the earliest. Table 1 (attached) shows expected cash flow as determined from the 1976 estimate. Also attached as Table 2 is the Quarterly Cost Summary Report which details the estimate, expenditures and committments by FERC accounts.

Table #1

Pioneer Unit I

Estimated Construction Cash Requirements

Expended through July 31, 1981			(19) $290,000,000
Estimated			
1981	August	2,600,000	
	September	2,700,000	
	October	2,900,000	
	November	3,000,000	
	December	3,100,000	
1981 (total)			$ 14,300,000
1982			58,000,000
1983			56,700,000
Estimated Total			$419,000,000

(20) Note: Includes allowance for funds used during construction (AFUDC). UL&PCo. indirects are not included.

Tab #2

Pioneer Unit I

Quarterly Project Cost Summary

(21) (22) (23) (24) (25) (26)

Account	Plant Costs	Current Estimate	Expended in This Quarter	Total Expended Through 7/31/81	Total Committed and Expended Through 7/31/81
302	Franchise & License	1,500,000	----------	-----------	-----------
320	Land & Land Rights	1,000,000	----------	-----------	-----------
321	Structures & Improvements	64,200,000	2,000,000	42,000,000	66,700,000
322	Boiler Plant Equipment	40,200,000	2,400,000	28,000,000	44,200,000
323	Turbine-Generator Equipment	44,400,000	400,000	14,000,000	39,800,000
324	Accessory Electrical Equipment	15,400,000	200,000	10,000,000	17,000,000
325	Miscellaneous Power Plant Equipment	3,500,000	1,700,000	2,500,000	3,000,000
981	Engineering & Consultants	41,600,000	1,000,000	22,000,000	23,000,000
982	General & Administrative	4,500,000	150,000	1,900,000	3,700,000
983	Other Indirect Costs	12,000,000	250,000	6,700,000	8,900,000
984	Earnings & Expenses During Construction	4,300,000	----------	4,000,000	4,000,000
985	AFUDC	126,000,000	----------	39,000,000	106,000,000
991	Spare Parts	1,800,000	----------	-----------	-----------
992	Temporary Construction Facilities	4,900,000	300,000	5,600,000	5,600,000
993	Construction Tools & Equipment	6,200,000	200,000	1,900,000	4,700,000
995	Suspense	-----------	(400,000)	(2,100,000)	(2,100,000)
	Escalation	33,000,000	----------	-----------	-----------
	Omissions & Contingencies	14,500,000	----------	-----------	-----------
PLANT TOTAL		$419,000,000	$8,200,000	$175,500,000	$324,500,000

Pioneer Unit I

Construction Progress

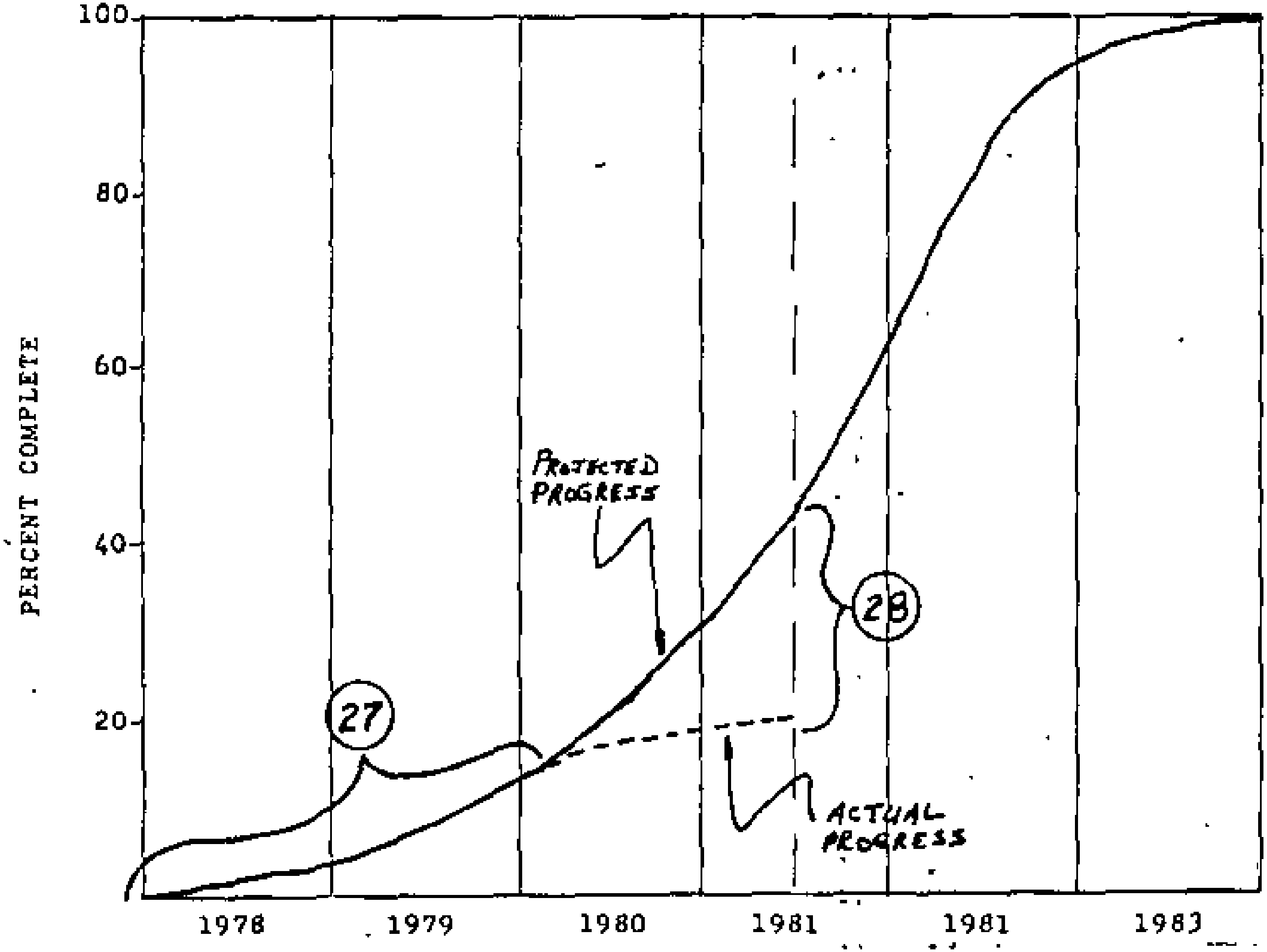


FIGURE 1

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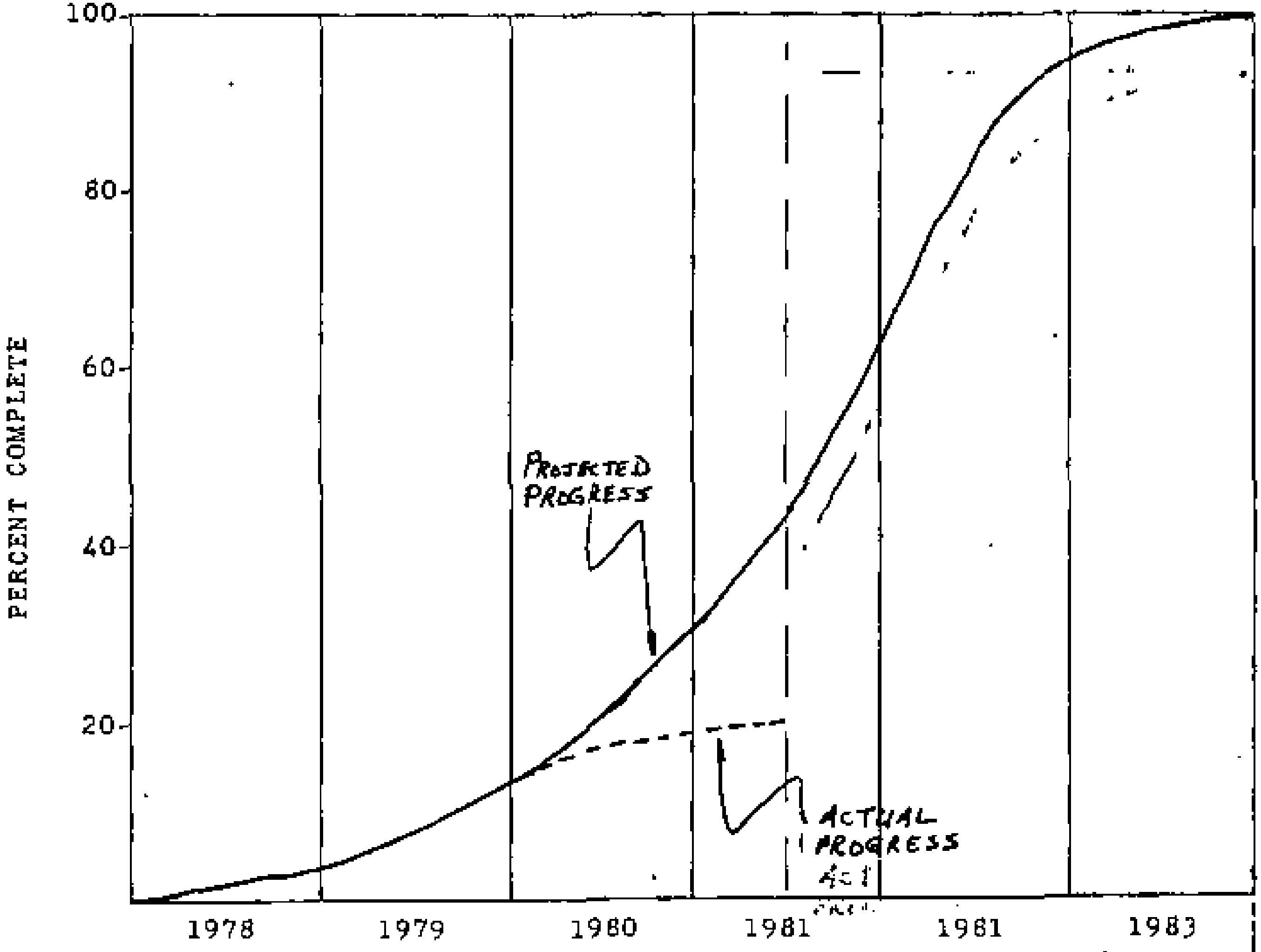
Pioneer Unit I

Construction Progress



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Utility Light & Power Company

Pioneer Unit I

Progress Report of 9/28/81

The following comments apply to correspondingly numbered markings on the Pioneer Unit I progress report for the month ending July, 1981.

1) There is a two-month lag from the end of the reporting period to issuance of the report. Considering the significance of the information given about the project in the report, this is too long.

2) This problem and its impact are described very subjectively. It says "things have been slow but we hope they will get better later on". This problem should be thoroughly explained. Cost and schedule impact (backed up by actual numbers) should be given, as well as an outline of the corrective action, if any, planned.

   The "recovery schedule" has been alluded to here as a new schedule, but nowhere else in the report is it mentioned. Has a new schedule been adopted? What is it?

3) As in (2) above, the problem of dewatering is defined very subjectively. No cost or schedule impact is given. As this is merely a summary, this treatment may be satisfactory - but we should expect a detailed discussion, containing quantitative information, later in the report. Unfortunately it doesn't exist. No information is given concerning the reason for the lack of additives, how long the problem has existed, how long it is expected to exist and what corrective action is being implemented or planned.

4) WAYLO's job-shoppers have increased - how many were added? What is the status of drawing production? How many additional manhours (at what cost) should it take to bring drawing production back on schedule?

5) It would be interesting to know how these precise percentages were obtained.

6) This engineering progress section is worthwhile in that it does detail progress by engineering <u>product</u> (as opposed to level of effort or man-hours expended). However, it doesn't relate the products completed to the number <u>scheduled</u> (or budgeted) for completion either.

for the reporting period or to-date. What it says is: "Here's the number of items to be done over the eight year project, and here's what we've done so far." This gives no early warning or estimated-to-complete information, nor does it measure performance of the engineering effort. In addition, it says nothing of cost. Note that "Engineering and Consultants" (account #981 of Table 2) is a $41,600,000 cost item and that one million dollars were expended for it during the month. It is a major candidate for control and performance reporting. As such, a baseline budget should be prepared, actual progress accumulated, and accomplishment measured both in terms of cost and schedule. Variances should be identified and corrective action described and estimates-to-complete should be listed.

7) This could be a very serious or a minor problem. Exception reporting is needed to isolate significant DCN issues. Additional information is required to describe:

- the number of DCN's issued-to-date.
- the number of DCN's resolved (and information concerning the significant ones).
- the number of DCN's issued during July.
- major sources of nonconformances.

8) This short paragraph brings quite a few major problems to our attention, yet does not explain their impact nor detail the corrective action that is "being planned".

9) As in 2) above, more impact data is required, along with corrective action. Many questions remain unanswered, i.e.: how long did the strike last, what did it impact, why is the recovery slow (how slow?), how great are the manpower shortages cited (number, percent, etc.), what can be done to alleviate this problem, what effects will corrective measures have, how much will they cost?

10) This section describes how late some major buildings are so far. Three primary deficiencies are apparent:

a. The progress, by building, does not match the format by which the work is performed (see discussion of construction packages, page 3) nor how costs are estimated (by FERC account, table #2). Meaningful comparisons between the three are impossible.

b. Other major construction activities are ignored. These include: piping (there is a shortage of pipefitter welders, tell us how this major activity is doing), electrical work, circulating water system, major equipment, turbine pedestal, etc.

While not pertaining to any particular structure, these items are significant and could easily lie on the critical path.

c. Again, no information concerning estimate-to-complete (will things get better or worse?), no reasons for delay and no outline of corrective action.

11) This summary gives the appearance that an "earned value" approach is being taken regarding construction manhours. However, it is not explained whether these figures reflect project to-date or merely the current reporting period. Comparisons between planned and actual manhours are missing. No actual or budgeted costs are listed. No variances are listed. The following items should be reported in order for an "earned manhour evaluation program" to have merit:

budgeted manhours }
actual manhours } both to-date and this period
earned manhours }

variances } cost and schedule

estimate-to-complete

Where major variances exist, detailed report isolating their causes should be available, as well as corrective action outlines.

12) This information has very little value. Like many of the other data given in the report, it only indicates the peak force. Manpower loading curves could be used to isolate resource constraints in the aggregate and by construction craft, as well as to show trends in staffing ability. All we know from this listing is the greatest number of bodies on the project for some particular day. Strikes and manpower shortages have been alluded to earlier in the report. What is their magnitude? Which crafts have been affected? How long have these conditions persisted and how severe have they been? How will the manpower loading appear in the future? How will this compare to required manpower, by craft? Manpower loading curves would give this information. Also, participants should know: How many shifts are being worked, what is the resulting productivity; how much overtime is being used and to what effect; what crafts will be heavily needed in the future, and will they be available: Why does WAYLO have one man for every 5½ contractor men during the day and one man for every 145 at night. Are these numbers mixtures of direct and indirect, (manual and nonmanual), etc?

13) No variances are explained. No cost data are given. For construction equipment, the word "committed" could mean scheduled, required, promised, or paid for. What does this data tell us? By the same token, what does "on hand"

mean? Could all equpment be on hand yet 50% of it out of service due to maintenance, repairs, etc.

14) Please note comment (10). Almost no quantitative results are given. Throughout this narrative we learn that a lot of work has "begun" and a lot of work "continues". This tells virtually nothing of its schedule status. It tells absolutely nothing regarding cost.

15) See comment (3) above. In addition, no status of piping work not in the yard is given. No objective information is given regarding the progress of this contractor to date, his schedule status, or corrective action plans to work around the dewatering problem.

16) Item (10) tells us that the cooling tower is 28 weeks behind schedule and that it lies on the critical path. Apparently, WAYLO is 28 weeks behind in preparing the bid specifications. Here we find out that their specification is in progress? When is it expected to be completed? How late will this put the cooling tower construction once it begins? What is being done to expedite WAYLO?

17) See items (3), (9) and (15) above. Earlier we are told that circulating water pipe installation has been halted due to the dewatering problem, and here we find out that all yard piping has ceased due to a shortage of pipefitters! Again, how great is the shortage; how long has it persisted; how long should we expect it to persist; what will it do to our project; and what can we do about it. This points out the need for exception reporting. This item, along with its extent and impact, should be headlined up front.

18) A "cash requirements estimate" should be prepared more often than yearly.

19) The amount expended through July 31, 1981, shown here, is dramatically different from that shown on Table #2 (see item (26)).

20) Note the inconsistency among the treatment of AFUDC and UL&PCo. indirects between Tables #1 and #2. In general, cash flow reporting format should agree with cost reports and any deviations should be fully explained.

21) Again, no performance data is given. No budgeted to-date or this period; no variance; no estimate-to-complete.

22) See comment (10). A cost summary by major property accounting code is virtually useless in understanding performance of the project.

23) Committed and expended amounts for accounts 321 and 322 already exceed those estimated. Some explanation of

these accounts is in order. In particular, a variance analysis is required and it should describe the estimate-to-complete for structures and improvements and boiler plant equipment.

24) See comment (6).

25) These items should be disturbing. What is "suspense"? What is the cost item "omissions"? There appears to be no reserve or "contingency" other than on the gross project level. Recommend contingencies, as well as escalation, be identified with the cost item they pertain to and their use monitored. This report says that no contingencies nor escalation amounts have been expended or committed during the first four years of the project! Recommend a reserve management program be implemented.

26) See comment (19).

27) It appears that the forecast has been changed to match the actual percent complete-to-date sometime in early 1980. How often is this done? What use is it to to compare actuals to forecast when the latter is changed to match the former.

28) A significant variance has occurred during 1981. The effect on "estimate-to-complete" (which is not shown) demands further explanation. This graph is difficult to read, and no numbers are listed for project forecast at the end of the reporting period.

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
OVERVIEW

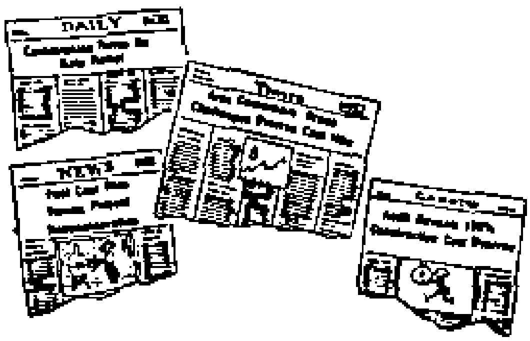
Audio Visual 79-751

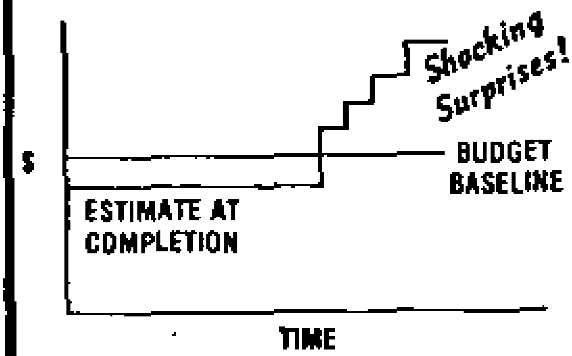
MANAGING INDUSTRIAL PROJECTS

"A PERFORMANCE ORIENTED APPROACH"

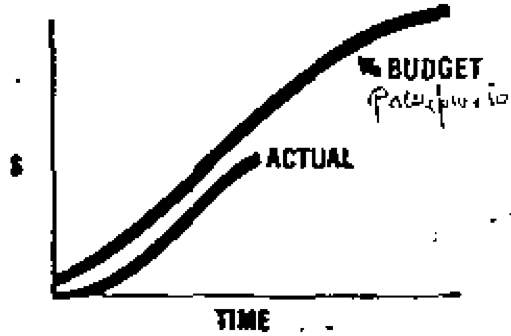
OVERVIEW OBJECTIVES

- ☑ RELATE GENERAL CONCEPTS TO INDUSTRY EXPERIENCE
- ☑ DESCRIBE SEMINAR CONTENT





PROJECT VISIBILITY?



COMMON PROBLEMS "POOR PROJECT VISIBILITY"

- INTEGRATION OF INFORMATION
- RESPONSIBILITY REPORTING
- PROBLEM TRACEABILITY
- INADEQUATE ESTIMATES AT COMPLETION

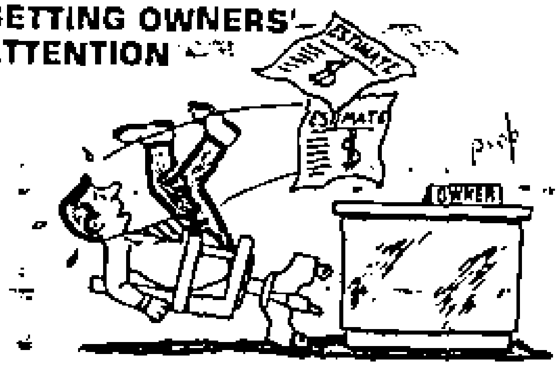
"MANAGING INDUSTRIAL PROJECTS" (MIPS)
OVERVIEW

Audio-Visual 79 751

IT'S GONNA COST WHAT IT'S GONNA COST . . .

. . . AND TAKE AS LONG AS IT TAKES!

THESE PROBLEMS ARE GETTING OWNERS' ATTENTION



CLEAR INDUSTRY TRENDS

- GREATER OWNER INVOLVEMENT
- DESIRE FOR BETTER CONTROL SYSTEMS

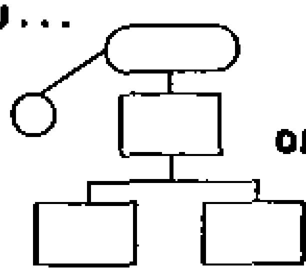
GREATER OWNER INVOLVEMENT

- PROJECT PLANNING
- DIRECTION OF CONTRACTOR CONTROL PRACTICES
- TRADE-OFF DECISIONS
- MONITORING AND CONTROL ACTIVITIES

IMPROVED CONTROL SYSTEMS

- BETTER DEFINITION OF REQUIREMENTS
- APPLICATION OF SELECTIVE CONTROLS
- TIMELINESS AND ACCURACY
- CONFIDENCE

REGARDLESS OF HOW YOU . . .

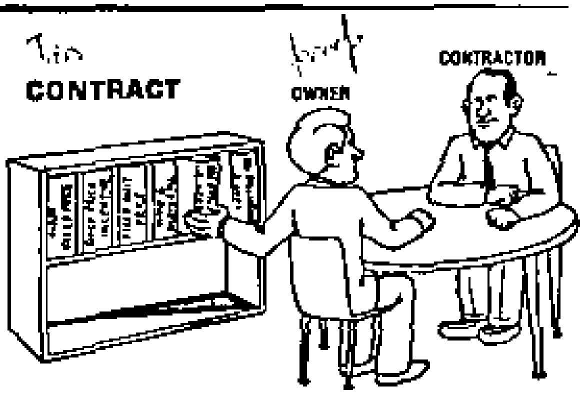


ORGANIZE

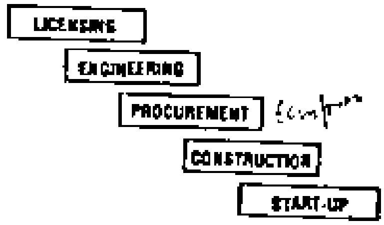
OR . . .

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
OVERVIEW

Audio-Visual 79-751

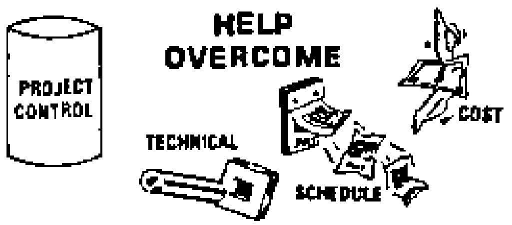


WHERE YOU ARE IN . . .



THE PROJECT LIFE CYCLE

ORGANIZED SYSTEMS HELP OVERCOME COMMON PROBLEMS



NEED FOR GOOD TOOLS

PEOPLE \ TOOLS	GOOD TOOLS	POOR TOOLS
OUTSTANDING	+	+
AVERAGE	+	−
BELOW AVERAGE	−	−

MANAGING INDUSTRIAL PROJECTS

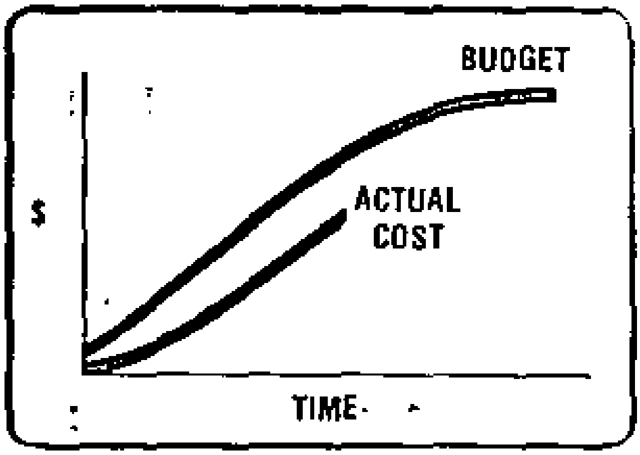
"A PERFORMANCE ORIENTED APPROACH"

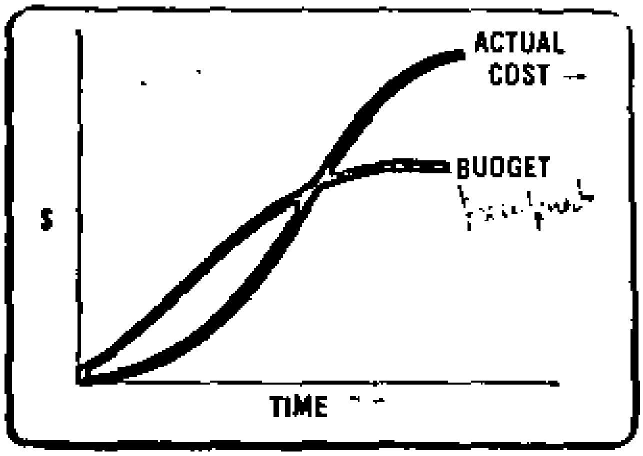
WHAT'S IN IT FOR YOU

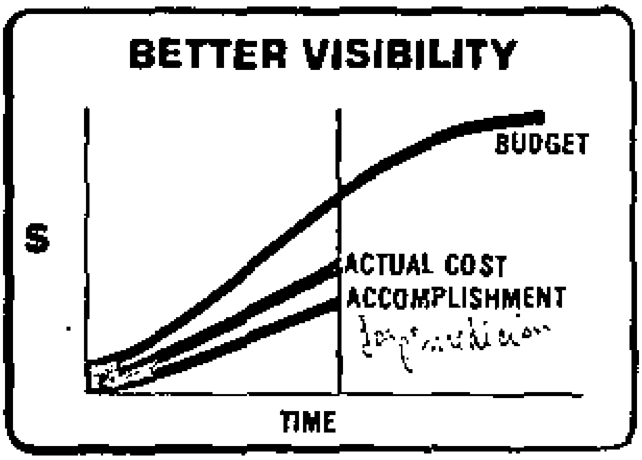
- IMPROVED PLANNING
- CLEARER RESPONSIBILITY
- COST AND SCHEDULE PERFORMANCE
- IMPROVED PROBLEM TRACEABILITY
- IMPACT OF KNOWN PROBLEMS
- EARLY WARNING OF POTENTIAL PROBLEMS
- HIGH LEVEL MANAGEMENT BY EXCEPTION
- IMPROVED ESTIMATES-AT-COMPLETION

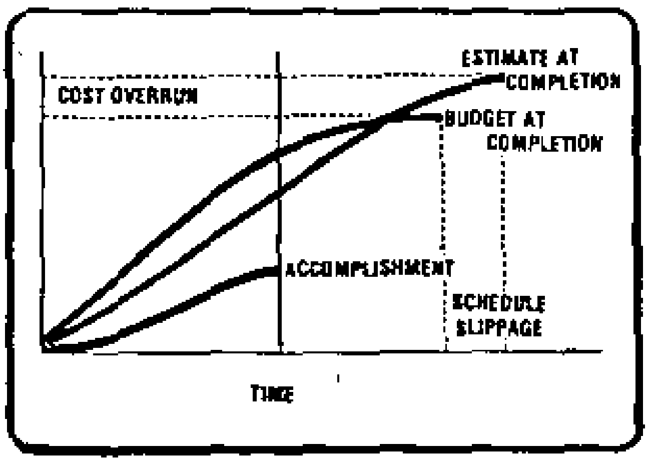
"MANAGING INDUSTRIAL PROJECTS" (MIPS)
OVERVIEW

Audio-Visual 79-751









PLANNING

- WORK DEFINITION
- RISK ANALYSIS AND SELECTIVE CONTROLS
- RESPONSIBILITY ASSIGNMENT
- SCHEDULE AND BUDGET FOR ALL WORK

CONTROLLING

- A QUANTITATIVE MEASURE OF ACCOMPLISHMENT
- TIMELY AND ACCURATE COST INFORMATION
- ANALYSIS OF PERFORMANCE
- FORMALIZED ESTIMATE AT COMPLETION
- CHANGE CONTROL

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

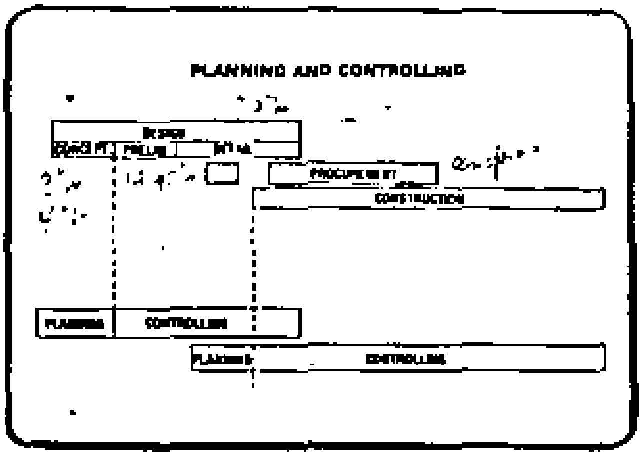
OVERVIEW

Audio-Visual 79-751

PERFORMANCE ORIENTED APPROACH—

WORKS!

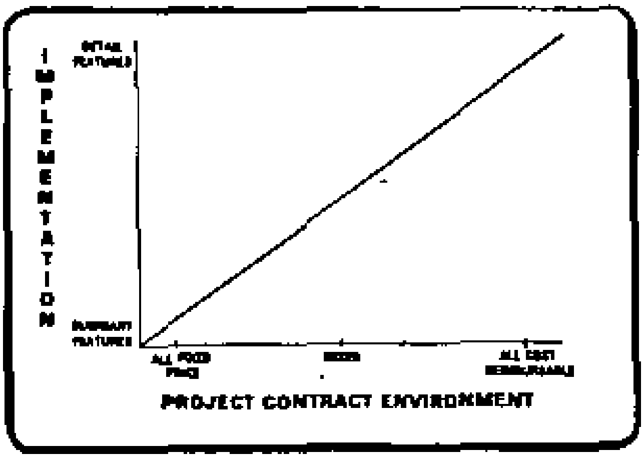
- FOR ENGINEERING
- FOR CONSTRUCTION

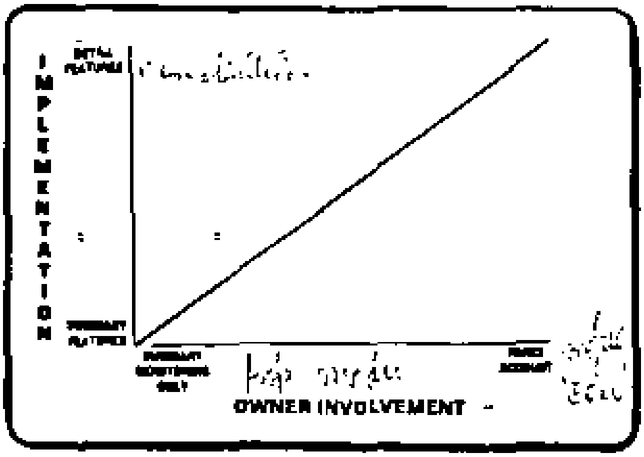


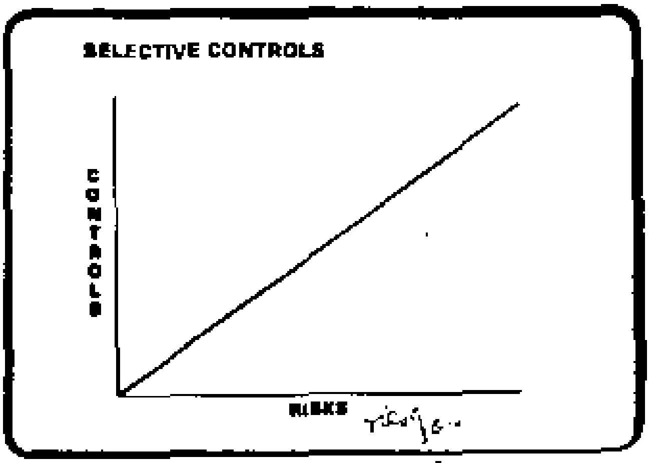
PERFORMANCE ORIENTED APPROACH

WORKS!

- FOR COST REIMBURSABLE WORK
- FOR FIXED PRICE WORK







"MANAGING INDUSTRIAL PROJECTS" (MIPS)
OVERVIEW

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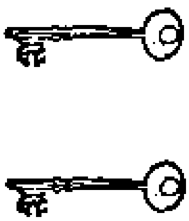
KEYS TO USE

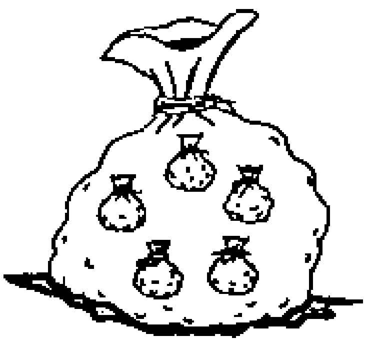


RULE OF REASON

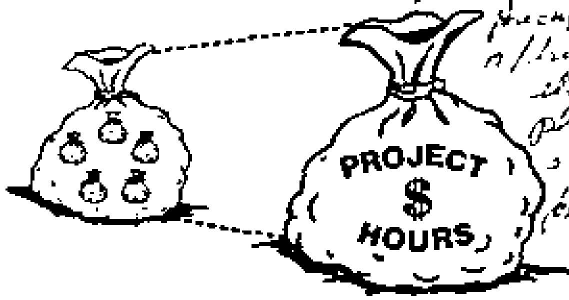
RISKS

PROJECT CONTROL

PROJECT CONTROL



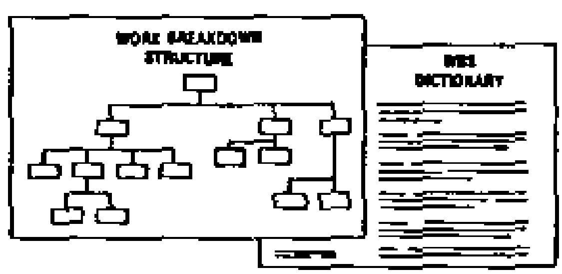
PROJECT CONTROL



SEMINAR AGENDA
PERFORMANCE ORIENTED
APPROACH

PLANNING/CONTROLLING

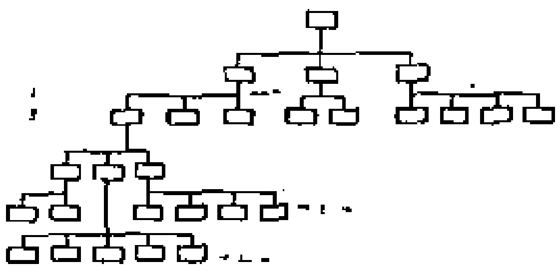
WORK DEFINITION

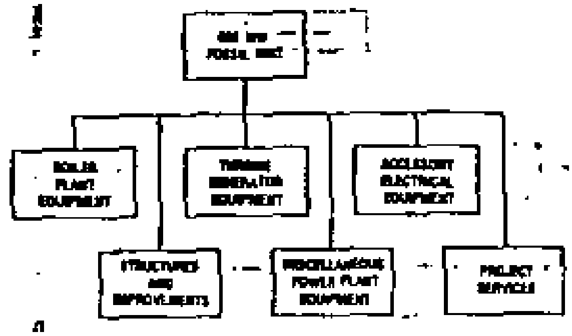


"MANAGING INDUSTRIAL PROJECTS" (MIPS)

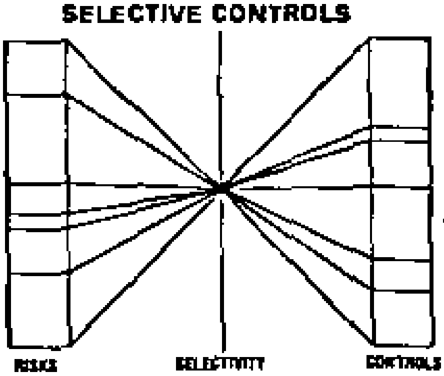
OVERVIEW

WORK BREAKDOWN STRUCTURE





RISK ANALYSIS AND SELECTIVE CONTROLS



TYPES OF RISK

TECHNICAL

IT WON'T WORK!

SCHEDULE

IT'S LATE!

COST

TOO MUCH!

SELECTIVE CONTROLS

- POLICIES AND PROCEDURES
- CONTRACT TYPES
- CONTRACT TERMS

SELECTIVE CONTROL CONSIDERATIONS

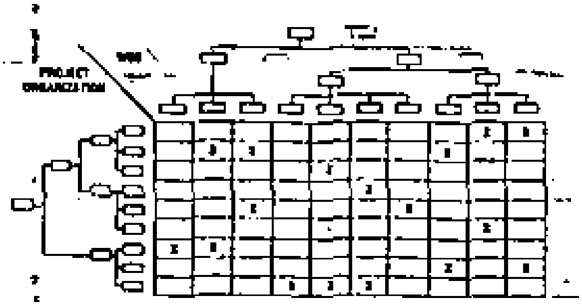
- PRODUCT/SERVICE
- SPECIAL CONDITIONS
- ORGANIZATIONAL CHARACTERISTICS

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

OVERVIEW

Audio/Visual 79-751

RESPONSIBILITY ASSIGNMENT



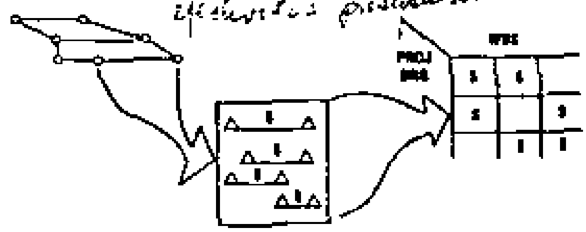
AND CONTROL ACCOUNT ESTABLISHMENT

CONTROL ACCOUNT

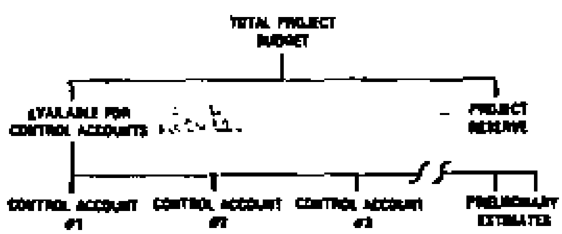
- RESPONSIBILITY
- BUDGET
- COST COLLECTION
- MEASURING ACCOMPLISHMENT
- VARIANCE ANALYSIS
- CORRECTIVE ACTION

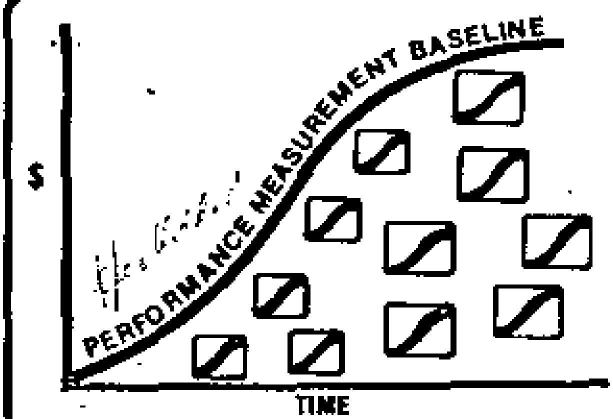
CONTRACT ADMINISTRATION

SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING



BUDGET TRACEABILITY

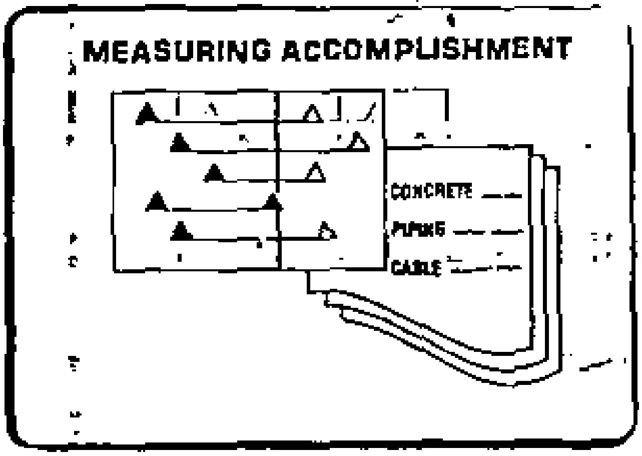


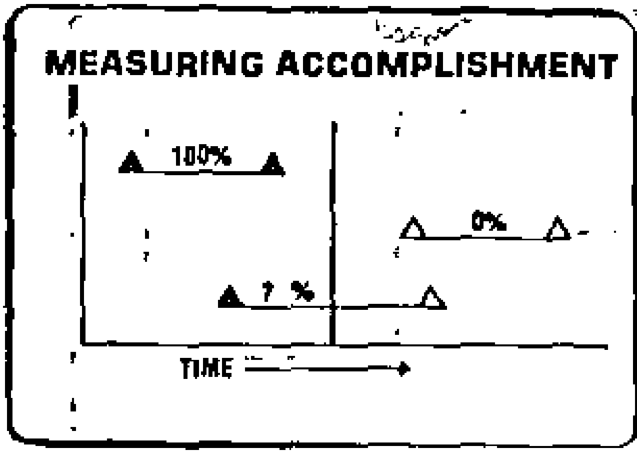


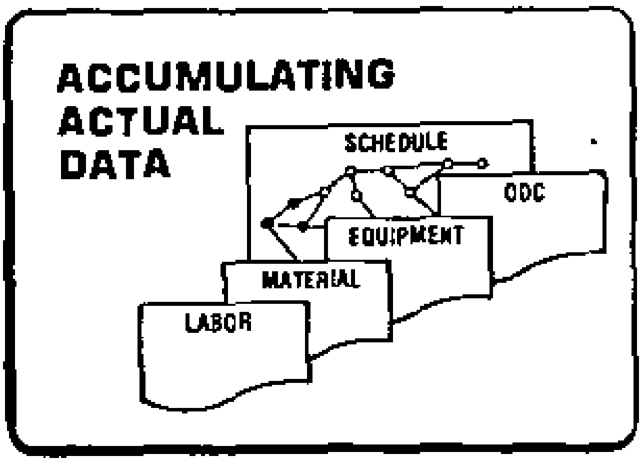
"MANAGING INDUSTRIAL PROJECTS" (MIPS)

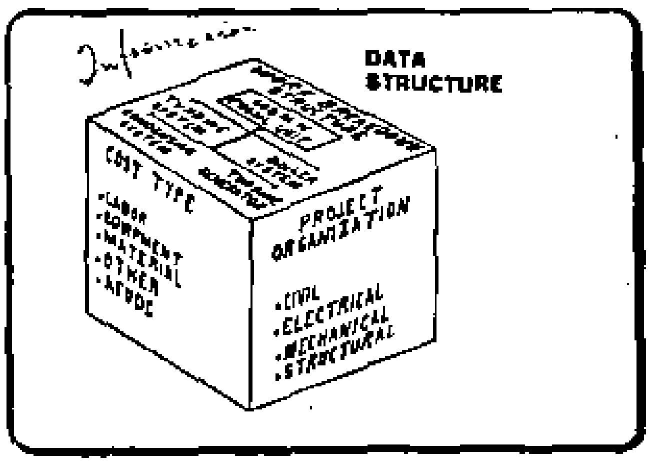
OVERVIEW

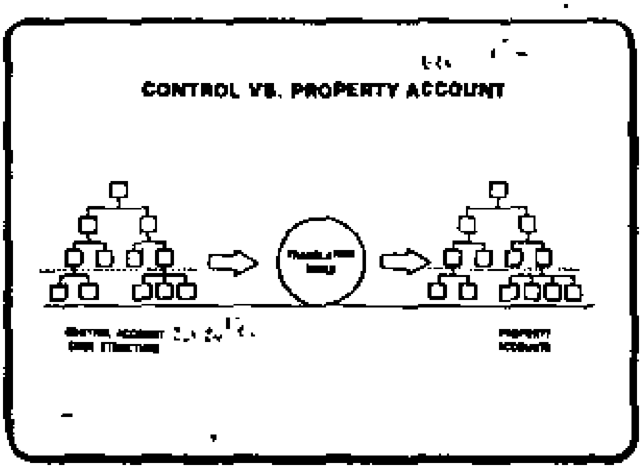
Audio/Visual 78-781

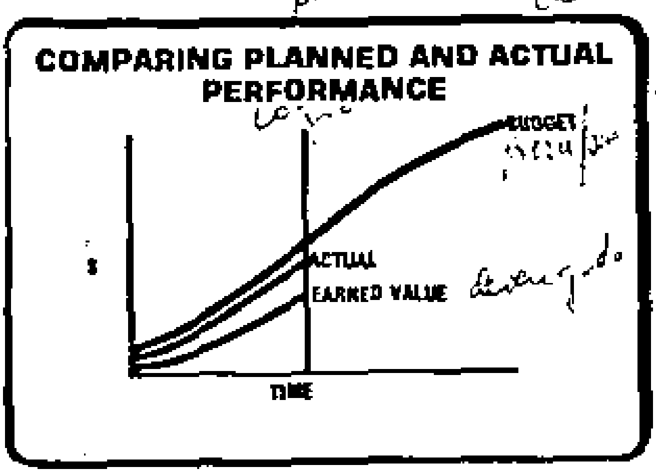








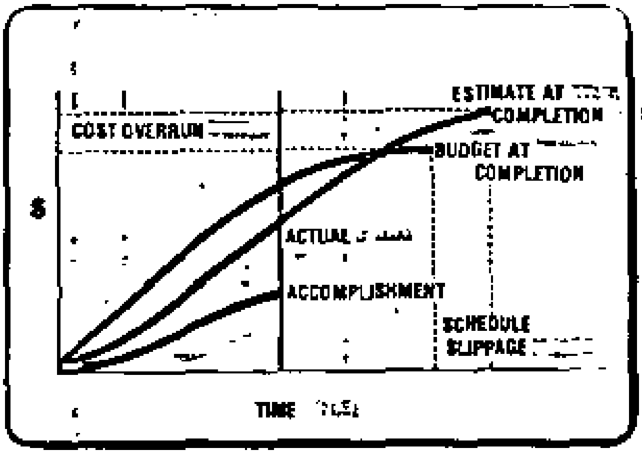




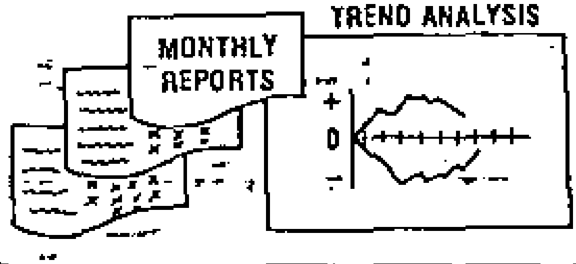
"MANAGING INDUSTRIAL PROJECTS" (MIPS)

OVERVIEW

Audio-Visual 79-751



REPORTING AND ANALYSIS



KEY INDICATOR REPORTS

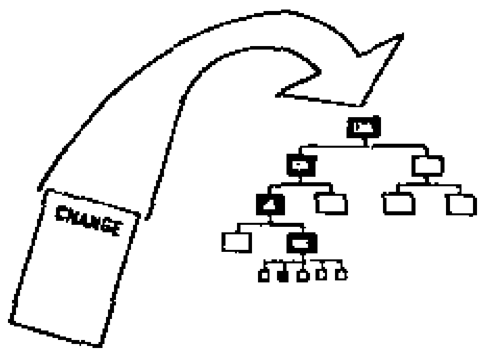
CASH FLOW — PROCUREMENT STATUS

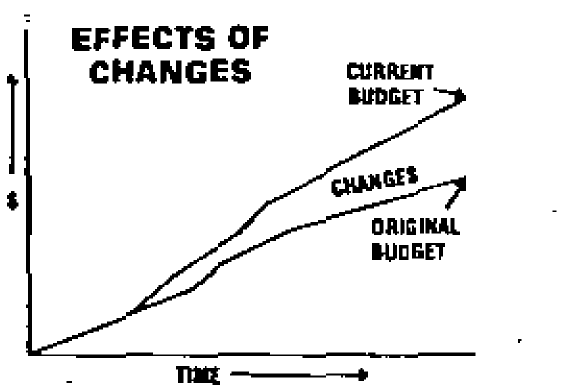
COMMITMENTS — RESERVE APPLICATION

SCHEDULE — CHANGES

PERFORMANCE

CHANGE CONTROL





IMPLEMENTATION

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
OVERVIEW

Audio-Visual 79-751

AUTOMATION

WILL IT WORK FOR YOU?

- IMPROVED PLANNING
- CLEARER RESPONSIBILITY
- COST AND SCHEDULE PERFORMANCE
- IMPROVED PROBLEM TRACEABILITY
- IMPACT OF KNOWN PROBLEMS
- EARLY WARNING OF POTENTIAL PROBLEMS
- HIGH LEVEL MANAGEMENT BY EXCEPTION
- IMPROVED ESTIMATES-AT-COMPLETION

WORK DEFINITION

WBS element title:	WBS element no.
COOLING TOWER	03.04
Parent WBS No.: 03 Parent WBS title: TURBINE GENERATOR EQUIPMENT	WBS level 3

Program:	Contract:
600 MW FOSSIL UNIT	BOILER – TURBINE

WBS element description:

A single unit, hyperbolic natural draft wet cooling tower, constructed of reinforced concrete, complete with basin, pumphouse, core and all associated mechanical and electrical equipment and controls. This element does NOT include the circulating water pipe. The internal piping and distribution system (included) begins at the thrust blocks of inlet of CW piping and ends at outside of face of collector basin flume.

600 MW FOSSIL UNIT

WORK BREAKDOWN STRUCTURE

CASE PROBLEM #2

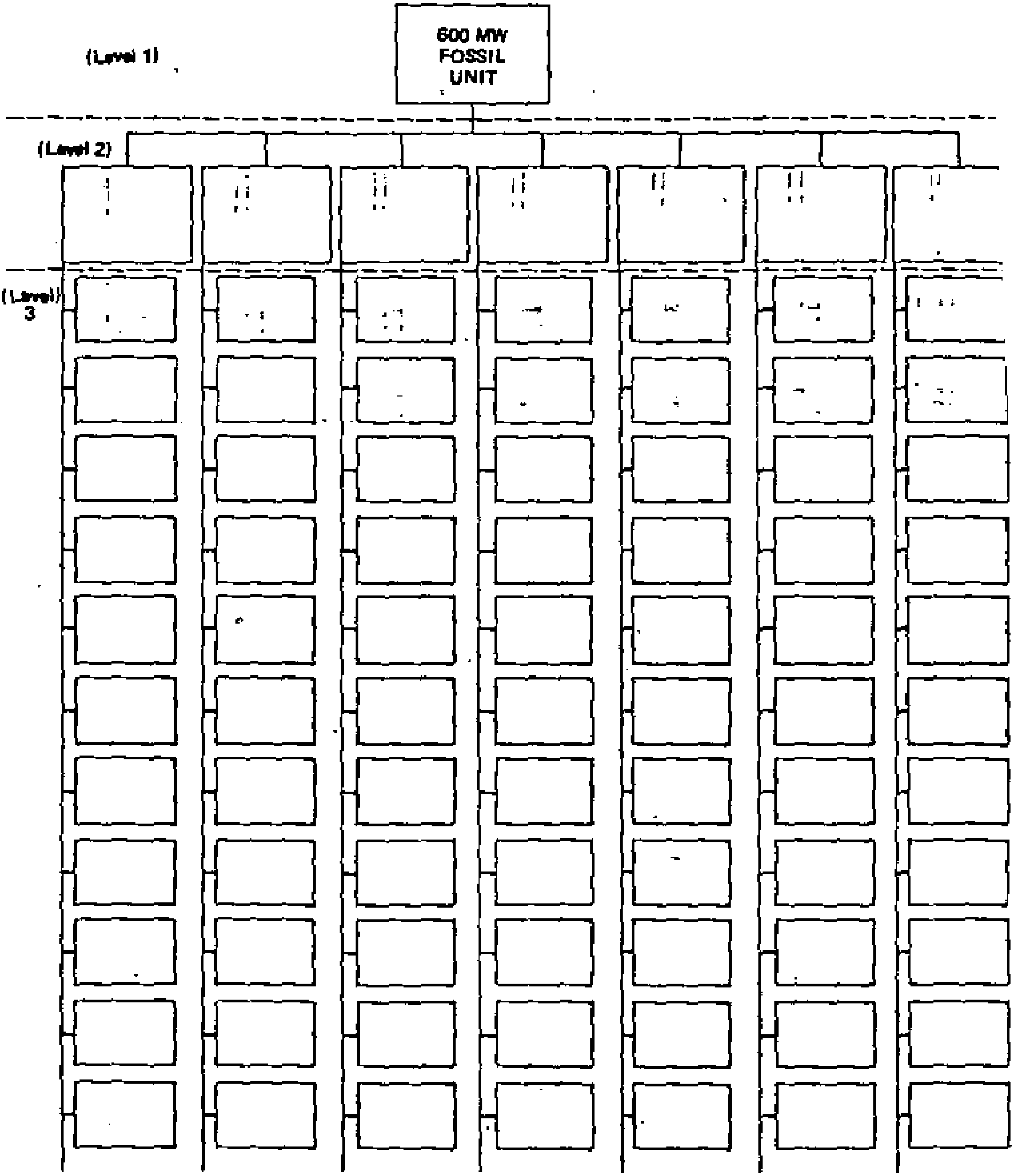
The Utility Light and Power Company plans to build a new 600 Megawatt Fossil Unit. The unit has been designed, but the Vice President for Construction wants something which he says "breaks all the work down into manageable pieces so I can make somebody responsible for each piece." He also wants to use this "to decide what work the utility will do and what it will contract out." The Project Manager has told your team "What the boss wants is a Work Breakdown Structure. I think it ought to go down about three levels".

PROBLEM

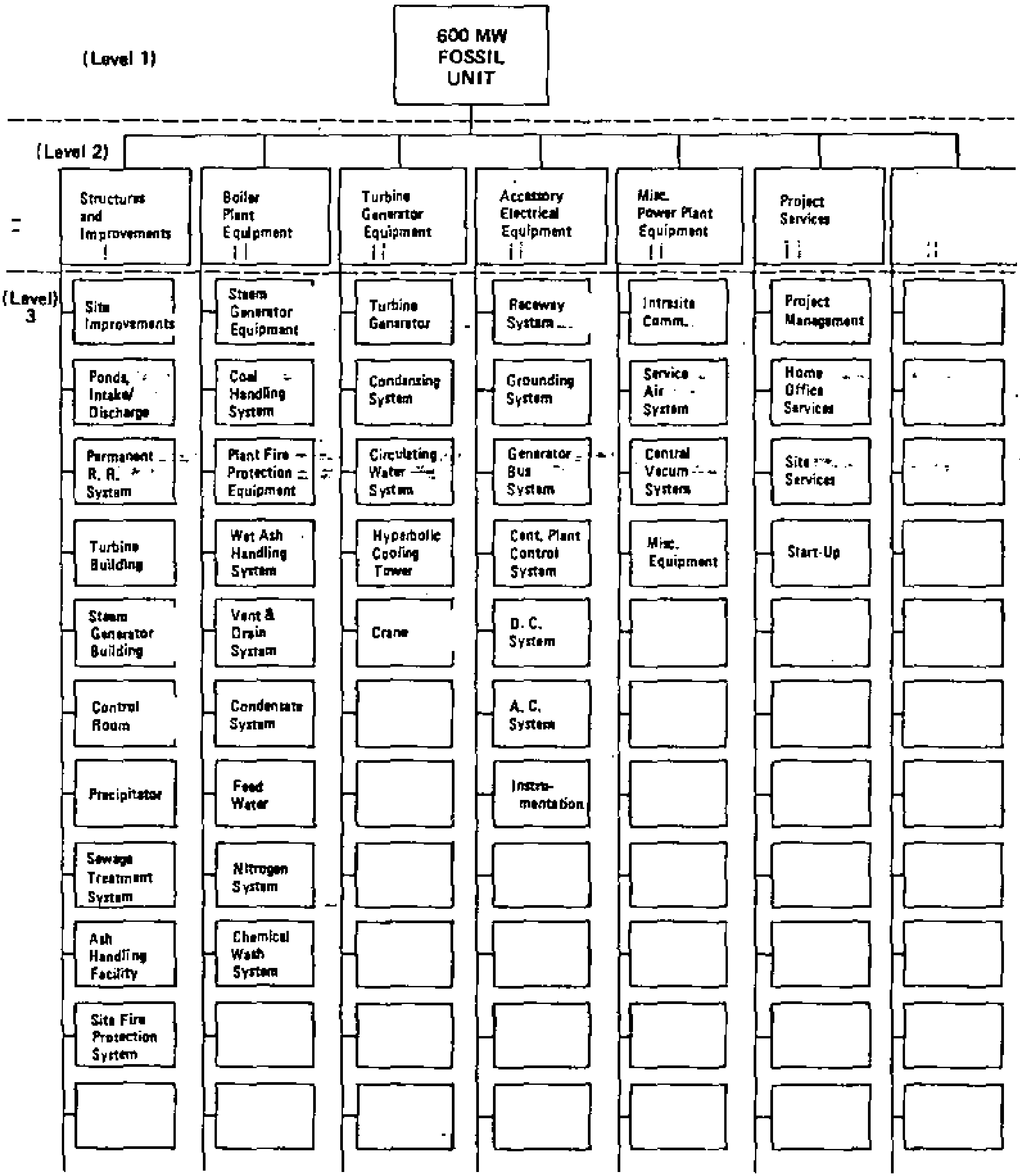
Based on your experience with power plant construction, construct a WBS. You will need to consider at least the following elements:

1. Boiler Plant Equipment
2. Site Improvements
3. Steam Generator Equipment
4. Turbine Generator
5. Raceway System
6. Intrasite Communications
7. Project Management
8. Turbine Generator Equipment
9. Plant Fire Protection Equipment
10. Generator Bus System
11. Site Services
12. Turbine Building
13. Hyperbolic Cooling Tower
14. Miscellaneous Equipment
15. Structures and Improvements
16. Vent and Drain System
17. D. C. System
18. Consensate System
19. Precipitator
20. Instrumentation
21. Sewage Treatment System
22. Chemical Wash System
23. Project Services
24. Ponds, Intake/Discharge
25. Coal Handling System
26. Condensing System
27. Grounding System
28. Service Air System
29. Home Office Services
30. Permanent R. R. System
31. Circulating Water System
32. Central Vacuum System
33. Accessory Electrical Equipment
34. Wet Ash Handling System
35. Central Plant Control System
36. Start-Up
37. Steam Generator Building
38. Crane
39. Control Room
40. A. C. System
41. Feed Water System
42. Misc. Power Plant Equipment
43. Nitrogen System
44. Ash Handling Facility
45. Site Fire Protection System

CASE PROBLEM # 2



CASE PROBLEM # 2



600 Megawatt Fossil Unit

ENGINEERING/DESIGN WBS

BACKGROUND INFORMATION

Assumptions: Utility has hired a typical Architect--Engineering Firm (A/E) to design the 600 MW Fossil Unit. As such, the A/E's scope of work includes all the pure design and coordination of vendor designs and submissions (shop drawings, O&M Manuals, etc.) necessary to procure, construct, and operate the facility.

As the Utility Company has decided to be its own Project Manager and control the project itself, it will retain responsibility for project services in the home office and at the site. However, it is assigning some design-related activities to the A/E. Principal among these is Licensing (permits, studies) Support. The Utility will perform its own procurement, labor relations, safety, QC, contract administration, scheduling, estimating, accounting, construction management, etc. The Project Engineer (lead A/E person) and his people will integrate into the Utility's project organization, reporting to the Deputy Project Manager. The A/E will also have "liaison engineers" at the site, once construction begins, who will supplement the Utility's rResident Engineering staff. Liaison Engineers will interface with the A/E's home office effort when field engineering problems occur, i.e., when something can't be constructed as designed and quick fixes are needed.

Development of Engineering WBS:

A basic inconsistency always exists when applying WBS criteria to the activities of design and construction of a power plant. This is because a project is designed by SYSTEM, yet constructed by STRUCTURE, EQUIPMENT, COMPONENTS, and COMMON SERVICES. There is no one-to-one correlation between WBS elements used to define the design and construction processes. For this reason it is difficult to establish control accounts, numbering schemes, etc., which would span both.

It is beneficial, if not essential, therefore, to establish control systems, over design as well as construction, which are commensurate with the way the work is done and end-product-oriented. Just as our construction WBS is product-oriented (foundations, structural steel, elevators, cabletray), so is our design WBS. The products of the design effort are essentially drawings and specifications, and the development of these products can be monitored with progress, and cost measured against established standards. Earned Value can be calculated.

In that an A/E contract is typically cost-reimburseable, it is a prime candidate for application of Performance Measurement techniques for cost and schedule control.

The design WBS depicted here is based on the systems commonly encountered in a fossil unit design. Although nomenclature may vary from one user to another, the WBS levels descend from "groups of systems" to "systems" to "subsystems." In order to reach a product-oriented level, we have extended the WBS to types of drawings and specifications, arranged by engineering discipline.

All activities conducted by the A/E are not directly allocable to a specific system. For this reason we have established a "core activities" element at level 2 of our WBS. Items such as Licensing Support, Records Management, etc., are included in this element.

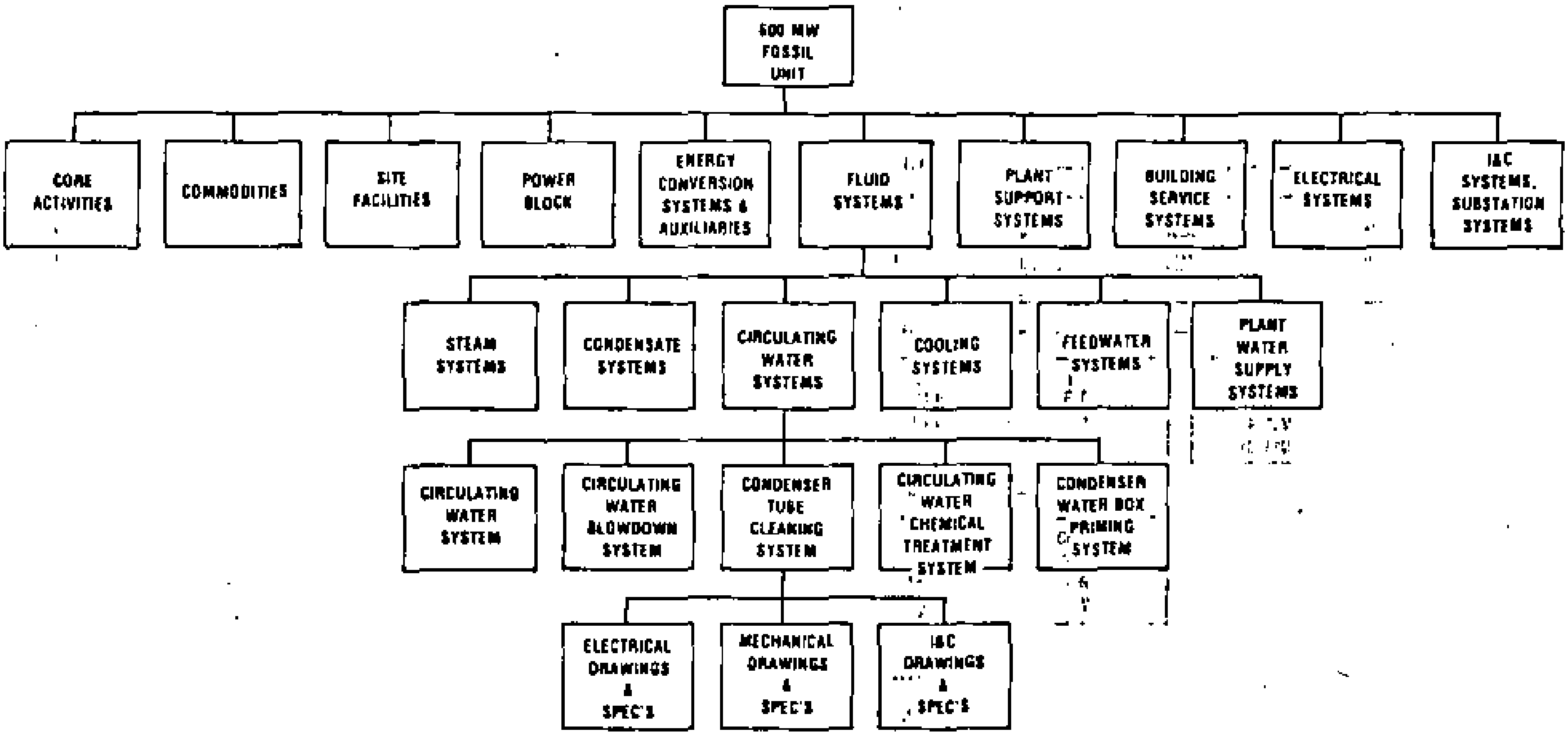
Although it may appear tedious to break down the engineering process to such an extent, it has many benefits. Among these are:

- Common basis for work assignment; progress measurement & reporting.
- Built-in Unique Identification System for drawings, specifications, equipment lists, etc.
- Aids communication between A/E and Utility.
- Once done, can be used for any power plant construction project (transferable).

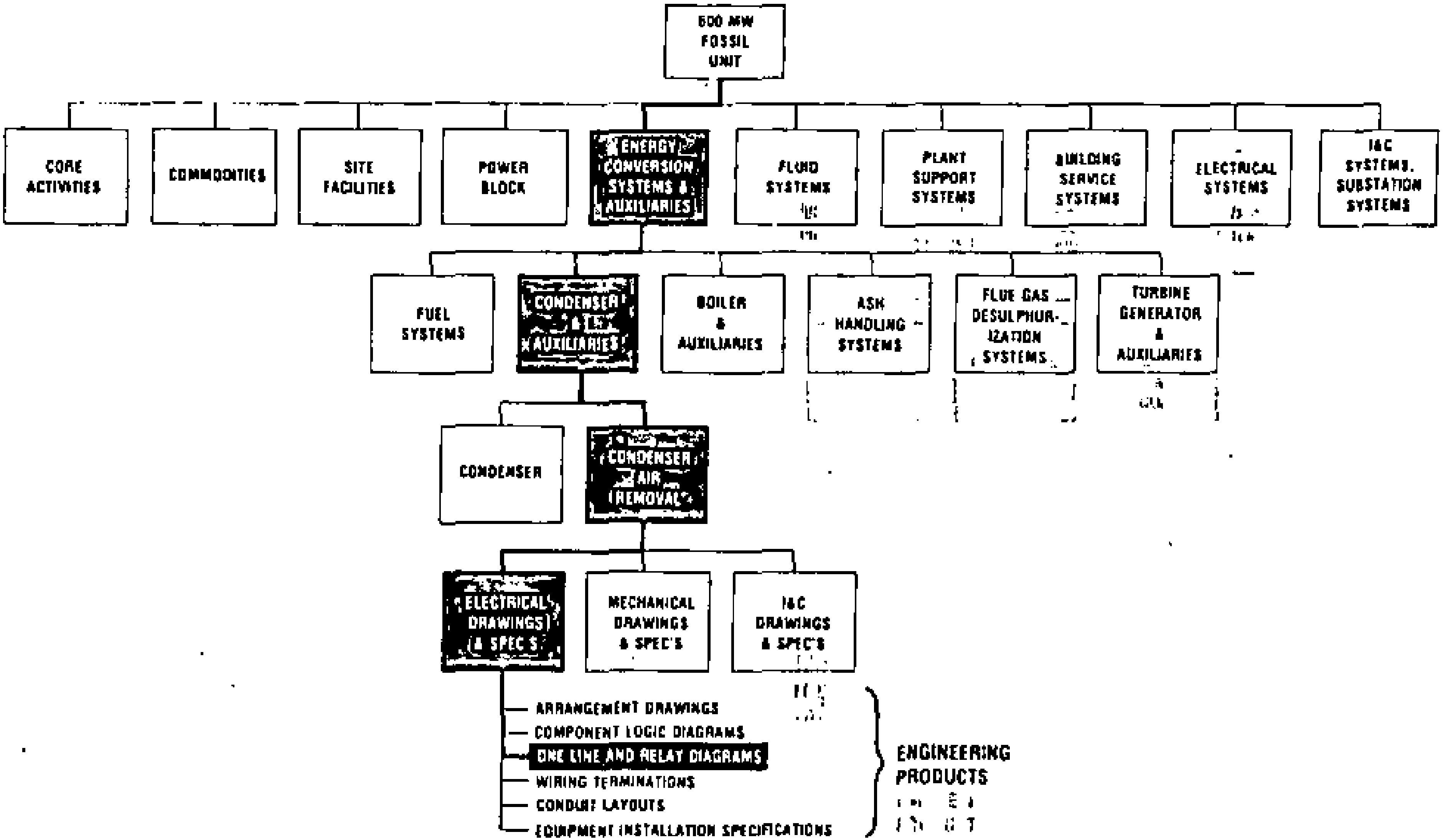
Rather than present an entire WBS scheme for a fossil unit to the lowest level of detail, we have shown two paths which reach elements associated with our case study examples (Exhibits 1 & 2). Examination of both paths will demonstrate the incompatability (one-to-one) of engineering and construction WBSs in our condenser example.

In order to show the relationship between the WBS and the engineering organization (Exhibit 3), a piece of each is matched where work is performed on condenser systems design (Exhibit 4).

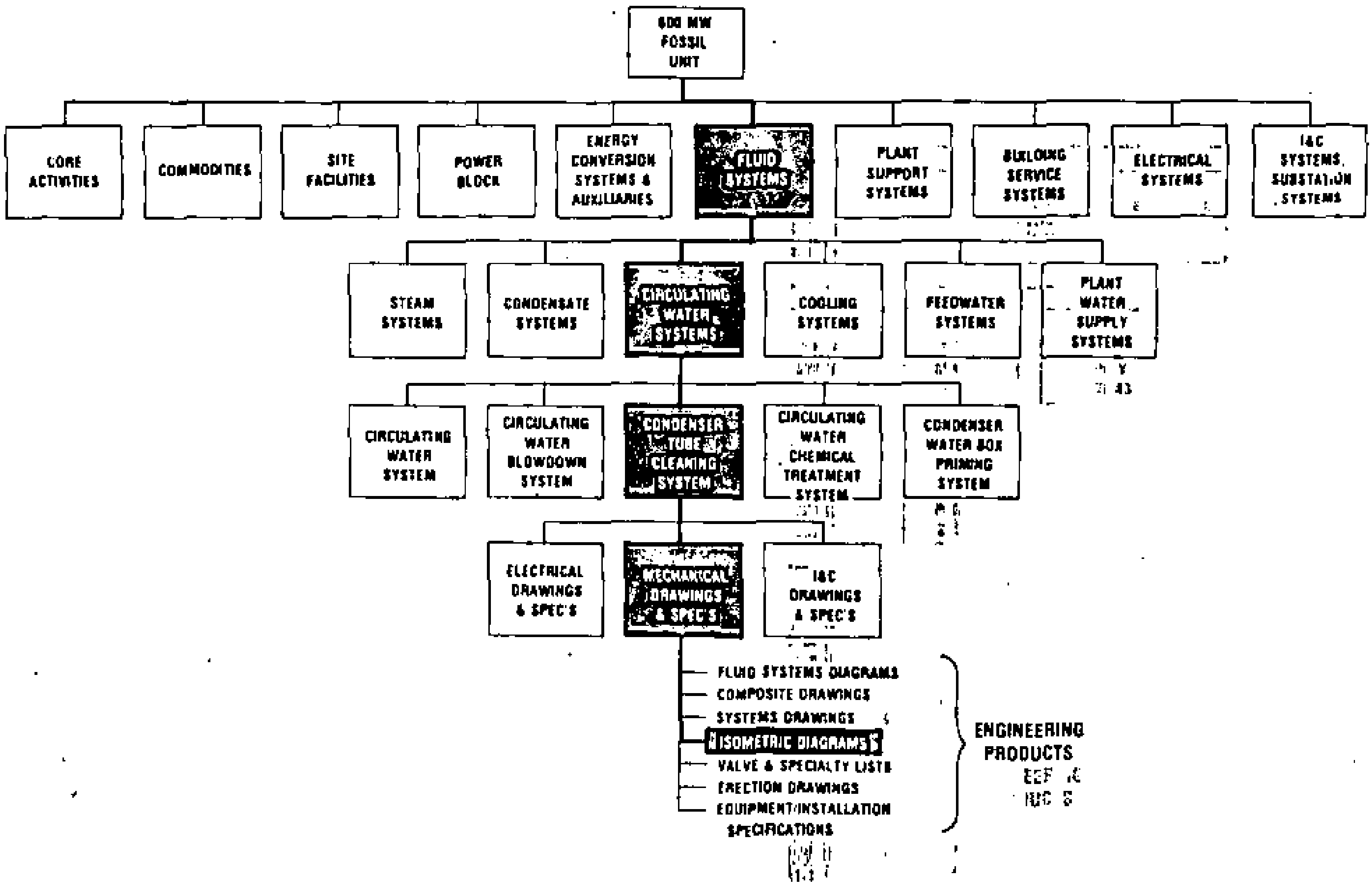
ENGINEERING/DESIGN WBS

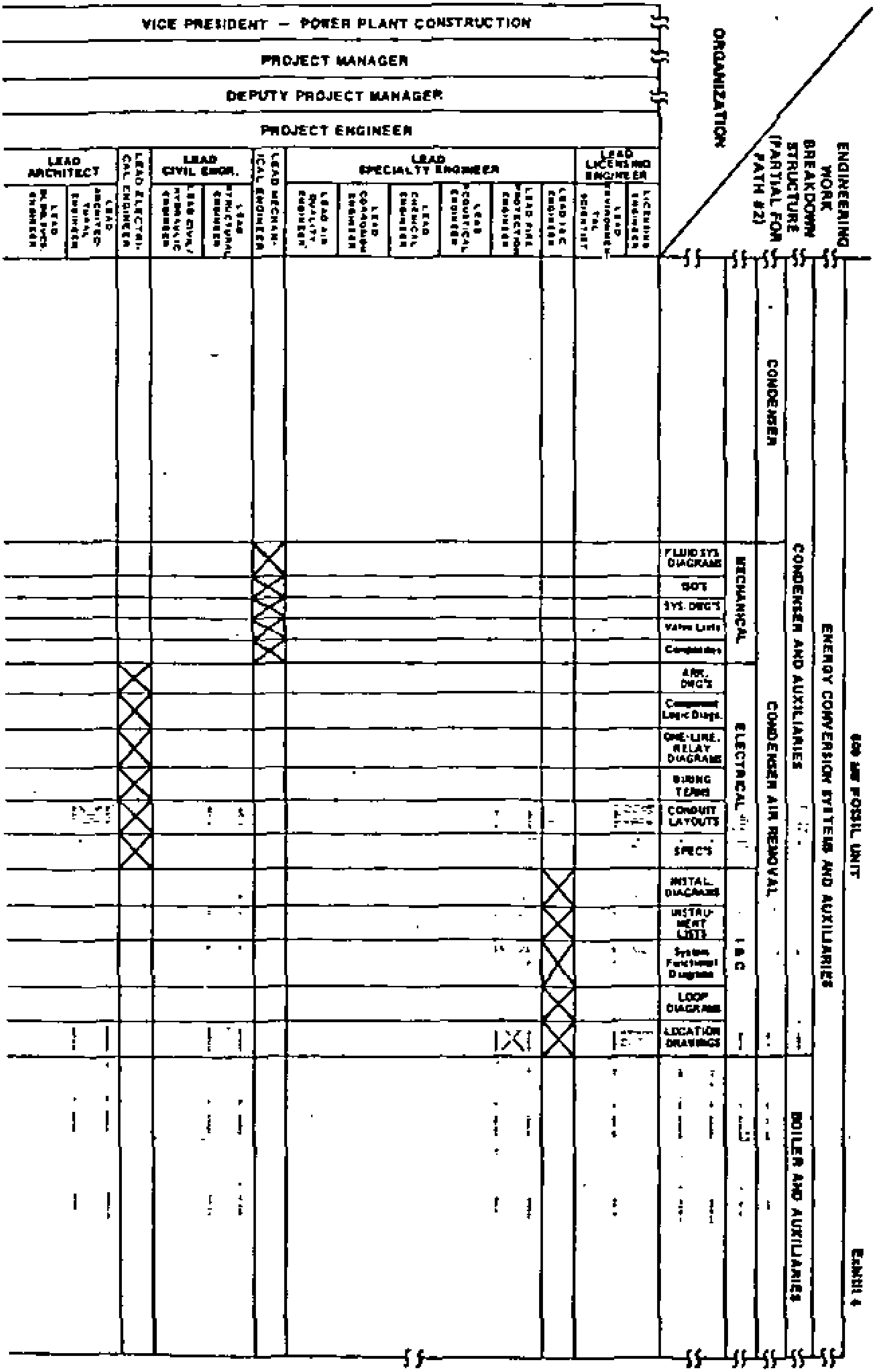


ENGINEERING/DESIGN WBS



ENGINEERING/DESIGN WBS





VICE PRESIDENT — POWER PLANT CONSTRUCTION
PROJECT MANAGER
DEPUTY PROJECT MANAGER
PROJECT ENGINEER
LEAD ARCHITECT
LEAD ELECTRICAL ENGINEER
LEAD CIVIL ENGR.
LEAD MECHANICAL ENGINEER
LEAD SPECIALTY ENGINEER
LEAD LICENSING ENGINEER
ORGANIZATION
ENGINEERING WORK BREAKDOWN STRUCTURE (PARTIAL FOR PATH #2)
FLUID SYS DIAGRAMS
SYS. DWG'S
Valve Lists
ARK. DWG'S
ONE-LINE, RELAY DIAGRAMS
CONDUIT LAYOUTS
SPEC'S
INSTAL. DIAGRAMS
INSTRUMENT LISTS
System Functional Diagrams
LOOP DIAGRAMS
LOCATION DRAWINGS
MECHANICAL
ELECTRICAL
I & C
CONDENSER
CONDENSER AIR REMOVAL
CONDENSER AND AUXILIARIES
BOILER AND AUXILIARIES
ENERGY CONVERSION SYSTEMS AND AUXILIARIES
FOSSIL UNIT

(WORK DEFINITION)

SCOPE DOCUMENT

PIONEER UNIT I

PACKAGE

C-18 Installation of Circulating Water System.

General Description of Work

Install Owner-furnished underground circulating water pipe from condenser to cooling tower, make-up system and intake structure including excavation, sheathing and backfill.

A. Scope of Work:

1. Excavation of pipe trenches.
2. Local dewatering.
3. Furnishing and installing trench sheathing.
4. Installing and connecting to thrust blocks.
5. Furnishing and installing pipe bedding.
6. Installing the underground circulating water piping from the condenser to the cooling tower.
7. Installing circulating water make-up piping system.
8. Installing underground auxiliary cooling water piping system.
9. Installing underground circulating water blowdown piping system.
10. Furnishing and installing fill material.
11. Testing of all piping systems installed.

B. Technical Specifications Required:

No. 394 Circulating Water System Major Yard Piping.

No. 107 Earthwork (including excavation, sheathing, pipe bedding, design, local dewatering, compaction, and backfill).

No. 166 Structural Concrete.

B. Technical Specifications Required (Continued):

No. 186 Miscellaneous Steel - Fab. and deliver.

No. 188 Miscellaneous Steel - Erection.

No. 219 Reinforcing Steel.

C. Drawings Required:

Discipline	Sub Identification
Layout	Plot Plans Ground Floor Plans Cross Sections Plans and Sections - Pump Structures
Piping	Circulating Water System
Structural Concrete	Circulating Water System
Civil	Circulating Water System Plot Plans Site Preparation
Structural Steel	Circulating Water System
Standard	Concrete Steel Civil Piping

D. Attachments Required:

1. Geological Survey.

E. Closely Related Work Not Included:

1. Furnishing circulating water pipe including bifurcations.
2. General Area Dewatering.
3. Furnishing and installing mechanical equipment (including pumps, screens, etc.).
4. Cooling Tower Pump House Construction.
5. Cooling Tower erection, including basin.
6. Condenser installation.

E. Closely Related Work Not Included (Continued):

7. Installing circulating water and blowdown piping from condenser to terminal point of underground thrust block.

8. Turbine Building Foundation.

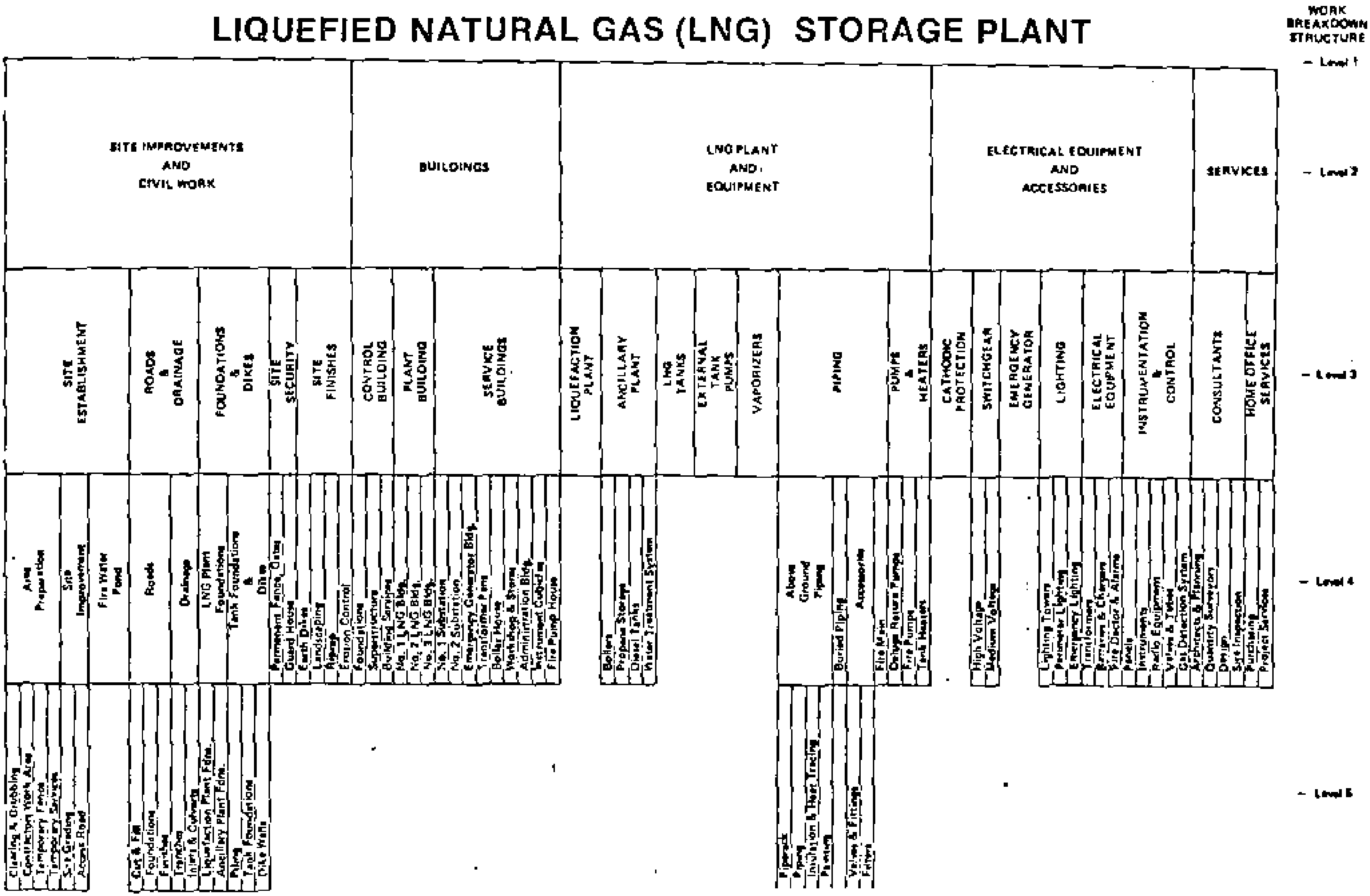
9. Intersecting yard piping systems.

10. Piling.

11. Supply and delivery of concrete to contractor's receptacle at grade elevation.

12. Intake structure construction.

LIQUEFIED NATURAL GAS (LNG) STORAGE PLANT

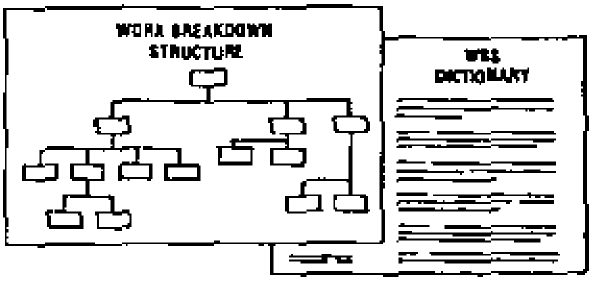


"MANAGING INDUSTRIAL PROJECTS" (MIPS)

WORK DEFINITION

Audio-Visual 79-751

WORK DEFINITION



WORK DEFINITION

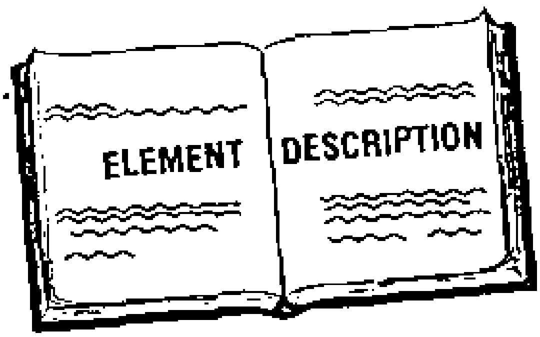
- ☑ PROVIDE A METHOD FOR ORGANIZING THE PROJECT WORK SCOPE
- ☑ PROVIDE AN EXAMPLE OF A 600 MW FOSSIL UNIT STRUCTURE

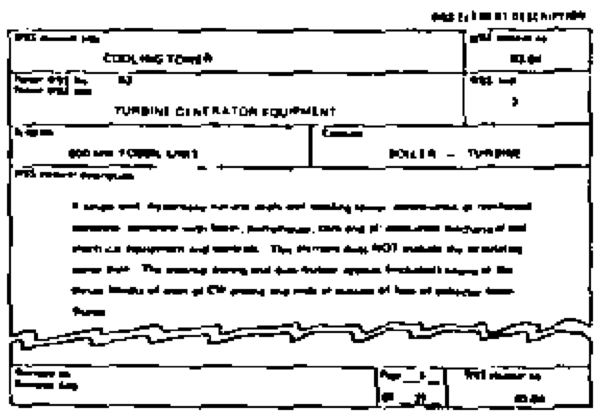
WORK BREAKDOWN STRUCTURE

IT IS:

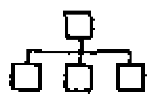
A PRODUCT-ORIENTED LOGICAL SUBDIVISION OF PLANT, EQUIPMENT, SERVICES AND OTHER TASKS THAT MAKE UP THE PROJECT.

WBS DICTIONARY

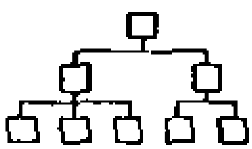




DIFFERENT WBS FOR EACH PHASE



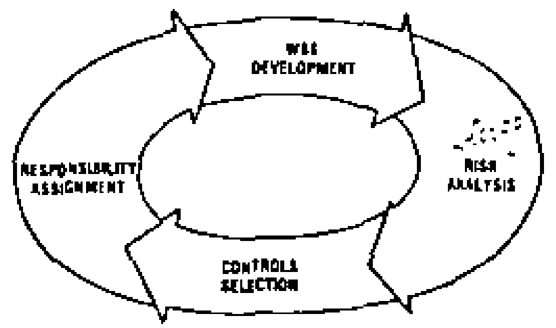
ENGINEERING DESIGN BY SYSTEM



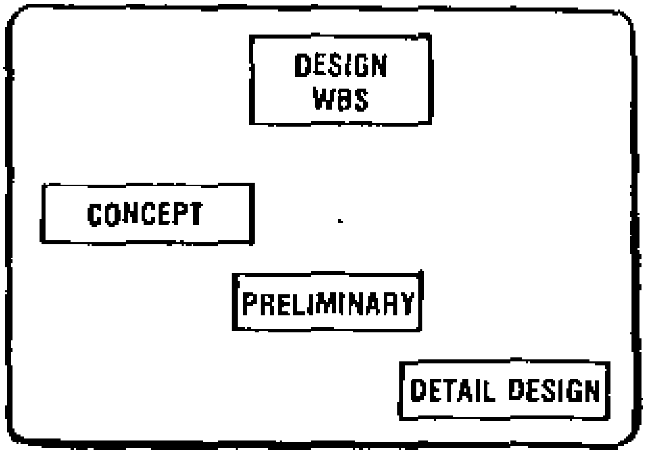
CONSTRUCTION BY DISCIPLINE OR AREA

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
WORK DEFINITION

Audio-Visual 79-751



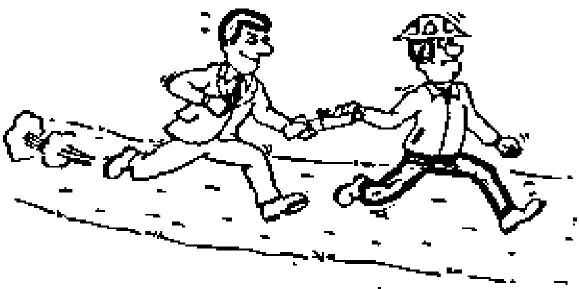
THE ITERATIVE PLANNING PROCESS



"MANAGING INDUSTRIAL PROJECTS" (MIPS)
WORK DEFINITION

Audio Visual 79-751

DESIGN-CONSTRUCTION INTERFACE



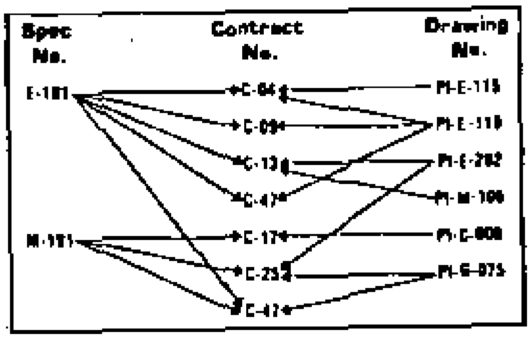
CONSTRUCTION PACKAGING

- PLANNED DIVISION OF THE WORK
- SCOPE DOCUMENTATION
- CONTRACTS OR INTERNAL PACKAGES (COLLECTION OF WBS ELEMENTS)

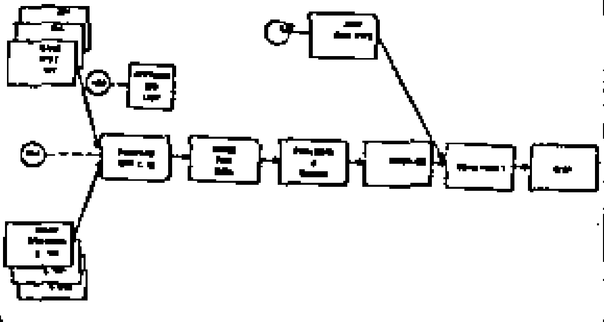
RESOURCE ANALYSIS

- TECHNICAL SPECIFICATIONS (BUILDING BLOCKS)
- DRAWINGS
- FBO MATERIAL & EQUIPMENT LISTS

PRODUCT — USER MAPPING



INTEGRATED SCHEDULING



600 MEGAWATT FOSSIL UNIT

RISK ANALYSIS

CASE PROBLEM #3

For the functions specified by the instructor, discuss the following items in your group:

1. Based upon your knowledge of or experience with the function, what issues are likely to be important regarding:

   a. Technical risks.

   b. Schedule risk.

   c. Cost risk.

2. Based upon these issues:

   a. What contracting form(s) are most likely desirable to the owner and why?

   b. What contracting form(s) are most likely desirable to the contractor and why?

   c. What level of supervision by the owner or construction manager would be needed and why?

   d. What factors are important for cost information and control:

      (1) for owner?

      (2) for contractor?

(STUDENT WORKSHEET)

CASE PROBLEM No. 3

RISK ANALYSIS AND SELECTIVE CONTROLS

RISK ITEM (& ASSUMPTIONS)	NUMBER	TYPE	LEVEL	REASON	POSSIBLE CONTROL TECHNIQUES: ORGANIZATION/RESPONSIBILITY	POSSIBLE CONTROL TECHNIQUES: CONTRACT TYPE/TERMS	POSSIBLE CONTROL TECHNIQUES: PROCEDURES
EXCAVATION FOR TURBINE BUILDING (Good subsurface data & design. Possibility of extra rock excavation. Very short construction season due to rains, freezing)	3	Technical Cost Schedule	Low Med. High	Good data, design, proven methods Contractor could encounter much rock & charge extras Short season, need to get foundations in for turbine bldg. erection	Choose large, capable site excavation contractor. Monitor with utilities. Civil superintendent and civil area engineer.	Consider bonus penalty clause in a Lump Sum contract with unit prices for adds and deducts. Require daily reporting of progress and weekly schedule updates. Allow cost for overtime at owner's request	Require comprehensive scheduling, equipment availability & reporting. Quantity excavated reports. Use surveyor for quantity determinations.
PLANT STARTUP & TEST (Begins 2 years prior to commercial operation)	140	Technical Cost Schedule	High High High	Sophisticated equipment, systems Potential for rework, maintenance & operations problems Potential for rework, delay of operation			
ERECTION OF TURBINE BLDG. CRANE (Done by structural steel erection contractor)	28	Technical Cost Schedule					
ELECTRICAL GROUNDING SYSTEM (Incomplete design due to problems with soil resistivity studies and changing code criteria)	48	Technical Cost Schedule	Med. High High	Grounding system changes "shouldn't" affect technical performance Changed work, rework, overtime are possible Delay in design could cause schedule problems			
TANK ERECTION FOR SITE FIRE PROTECTION SYSTEM (Firewater tanks. Needed immediately for construction fire protection safety)	27	Technical Cost Schedule					
SURVEYING (Includes plant layout, baselines and benchmarks, plant grid system, and surveying services for verification of quantities and contractors' lines & grades)	13	Technical Cost Schedule	High Low Low	Mistakes, errors would be disastrous Small price for increased safety work Takes little time			
CIRCULATING WATER SYSTEM (Good contractor, state of art design & materials, drawings and specifications will be ready in plenty of time for construction scheduling)	70	Technical Cost Schedule					

APPENDIX D

SELECTIVE PROJECT CONTROLS

One of the underlying concepts of the Construction Project Management System is the application of contract controls on a selective basis depending upon the risk associated with a specific contract and the type of service or product being provided.

Execution of the control approach should include a description, in each request for proposal (RFP), of the control and reporting requirements to which all contractors will be subjected. In addition, a specific risk analysis should be performed on each selected contractor prior to negotiation and signing of a written contract. Based upon the results of the risk analysis, a specific control program should be developed for the contractor and, where appropriate, the reporting and control requirements will be incorporated in the terms and conditions of the contract.

A general list of control techniques is provided below, along with a brief description of each. An overall Selective Control Profile, which is provided in Exhibit D-1, relates the various controls to the major types of contracts, services, and special conditions which may be encountered. This profile represents only a guideline and must be expanded and tailored as each specific situation is addressed. The various types of controls may be applied by an owner or his representative to all contractors or by a major contractor to subcontractors.

. Change Control. A program which keeps changes (contract, budget, schedule, etc.) to a minimum and insures that all potential changes are (1) recognized at the earliest possible point, (2) thoroughly evaluated in terms of cost, technical performance and schedule impact, and (3) approved or disapproved at the proper level in the organization.

. Schedule Control. A series of procedures and reports designed to provide early warning of potential delays in contract performance so that the cause of the delay can be properly evaluated and the necessary corrective action taken to keep the project on schedule.

. Retainage. A portion of the contract price may be withheld by the owner until the contractor has substantially completed his performance under the contract.

. Schedule Penalties/Incentives. Arrangements in the terms and conditions of a contract whereby financial incentives or penalties are applied to a contractor based upon demonstrated performance in meeting agreed-upon schedule dates. The objective is to apply special emphasis to the timely completion of tasks which are particularly critical to overall project timing.

. Work Packaging. A control technique which segments the project or contract into manageable units of work based on how the work is to be accomplished. Specific criteria include visibility, single responsibility, limited duration, and defined start and completion. The principal objective is to insure that contractors have a sound basis for evaluating the progress of their work and identifying variances and potential problems at an early point in the contract.

. Audit of Records. An independent and periodic review of the accounting and control records of a contractor, CM, A&E, consultant, etc. in order to insure that the work is being satisfactorily controlled and that reliance can be placed on invoices and other data submitted by these companies.

. Reporting Frequency. Relating status reporting frequency to the degree of risk inherent in a contract.

. Control of Personnel Assignments. Contractual agreement stipulating that the owner, or his representative, will approve the assignment and transfer of all key project personnel. This particularly applies to contracts where the experience of selected personnel is critical to the success of the project.

. Establishment and Audit of Reimbursable Contracts. The negotiation and contractual documentation of specific reimbursable costs for "cost plus" and "time and materials" contracts and the subsequent review of charges for conformance with contract terms and conditions.

. Control of Contractor Procurements. When the owner is required to reimburse the contractor for equipment and material which is procured by the contractor, the equipment specifications, vendor bids, delivery schedule, etc., should be reviewed to insure that the procurement cycle is performed in a cost-effective and efficient manner.

. Progress Payments Based on Performance Reports. In situations where physical progress is difficult to quantify, the contractor should support his percentage-of-completion estimate (basis of progress payment) through detailed performance reports. (Relates to work packaging controls discussed above.)

. Design to Cost. Costs at completion should be periodically reestimated during the design phase to insure that the project can be completed within planned costs.

. Verification of Reported Quantities. On contracts involving unit pricing, all reported quantities should be verified prior to approval of submitted invoices.

. Review of Contractor Systems. Contractor accounting and project control systems should be reviewed and evaluated for adequacy of controls and ability to satisfy the owner's information requirements. Any needed enhancements should be incorporated by the contractor.

. Early Quotes/Purchase Orders. Quotes and, where possible, early commitments should be obtained for long lead and escalation sensitive materials and equipment as soon as their requirements can be determined. The objective is to obtain early cost visibility and minimize the cost impact of inflation.

. Special Escalation Reporting. For contracts involving escalation reimbursement, resource trend reports and other techniques should be utilized to monitor the escalation rate of selected resources and establish a forecasted cost at completion.

. Engineering and Configuration Controls. A program to maintain design integrity over the life of the project. This includes, but is not limited to, reviewing design and engineering output for conformance to original concepts and insuring that all engineering documentation ultimately reflects the "as built" status.

. Report Staffing Level vs. Plan. For nonfixed-price contracts, particularly where a high degree level of effort work is involved, the contractor should be required to periodically report actual staffing levels in comparison to planned levels.

. Report Spending Rate vs. Plan. This is similar to the staffing level reporting and encompasses all resources being expended.

. On-Site Expediting. The owner may provide on-site expediting of contractors or vendors at remote locations to help insure timely availability of required equipment. This would particularly apply to equipment which is highly developmental in nature or where there is limited capacity for manufacturing the product.

. Analyze Rate Variance. On cost-reimbursable contracts, billed rates should be compared to standard rates and all variances analyzed for cause.

. Progress Narrative. The contractor should be required to submit detailed progress narratives with particular emphasis on potential problem areas and suggested solutions.

. Equipment Scheduling. Detailed schedules should be maintained for the procurement and receipt of materials and equipment which can cause delays in construction progress. The schedule should include development of specifications, specification approval, issuance of RFP, purchase order release, and delivery to the job site.

. Progress Photographs. Periodic photographs should be taken of in-process construction to support status reports and visually portray specific problem areas.

. Detailed Test Records. Detailed records of all technical and performance tests will be maintained as a record of contractor and vendor performance and for review by the owner prior to final acceptance.

. Drawing Approval. Before drawings and specifications are released for use by construction and estimating personnel, the owner or his representative should review and approve them to insure that original design integrity has been maintained.

. Progress Meetings. Periodic presentations should be made by contractors, construction managers, etc., to the owner management to describe project status and discuss potential problem areas.

CONSTRUCTION PROJECT MANAGEMENT SYSTEM
SELECTIVE CONTROL PROFILE

	CHANGE CONTROLS	SCHEDULE CONTROL	RETAINAGE	SCHEDULE PENALTIES	WORK PACKAGING: MAINTAINED BY CONTRACTOR	WORK PACKAGING: MAINTAINED BY OWNER	AUDIT OF RECORDS	REPORTING FREQUENCY	CONTROL OF SUBCONTRACT ASSIGNMENTS	ESTABLISHMENT OF REIMBURSABLE COSTS	CONTROL OF CONTRACTOR PROCUREMENTS	PROGRESS PAYMENTS BASED ON PERCENT COMPLETE	DESIGN TO COST PROGRAM	VERIFICATION OF REPORTED QUANTITIES	REVIEW CONTRACTOR SYSTEM: COST
CONTRACT TYPE															
TIME & MATERIALS	X	X	X			X	X	B	X	X	X	-	X	X	X
COST PLUS INCENTIVE FEE	X	X	X		-	X	X	B	X	X	X	-	X	X	X
COST PLUS FIXED FEE	X	X	X		-	X	X	B	X	X	X	-	X	X	X
FIXED PRICE LUMP SUM	X	X	X	-	-	-	-	A	-	-	-	X	X	-	X
FIXED UNIT PRICE	X	X	X	-		-	-	A	-	-		X	X	X	X
FIXED PRICE WITH ESCALATION	X	X	X	-	X	-	X	A	-	X	X	X	X	X	X
FIXED PRICE WITH INCENTIVE	X	X	X	-	X	-	X	A		-		X	X	-	X
TYPE OF SERVICE															
DESIGN & ENGINEERING	X	X	X		X	-	-	A	X	-	-	-	X		X
CONSTRUCTION MANAGEMENT	X	X	X		-	-	-	A	X	-		-	X	-	X
GENERAL CONSTRUCTION	X	X	X	-	-	-	-	A	-	-		X	X	X	X
MATERIAL & EQUIPMENT PURCHASES	X	X	Variable	-	-	-	-	-	-	-	-	-	X	-	
EQUIPMENT MANUFACTURE	X	X	X		X	-	X	A	-	-		X	X	-	X
EQUIPMENT TEST AND INSTALLATION	X	X	X	-	X	-	X	A	-	-	-	X	X	-	X
SPECIAL CONDITIONS															
STATE OF ART ACTIVITIES	X	X	X	-		X	-	B	X	-	-	-	X	-	X
CONTRACTS WITH POTENTIAL FOR DELAYING PROJECT	X	X	X	X		X	-	B	-	-	-	-	X	-	X
INEXPERIENCED CONTRACTOR	X	X	X	-	X	-	X	B	-	-	-	X	X	X	X
LONG TERM CONTRACT	X	X	X	-	X	-	-	-	-	-	-	X	X	-	X

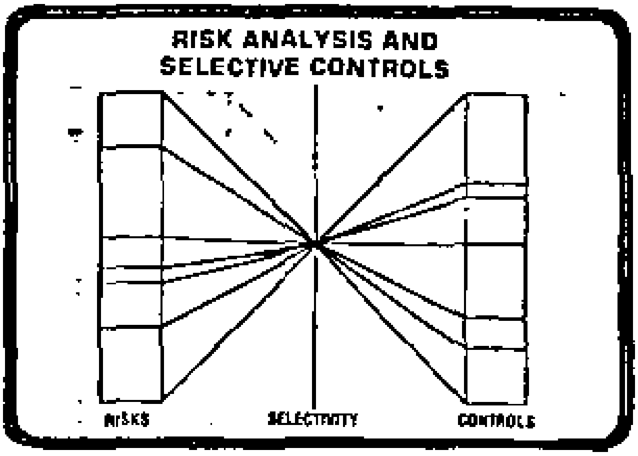
	REVIEW CONTRACTOR SYSTEM: SCHEDULE	EARLY QUOTES P.O.'S	SPECIAL ESCALATION REPORTING	ENGINEERING & CONFIGURATION CONTROLS	REPORT STAFFING LEVEL VS PLAN	REPORT SPREAD RATE VS PLAN	ON-SITE EXPEDITING	ANALYZE RATE VARIANCES	REPORTS & NARRATIVE	DETAILED EQUIPMENT SCHEDULING: CONTRACTOR	DETAILED EQUIPMENT SCHEDULING: OWNER	PROGRESS PHOTOGRAPHS	DETAILED TEST RECORDS	DRAWING APPROVAL	PROGRESS MEETINGS
CONTRACT TYPE															
TIME & MATERIALS	X	-	X		X	X	-	X	X	-	-	-	-	-	X
COST PLUS INCENTIVE FEE	X	-	X	-	X	X	-	X	X	-	-	-	-	-	X
COST PLUS FIXED FEE	X	-	X	-	X	X	-	X	X	-	-	-	-	-	X
FIXED PRICE LUMP SUM	X	-	-	-	-	-	-	-	X	-	-	-	-	-	X
FIXED UNIT PRICE	X	-	-		-	-		-	X	-	-	-	-	-	X
FIXED PRICE WITH ESCALATION	X	X	X	-		-		-	X	-	-	-	-	-	X
FIXED PRICE WITH INCENTIVE	X	-		-	-			-	X	-	-	-	-	-	X
TYPE OF SERVICE															
DESIGN & ENGINEERING	X	-	-	X	X	X		X	X	-	-	-	-	X	X
CONSTRUCTION MANAGEMENT	X	-	-	-	X	X	-	X	X	-	-	-	X	-	X
GENERAL CONSTRUCTION	X	-	-	-	-	-		-	X	X	-	X	X	-	X
MATERIAL & EQUIPMENT PURCHASES		X	-	-	-	-	X	-	X	-	X	-	X	-	X
EQUIPMENT MANUFACTURE	-	X	-	X	-	-	X	-	X	X	X	X	X	-	X
EQUIPMENT TEST AND INSTALLATION	X	-	-	-	-	-	-	-	X	-	-	X	X	-	X
SPECIAL CONDITIONS															
STATE OF ART ACTIVITIES	X	-	-	X	-	-	X	-	X	-	-	X	X	-	X
CONTRACTS WITH POTENTIAL FOR DELAYING PROJECT	X	-	-		-	-	X	-	X	X	X	-	-	-	X
INEXPERIENCED CONTRACTOR	X	-	-	-	-	-	-	-	X	-	-	-	-	-	X
LONG TERM CONTRACT	X	-	-	-	-	-	-	-	X	-	-	-	-	-	X

A - MONTHLY

B - WEEKLY, BIWEEKLY, ETC.

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
RISK ANALYSIS AND SELECTIVE CONTROLS

Audio-Visual 79-751



RISK ANALYSIS AND SELECTIVE CONTROLS

- ☑ PROVIDE AN APPROACH FOR HOW AND WHEN TO EVALUATE RISKS
- ☑ EXPLAIN RELATIONSHIP AMONG RISK ANALYSIS, CONTROLS AND WBS
- ☑ CONSIDER NEED FOR A MORE FORMAL RISK ANALYSIS PROCESS

TYPES OF RISK

TECHNICAL

IT WON'T WORK!

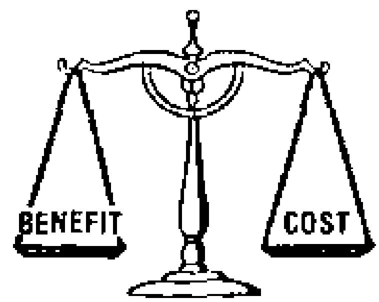
SCHEDULE

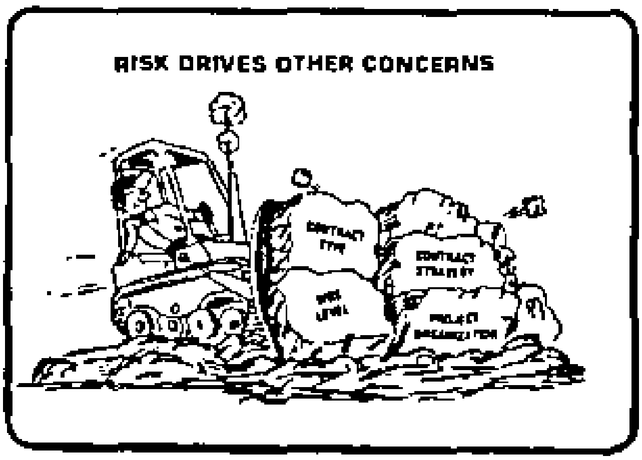
IT'S LATE!

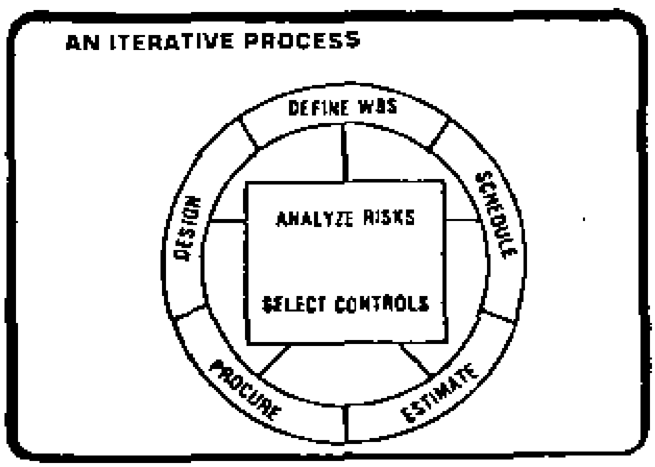
COST

TOO MUCH!

BALANCE COST WITH BENEFIT



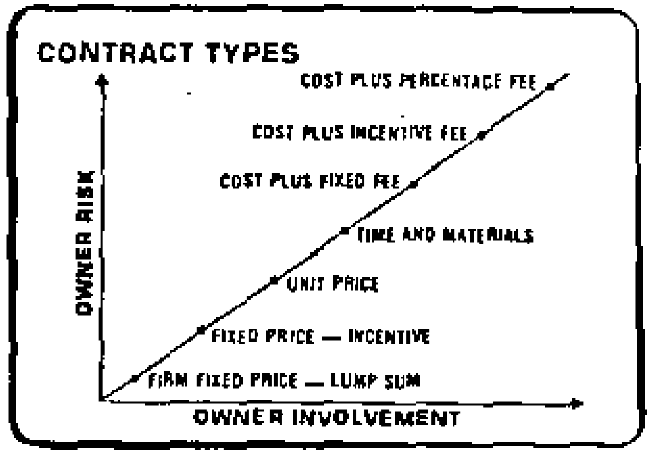


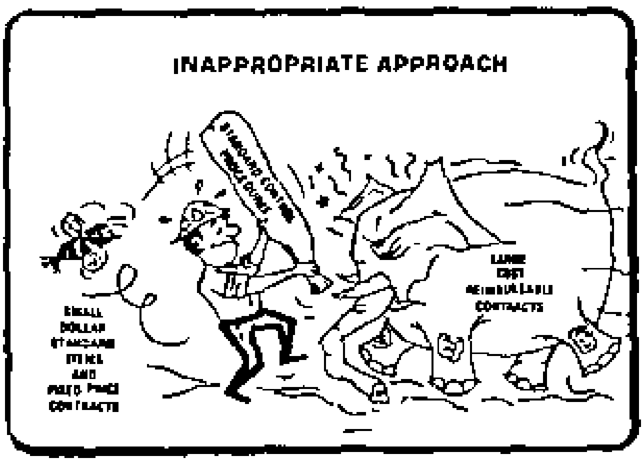


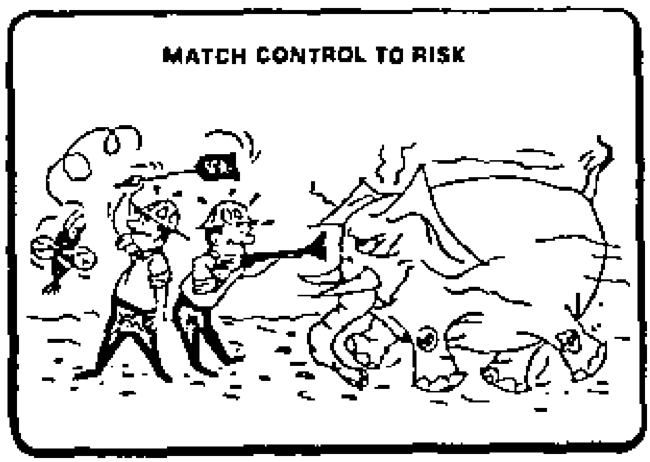
"MANAGING INDUSTRIAL PROJECTS" (MIPS)

RISK ANALYSIS AND SELECTIVE CONTROLS

Audio-Visual 79-751







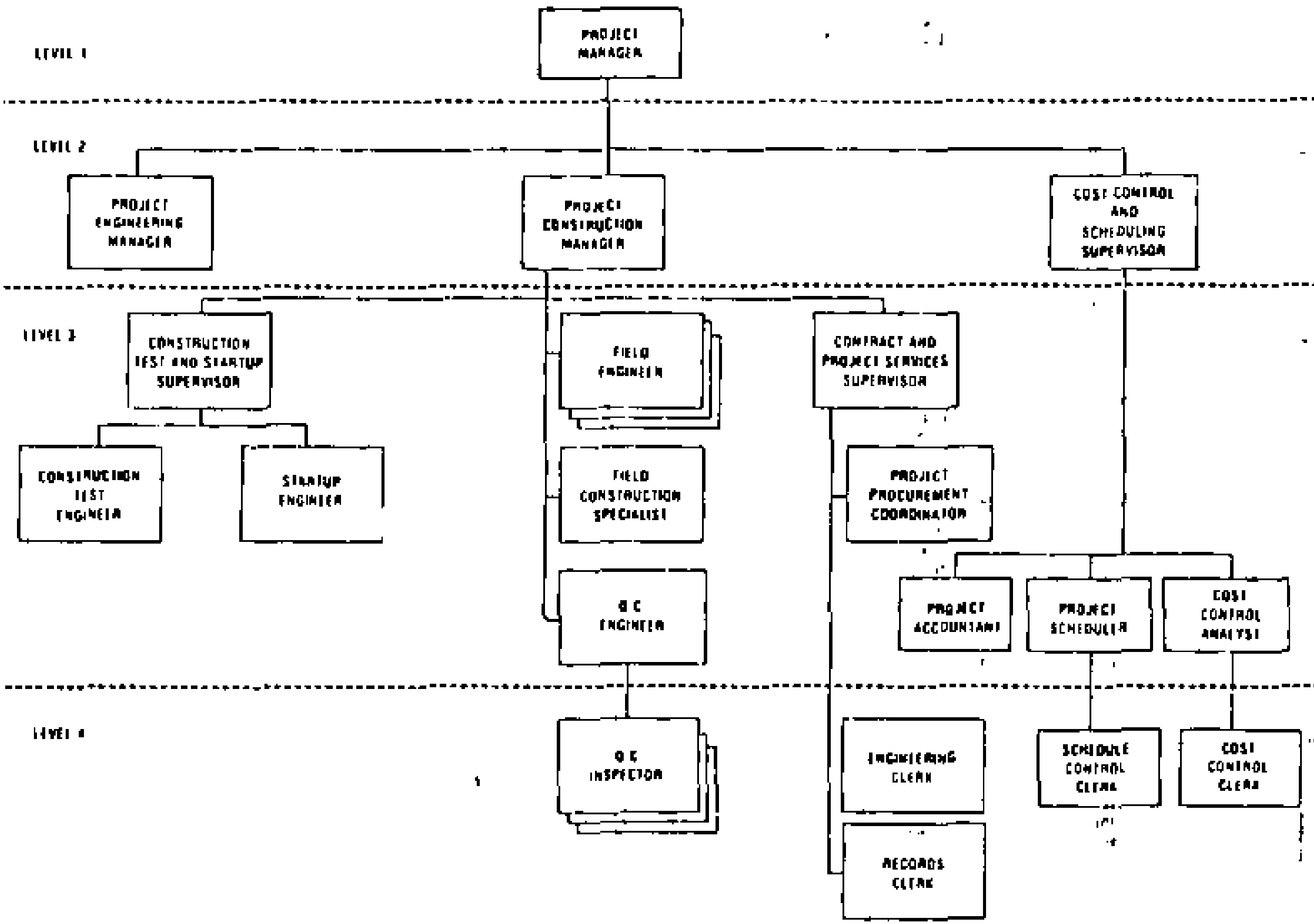
SELECTIVE CONTROLS

- POLICIES AND PROCEDURES
- CONTRACT TYPES
- CONTRACT TERMS

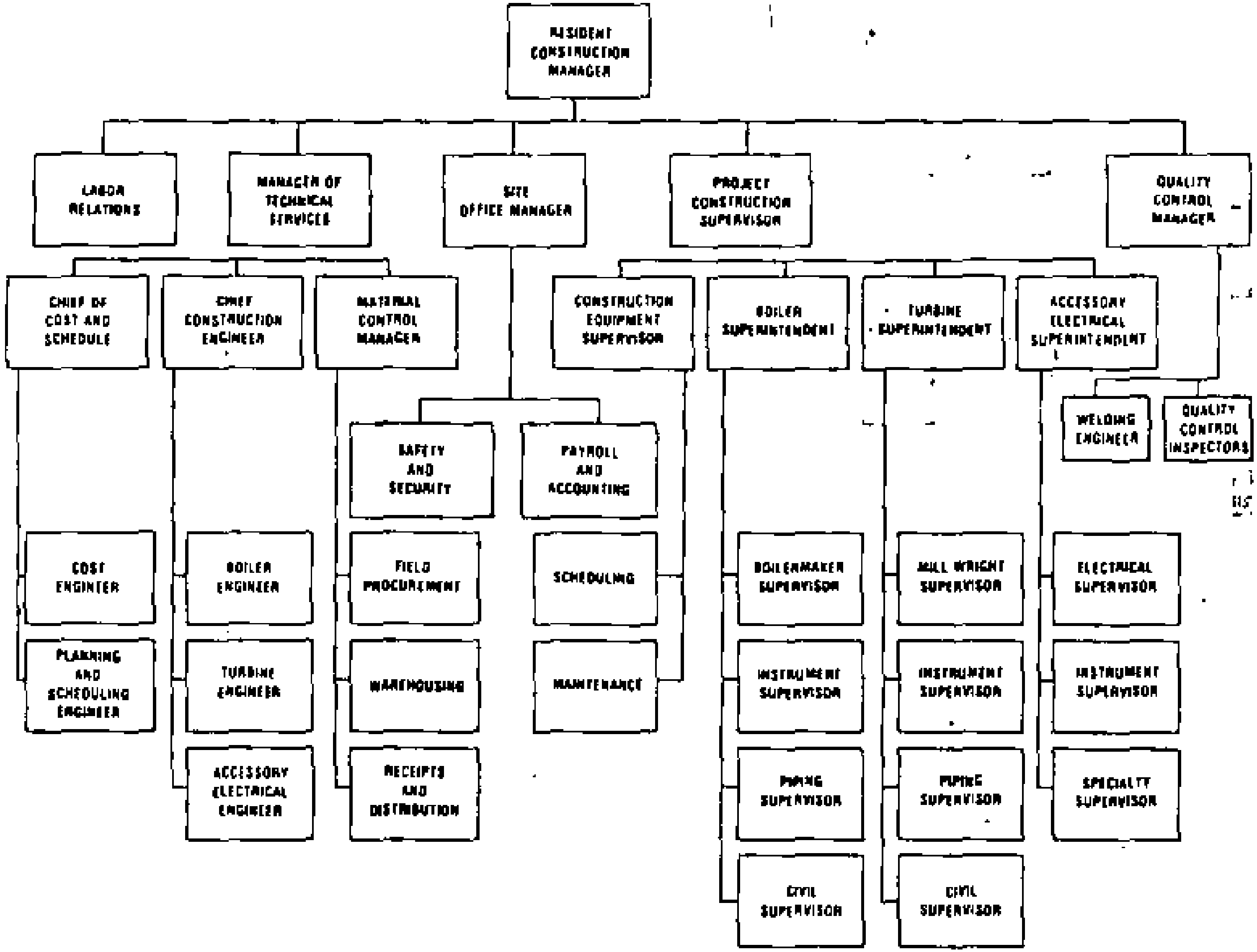
SOLUTION
CASE PROBLEM No. 3
RISK ANALYSIS AND SELECTIVE CONTROLS

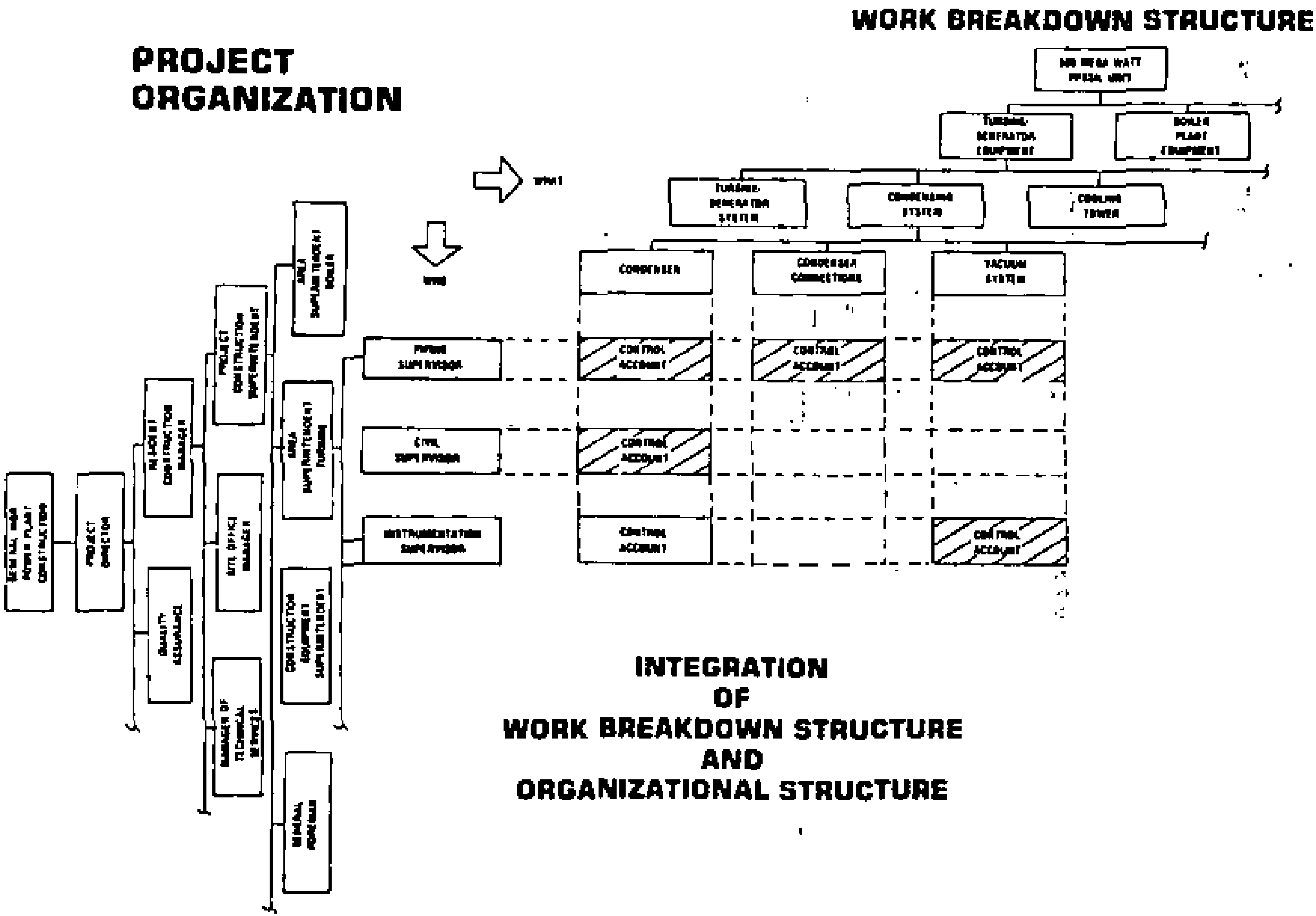
RISK ITEM (& ASSUMPTIONS)	NUMBER	TYPE	LEVEL	REASON	POSSIBLE CONTROL TECHNIQUES		
					ORGANIZATION/RESPONSIBILITY	CONTRACT TYPE/TERMS	PROCEDURES
EXCAVATION FOR TURBINE BUILDING (Good subsurface data & design. Possibility of extra rock excavation. Very short construction season due to rains, freezing)	3	Technical Cost Schedule	Low Med. High	Good data, design, proven methods Contractor could encounter much rock & charge extras Short season, need to get foundations in for turbine bldg. erection	Choose large, capable excavation contractor. Monitor with utilities Civil superintendent and civil area engineers.	Consider bonus penalty clause to a Lump Sum contract with unit prices for adds and deducts. Require daily reporting of progress and weekly schedule updates. Allow cost for overtime at owner's request	Require comprehensive scheduling, equipment availability & reporting. Quantity excavated reports. Use surveys for quantity determinations.
PLANT STARTUP & TEST (Begins 2 years prior to commercial operation)	140	Technical Cost Schedule	High High High	Sophisticated equipment, systems Potential for rework, maintenance & operations problems Potential for rework, delay of operation	Use composite forces on cost-plus basis, integrated with utility's operations team. Appoint experienced startup manager.	Cost-plus for contractors' furnishing craft manpower. Right to audit records. Pay premium differential for shift and overtime work. Right to reject contractor employees.	Start up and turnover procedures. Tagging procedures. Test procedures. Startup schedule. Progress reporting by system & area.
ERECTION OF TURBINE BLDG. CRANE (Done by structural steel erection contractor)	26	Technical Cost Schedule	Low Low Med.	Simple erection process Low cost, not subject to changes Must rely on crane vendor to ship. Late delivery slows turbine bldg. erection.	Monitor by structural supervisor.	Lump Sum or Unit Prices. Separate standby – mobilize – demobilize prices for heavy lifting equipment.	Expedite crane vendor. Schedule structural steel to detailed level.
ELECTRICAL GROUNDING SYSTEM (Incomplete design due to problems with soil resistivity studies and changing code criteria)	46	Technical Cost Schedule	Med. High High	Grounding system changes "shouldn't" affect technical performance Changed work, rework, overtime are possible Delay in design could cause schedule problems	Split into 2 contracts – No. 1 for early "site" electrical contractor for subsurface grounding – No. 2 for internal plant grounding for larger electrical contract later.	Cost-plus with incentive, or unit price additions for grounding work on an otherwise lump sum contract.	Quantity installed reports for unit prices. Audit charges for cost plus. Schedule Electrical Design work & monitor performance.
TANK ERECTION FOR SITE FIRE PROTECTION SYSTEM (Two water tanks. Needed immediately for construction fire protection safety)	27	Technical Cost Schedule	Low Low High	Simple water tank Price not subject to change much Necessary for construction to begin	Single furnish & erect contractor. Performance monitored by structural supervisor.	Lump Sum fixed price. Progress payments, retention. Furnish and erect combined in one contract.	Schedule furnished & updated by contractor. Daily progress reporting. Schedule water source alternatives.
SURVEYING (Includes plant layout, baselines and benchmarks, plant grid system, and surveying services for verification of quantities and contractors' lines & grades)	13	Technical Cost Schedule	High Low Low	Mistakes, errors could be disastrous Small price for increased survey work Takes little time	Contract highly reputable surveying company. Monitor by civil supervisor and civil/structural area engineers.	Cost plus fixed fee. Sign time sheets and agree to rates for personnel & equipment. Require performance reports and records. Specify independent review of calculations, work.	Require Quality Control procedures for surveying & independent checks by civil area engineers. Require layout drawings and notes for records.
CIRCULATING WATER SYSTEM (Good contractor, state of art design & materials, drawings and specifications will be ready in plenty of time for construction scheduling)	70	Technical Cost Schedule	High Med. Low	New design, materials Large cost item, buried piping – costly to rework Time permits comfortable schedule	Use large piping contractor and have him appoint a superintendent for CCW piping.	Fixed price with escalation. Independent testing agency. Retention. Warranty if possible.	Have Q.C. plan for CCW piping. Progress reports for inspections. Testing at vendor's shop and in field.

SAMPLE ORGANIZATION STRUCTURE



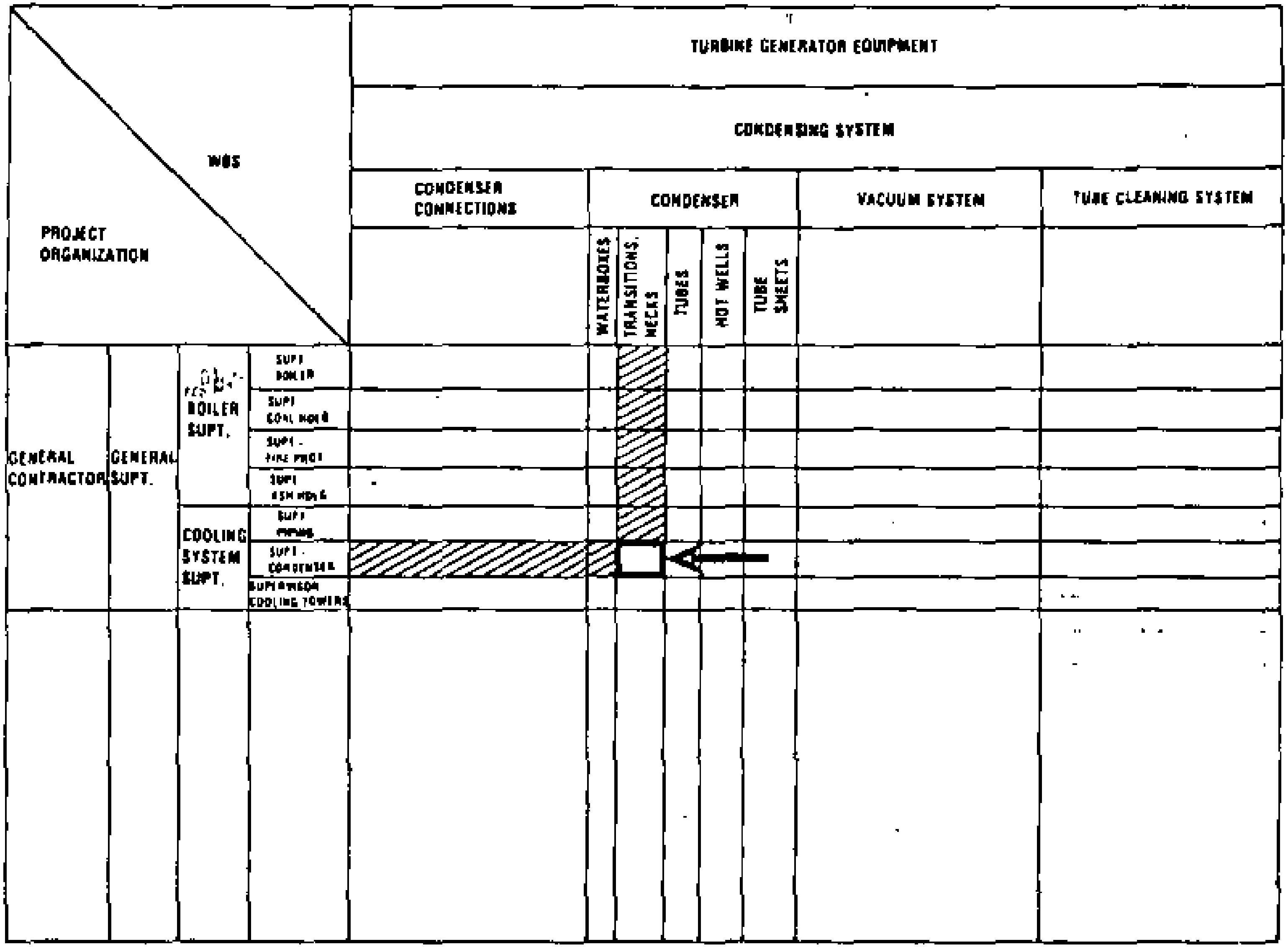
SAMPLE ORGANIZATION STRUCTURE





INTEGRATION OF WORK BREAKDOWN STRUCTURE AND ORGANIZATIONAL STRUCTURE

CONTROL ACCOUNT EXAMPLE #1



CONTROL ACCOUNT EXAMPLE #2

WBS / PROJECT ORGANIZATION				TURBINE GENERATOR EQUIPMENT			
				CONDENSING SYSTEM			
				CONDENSER CONNECTIONS	CONDENSER	VACUUM SYSTEM	TUBE CLEANING SYSTEM
GENERAL CONTRACTOR	GENERAL SUPT.	BOILER SUPT.					
		COOLING SYSTEM SUPT.					

CONTROL ACCOUNT EXAMPLE #3

WBS / PROJECT ORGANIZATION				TURBINE GENERATOR EQUIPMENT			
				CONDENSING SYSTEM			
				CONDENSER CONNECTIONS	CONDENSER	VACUUM SYSTEM	TUBE CLEANING SYSTEM
GENERAL CONTRACTOR	GEN SUPT	BOILER SUPT.	BOILER SUPT				
			SUPT COAL HDLG				
			SUPT FIRE PROTECT				
			SUPT ASH HDLG				
		COOLING SYSTEM SUPT.	SUPT PIPING				
			SUPT CONDENSER				
			SUPT COOL TOWERS				

CONTROL ACCOUNT EXAMPLE #4

PROJECT ORGANIZATION \ WBS				TURBINE GENERATOR EQUIPMENT			
				CONDENSING SYSTEM			
				CONDENSER CONNECTIONS	CONDENSER	VACUUM SYSTEM	TUBE CLEANING SYSTEM
GEN. CONTRACTOR	GEN. SUPT.	BOILER SUPT.	SUPT BOILER				
			SUPT COAL HDLG				
			SUPT FIRE PROT				
			SUPT ASH HDLG				
		COOLING SYSTEM SUPT.	SUPT PIPING				
			SUPT CONDENSER				
			SUPT COOL TOWERS				

600 Megawatt Fossil Unit

CONTROL ACCOUNT ESTABLISHMENT
CASE PROBLEM #4

The Utility Power & Light Company wants to begin construction of its 600 Megawatt Fossil Unit in February of 1980. Mr. J. Wagner was appointed the Project Director. Mr. Wagner wanted to assure that his project organization would be structured to manage effectively, so he wanted to establish responsibilities for the work he had already broken down into manageable subdivisions using his Work Breakdown Structure (WBS). The next step was to integrate his organization with the WBS to identify Control Accounts. Wagner recognized the excellent job that the special WBS team had done in its first assignment and felt that the familiarity with the WBS would help them in the next task of recommending the control accounts for the Project.

PROBLEM

Your team is to prepare a recommended set of control accounts for the construction project. Using the Control Account Matrix (Attachment 1) which indicates those intersections of the matrix where work has been identified to an organization, determine your recommended control accounts by blocking the "X" patterns horizontally and/or vertically. "X's" may also be consolidated by moving some to include them with others. Use arrows to indicate this type of grouping. Be prepared to justify each recommendation from the point of view of:

(1) degree of management control (both product and organizational levels), considering cost, schedule and technical criticality of the WBS elements; and

(2) level of reporting detail.

Use the "Scope of Work Assumptions" and "Factors to Consider When Developing a Control Account Matrix."

600 Megawatt Fossil Unit

CASE PROBLEM #4

FACTORS TO CONSIDER WHEN DEVELOPING A CONTROL ACCOUNT MATRIX

When developing a matrix, a number of factors must be considered. The list below, stated in terms of questions and factors, should be considered.

1. Does the proposed WBS provide a home for every charge activity on the project, and does it minimize the difficulty with which identification can be made?

2. Are elements appearing at the same level of the WBS approximately equal in magnitude in terms of management interest? Management interest is defined in terms of technical complexity, cost and schedule importance.

3. Does each element represent an aggregation of all the subordinate elements below it?

4. Can all of the items appearing on the WBS be indentified to a schedule?

5. Can cost be easily identified to an individual Control Account without allocation to two or more Control Accounts? Can costs be collected and summarized upward without bypassing lower-level elements?

6. Will the integration of the lowest level of the WBS with the project organization produce control accounts that are not too small; i.e., the administration cost is not justified by the control gained?

7. Some activities occur in many hardware elements of the WBS. Are these activities significant enough to warrant being identified as specific elements?

8. Can significant contractor and contracted effort be identified on the matrix?

WBS MATRIX - 600 MW FOSSIL PLANT

"SCOPE OF WORK" ASSUMPTIONS:

1. Excavation (fixed price, lump sum)

   a. The following systems are constructed with foundations <u>included</u> in the contract (i.e., general excavation contractor does not excavate):

      . Railroad System
      . Ponds, Intake, Discharge
      . Precipitator
      . Coal Handling System
      . Cooling Towers
      . Circulating Water System

   b. Excavation Contractor does not excavate trenches or dewater.

2. Site Services (cost plus a percentage)

   a. This is a general contractor present at site for most of the project. He does site preparation and services and general pickup work, much of which is cost-plus. Includes dewatering if required. He is a good candidate for excavation on some systems in 1.a. above as a subcontractor. Installs fencing, gates, construction facilities, etc.

3. Surveyor (time and material)

   a. Hired by the owner to lay out plant grid system, baselines and benchmarks, and verify locations and elevations, quantities, etc., of contractors' and force account work.

4. Foundation Contractor (assume no piling required) (fixed price, lump sum)

   a. Same comment as 1.a.; applies to foundations.

   b. Basically a concrete and rebar placer with some embedded work.

   c. Installs turbine pedestal.

5. Structural Steel Vendor (unit price with escalation)

   a. Only supplies steel - no erection.

6. Superstructure Contractor (combination lump sum and unit price)

   a. Responsible for exterior walls, masonry, siding, decks, strairs, roofing, etc.

   b. Erects structural steel.

7. Coal Handling Contractor (fixed price, lump sum)

   a. Furnishes and installs complete system except for large equipment (pulverizers, crushers, etc.).

8. Field-Erected Tanks Contractor (fixed price, lump sum)

   a. Furnishes and installs large tanks (i.e., firewater storage, fuel oil storage).

9. Cooling Tower Contractor (fixed price with escalation)

   a. Under direction of "Supervisor - Towers."

   b. Complete "foundation-up" responsibility.

10. Electrical Contractors #1 and #2

   a. #1 appears early in construction period. Handles construction power, temporary electrical work, and yard grounding system. He is a candidate for subcontracting to do electrical work for early contractors. Cost plus a percentage.

   b. #2 arrives later and basically does all electrical work (huge contract, much of it unit price, i.e., $/ft. of cable, $/ft. of tray, $/termination, etc.).

11. Mechanical Equipment (cost plus a fixed fee)

   a. Mechanical Supterintendent #1 handles early, light service equipment (building HVAC, sewage treatment facility, etc.).

   b. Mechanical Superintendent #2 handles later, heavy equipment erection (turbines, large pumps and motors, etc.).

12. Insulation Contractor (fixed unit price)

   a. Insulates generally all buildings, piping and equipment.

   b. Does not install turbine-generator lagging, or precipitator insulation.

13. Painting Contractor

   a. Paints all buildings (outside) and some equipment and piping, including required touch-up.

   b. Basically unit price or T & M contract.

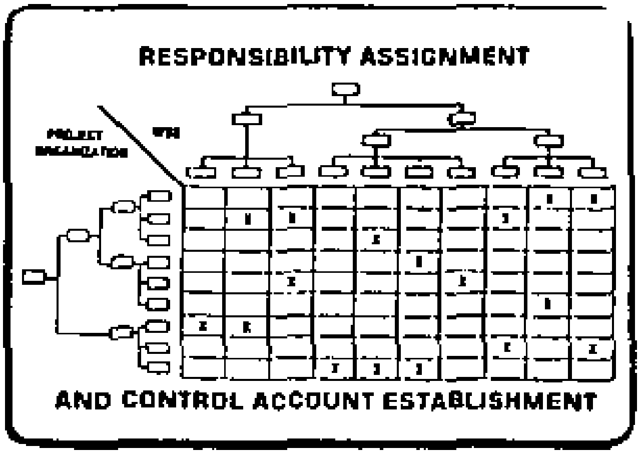
14. Interior Architectural Finishes Contractor (combination fixed price, lump sum and unit prices)

   a. Furnishes and installs floor coverings, interior partitions, doors, suspended ceilings; paints building interiors; etc.

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

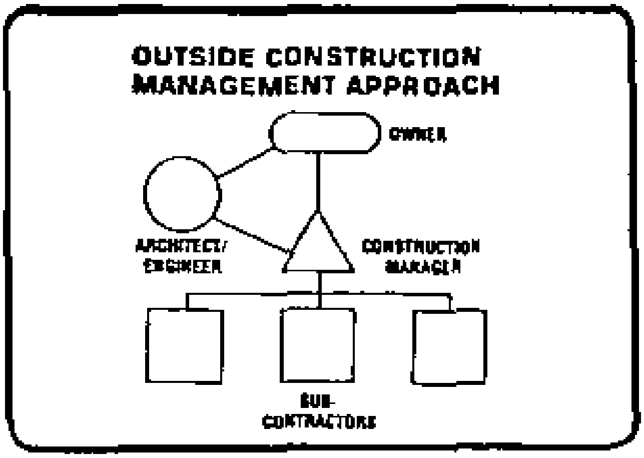
RESPONSIBILITY ASSIGNMENT AND CONTROL ACCOUNT ESTABLISHMENT

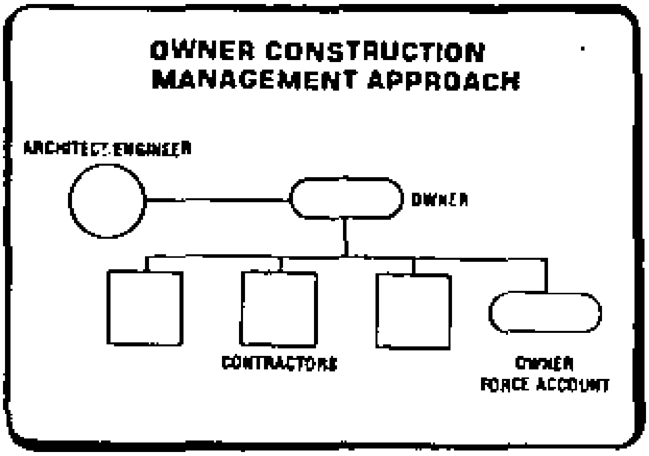
Audio-Visual 79-751

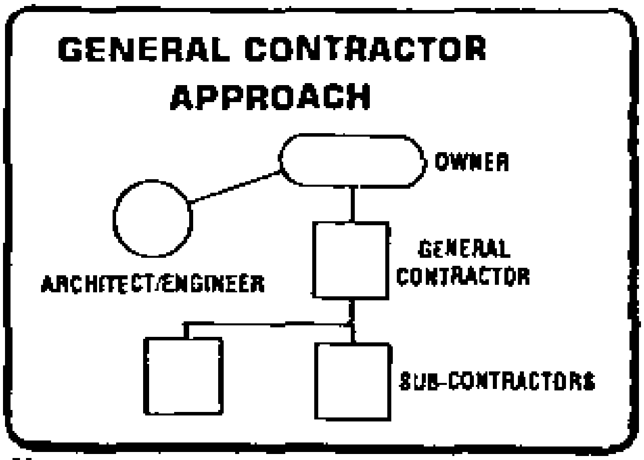


RESPONSIBILITY ASSIGNMENT

- ☑ REVIEW KEY CONSIDERATIONS IN THE ESTABLISHMENT OF PROJECT CONTROL RESPONSIBILITY
- ☑ PROVIDE THE MEANS TO ESTABLISH COST AND SCHEDULE PERFORMANCE MEASUREMENT RESPONSIBILITY — THE CONTROL ACCOUNT





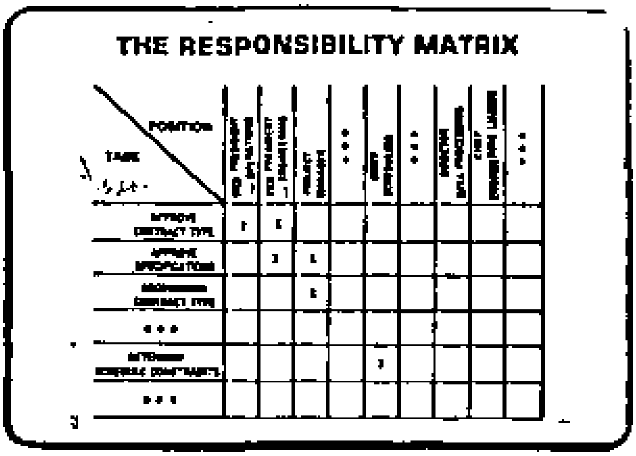


RESPONSIBILITY MUST BE CLEARLY DEFINED

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

RESPONSIBILITY ASSIGNMENT AND CONTROL ACCOUNT ESTABLISHMENT

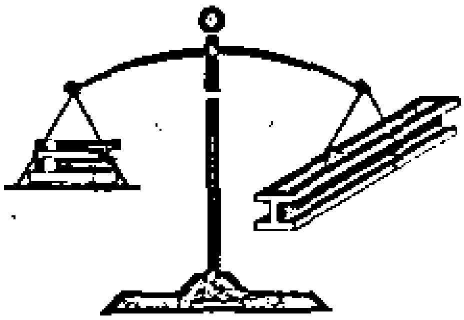
Audio-Visual 79-751



"MANAGING INDUSTRIAL PROJECTS" (MIPS)
CONTRACT ADMINISTRATION

Audio-Visual 79-751

CONTRACT ADMINISTRATION



CONTRACT ADMINISTRATION

- ☐ Introduce Terms & Define Relationships
- ☐ Review the Contract Formation Process
- ☐ Describe the Elements of Contract Administration
- ☐ Discuss Organizational & Implementation Approach

CONSTRUCTION CONTRACTS

Contracts Under Which Job-Site Labor Is Expended As Part of the Scope of Performance

- FURNISH ONLY } Purchases/Vendors
- FURNISH & ERECT
- LABOR ONLY

} Contracts/Contractors

CONSTRUCTION ORGANIZATIONAL/CONTRACTUAL APPROACHES

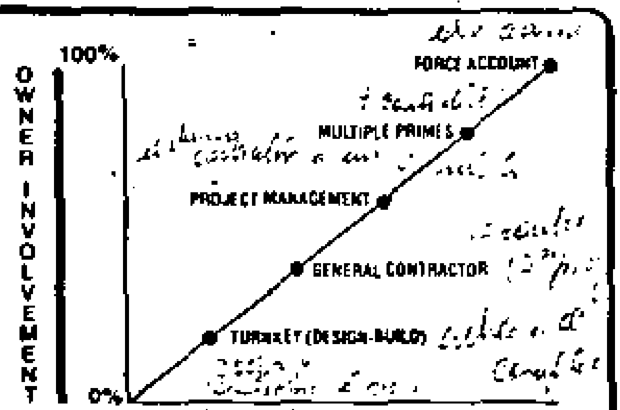
A. DESIGN-BUILD (TURNKEY)

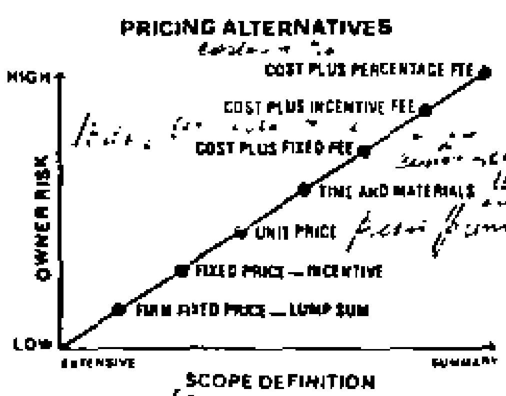
B. GENERAL CONTRACTOR

C. PROJECT MANAGEMENT

D. MULTIPLE PRIMES

E. IN-HOUSE (FORCE ACCOUNT)





"MANAGING INDUSTRIAL PROJECTS" (MIPS)
CONTRACT ADMINISTRATION

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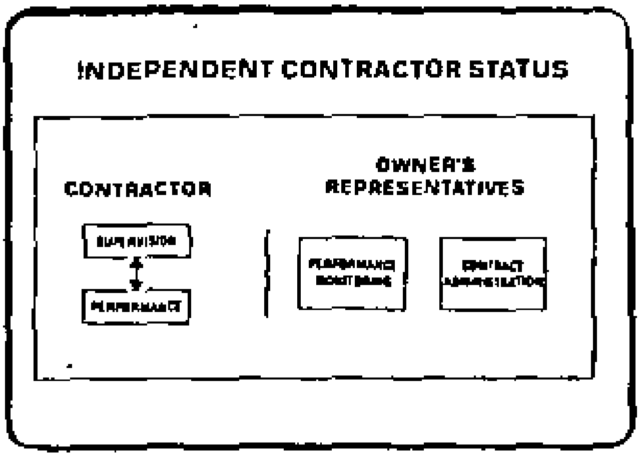

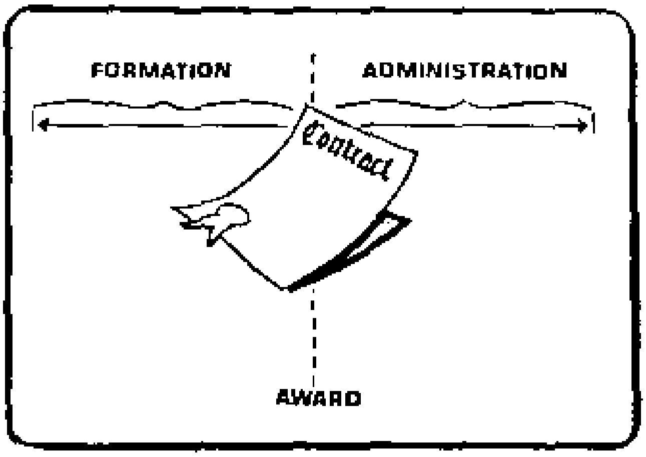

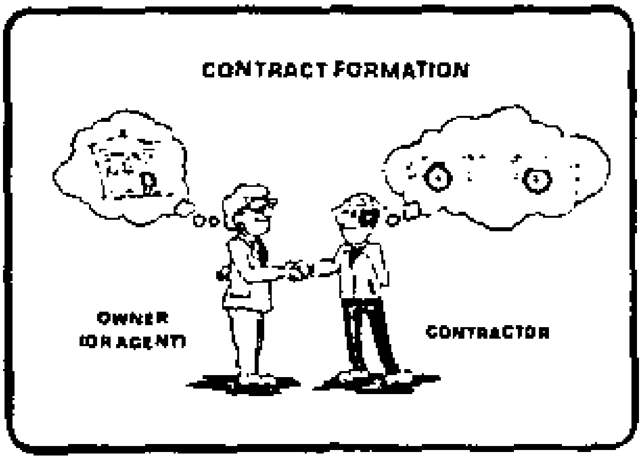

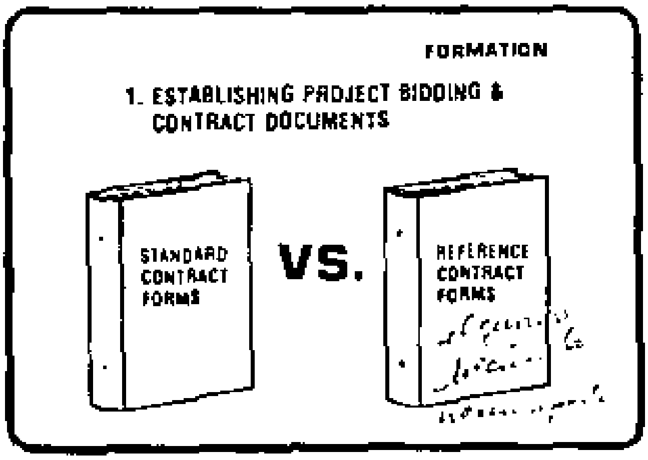

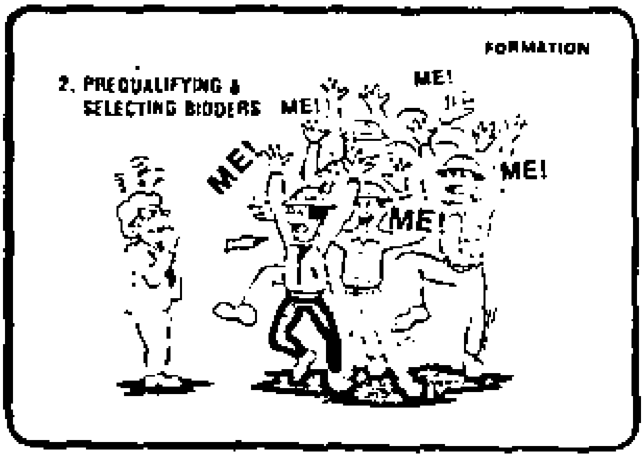

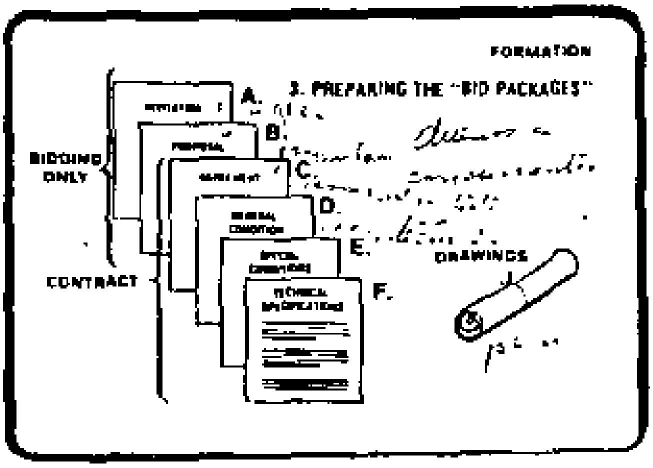

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

CONTRACT ADMINISTRATION

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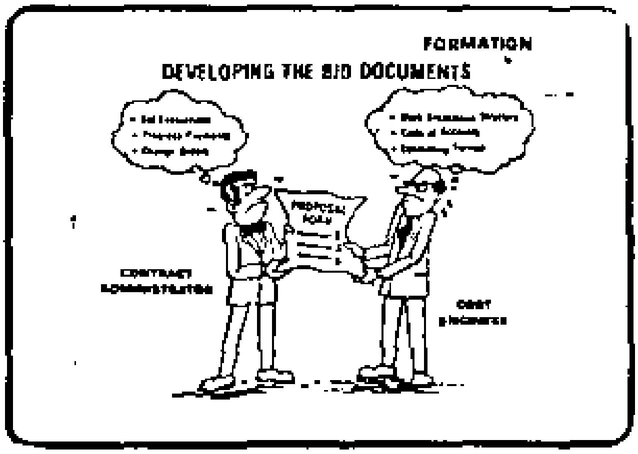

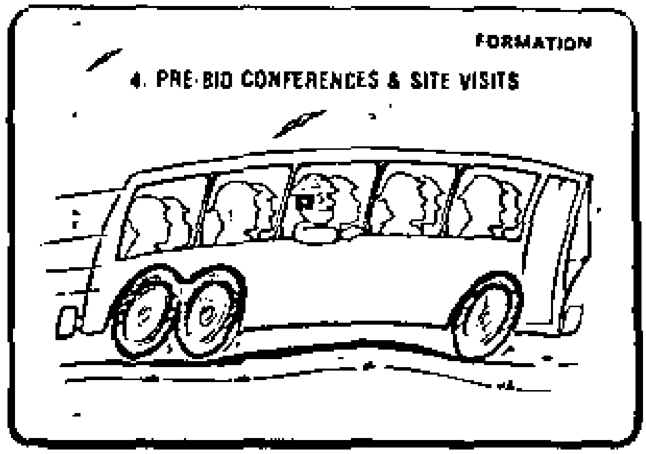

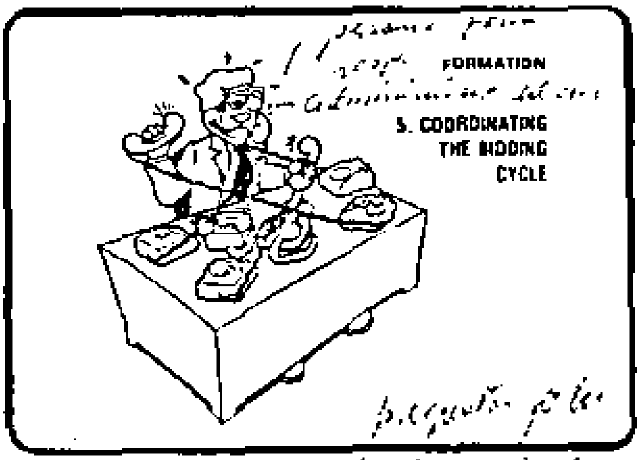

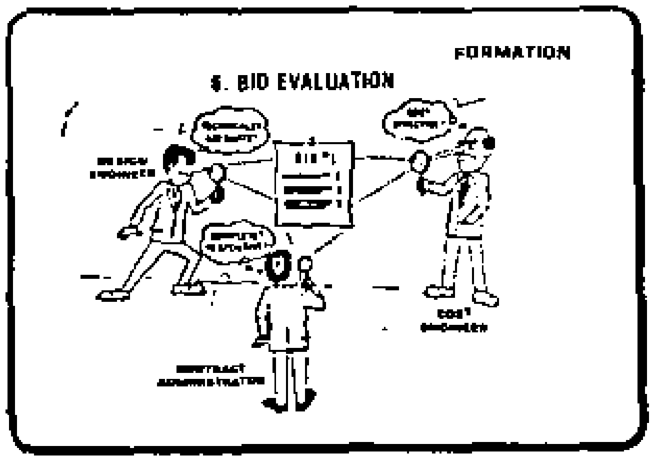

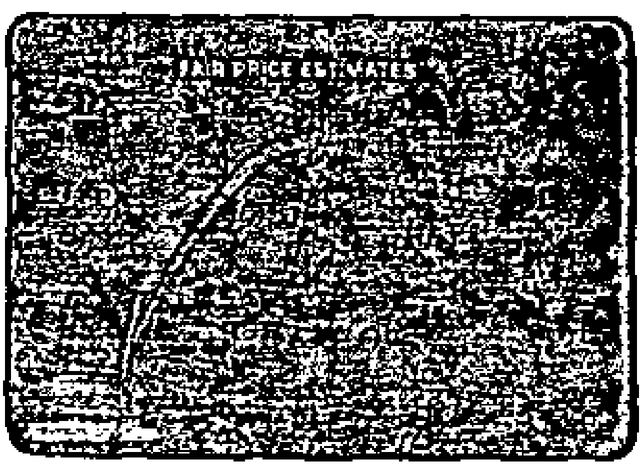

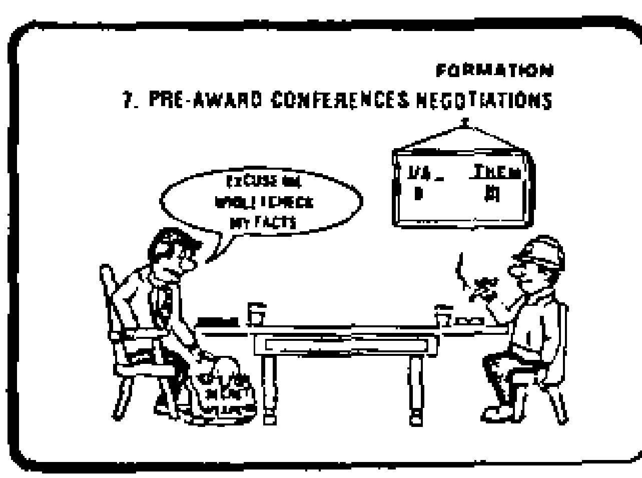

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CONTRACT ADMINISTRATION

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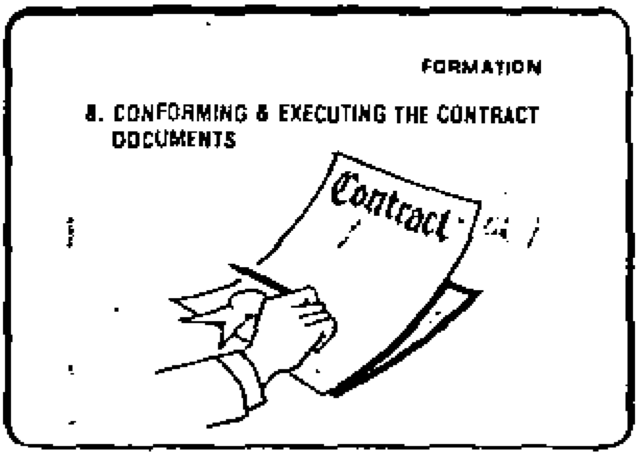

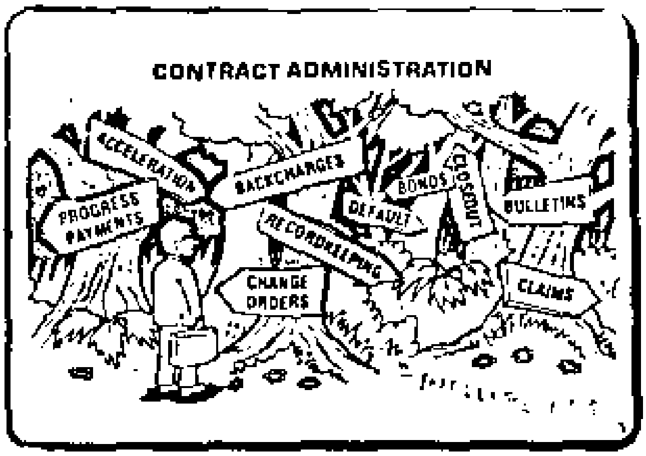

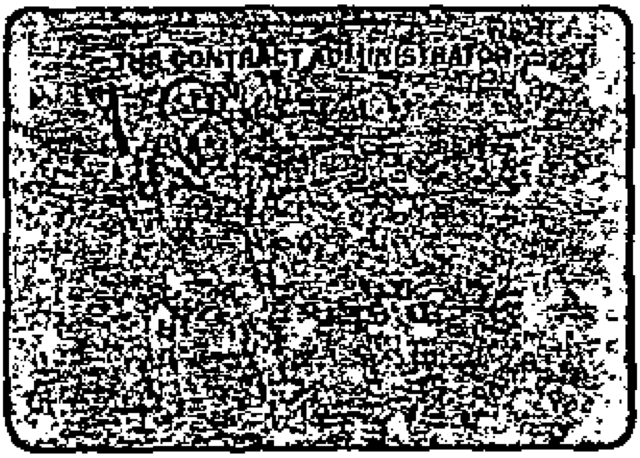

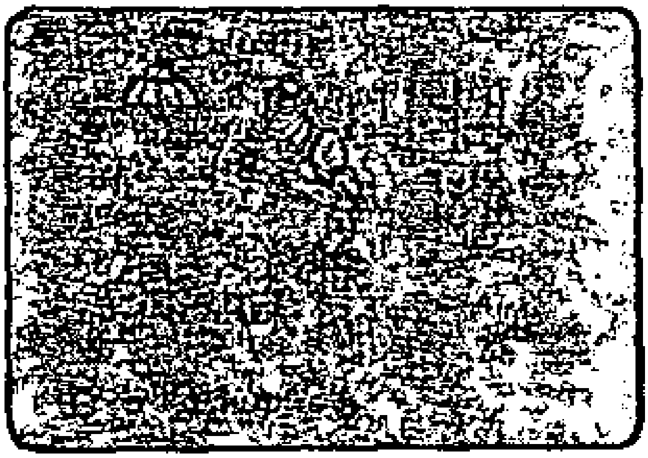

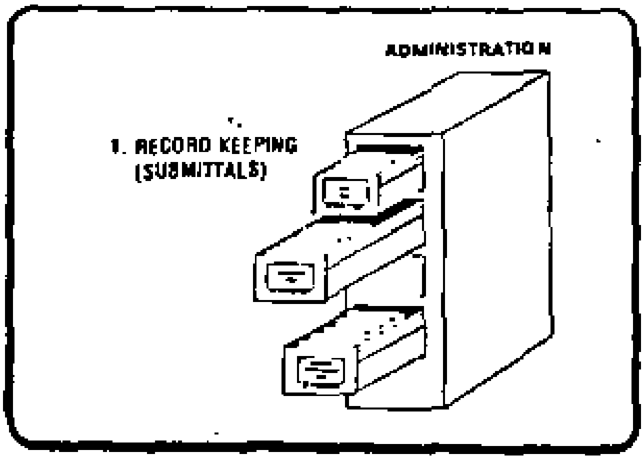

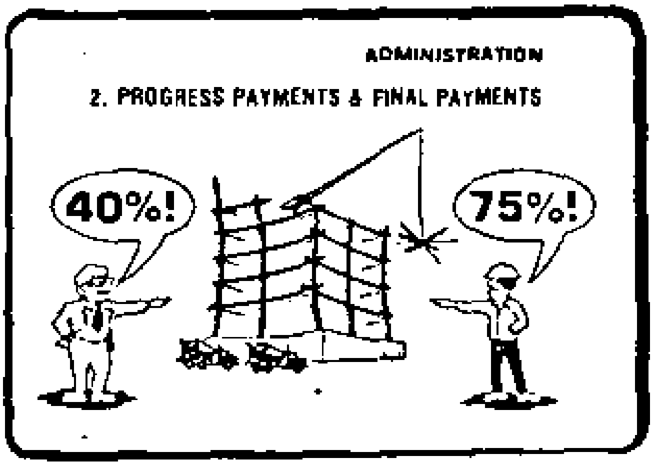

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
CONTRACT ADMINISTRATION

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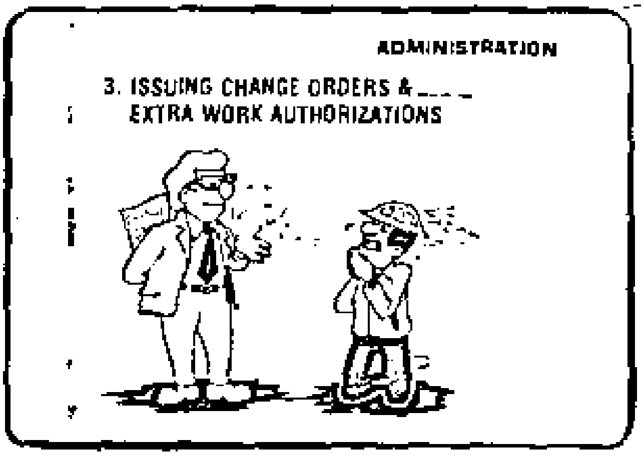
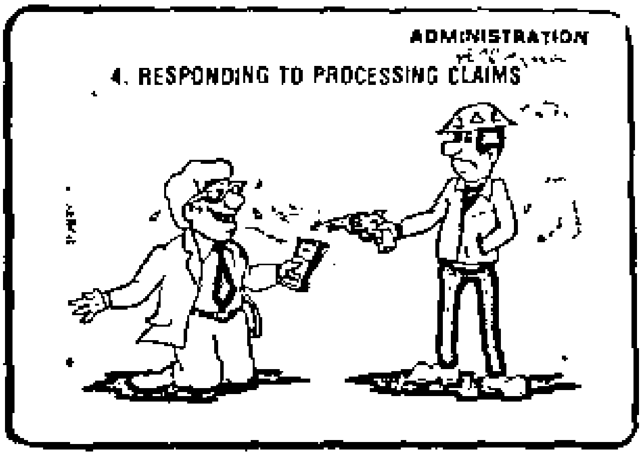
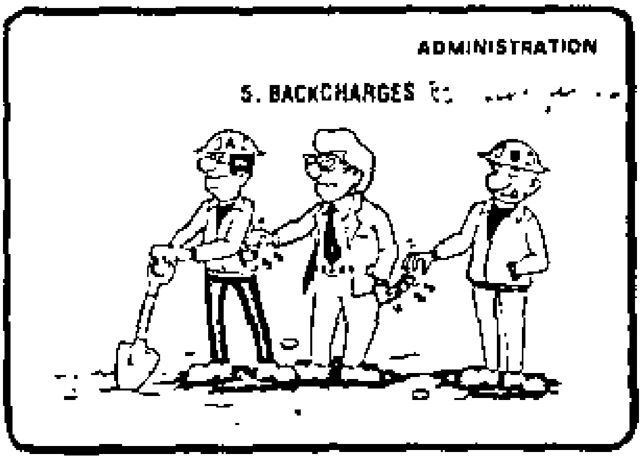
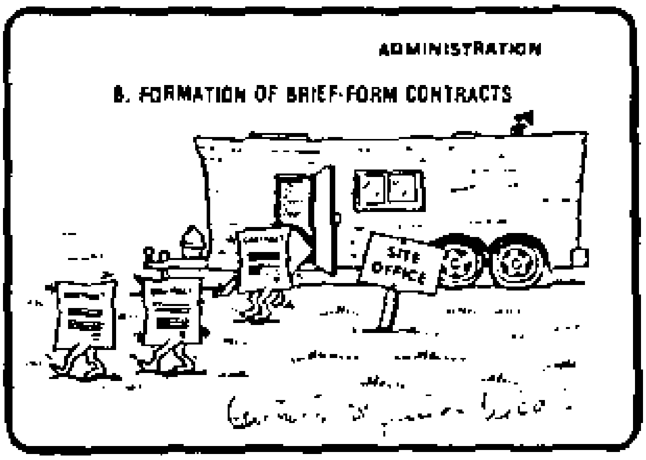








ORGANIZATIONAL APPROACHES

ORGANIZATION APPROACHES

THE "PURCHASING" APPROACH

- REPORTS TO HOME OFFICE PURCHASING (PROCUREMENT)
- LITTLE ENGINEERING CONSTRUCTION EXPERIENCE
- PHYSICALLY REMOVED (UNRESPONSIVE)

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

CONTRACT ADMINISTRATION

Audio-Visual 79-751

ORGANIZATION APPROACHES

THE "CONSTRUCTION ENGINEER" APPROACH

- POSSIBLE CONFLICT OF INTEREST
- LITTLE FORMATION EXPOSURE
- PAPERWORK PHOBIA

ORGANIZATION APPROACHES

THE "COMMITTEE" APPROACH

- UNRESPONSIVE
- LACK OF CONSISTENCY
- DIVIDE & CONQUER

ORGANIZATION APPROACHES

SUGGESTED APPROACH

- FULL TIME CONTRACT ADMINISTRATOR(S)
- REPORTING TO PROJECT OR CONSTRUCTION MANAGER
- FUNCTIONAL DEPT. PROVIDES PROJECT SUPPORT
- ADVISOR RATHER THAN ENFORCER

CONTRACT ADMINISTRATION

- ☑ Introduce Terms & Define Relationships
- ☑ Review the Contract Formation Process
- ☑ Describe the Elements of Contract Administration
- ☑ Discuss Organizational & Implementation Approach

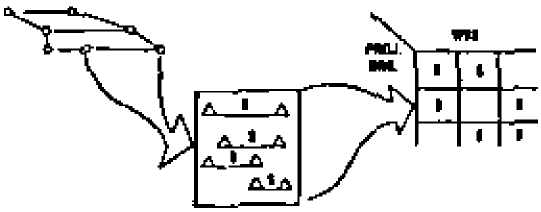
ESTIMATING, SCHEDULING AND PERFORMANCE BUDGETING

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING

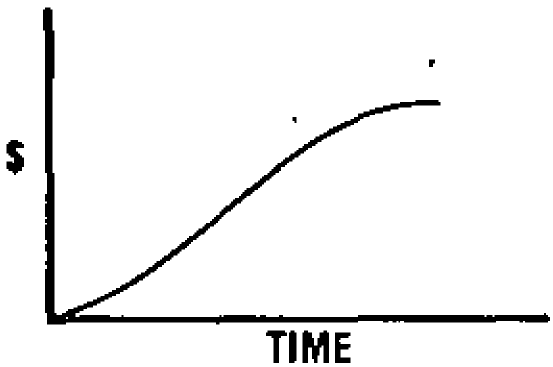
Audio-Visual 79 751

SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING

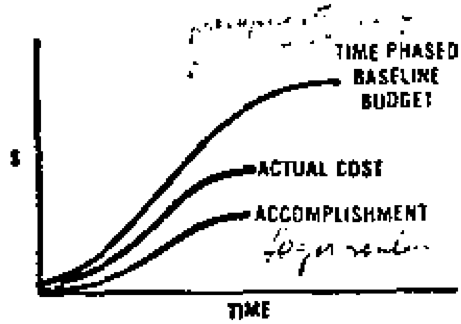


SCHEDULING, ESTIMATING & PERFORMANCE BUDGETING

- ☑ REVIEW KEY CONSIDERATIONS IN SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING.
- ☑ PROVIDE FOR THE PERFORMANCE MEASUREMENT BASELINE.

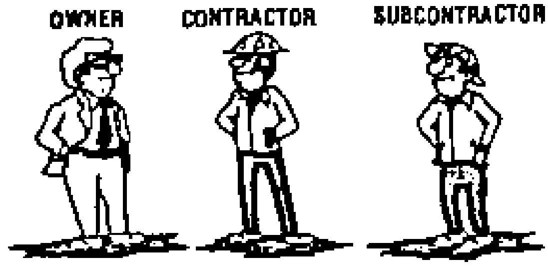


TIME PHASED BUDGETS



IMPROVE ASSESSMENT

SOMEONE MUST DO THIS



THE OWNER MUST INSURE IT'S DONE

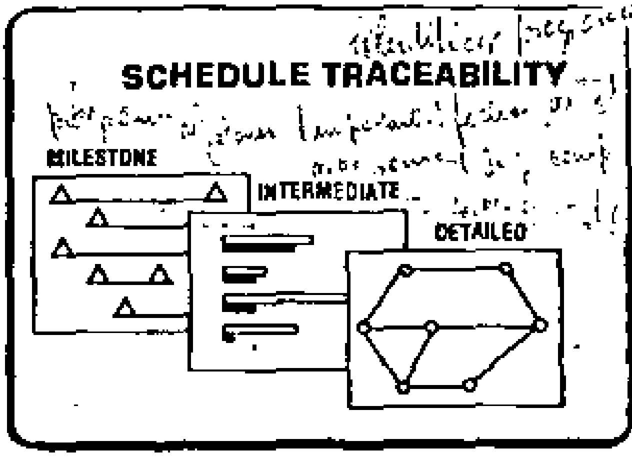
SCHEDULING

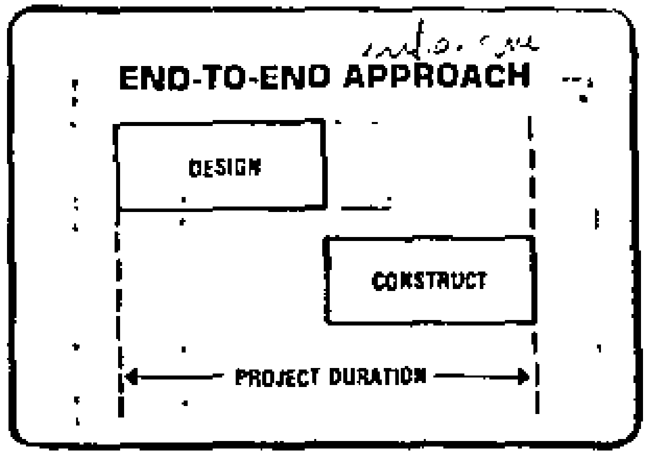
Assigning time durations, precedence, and start and complete dates to all activities

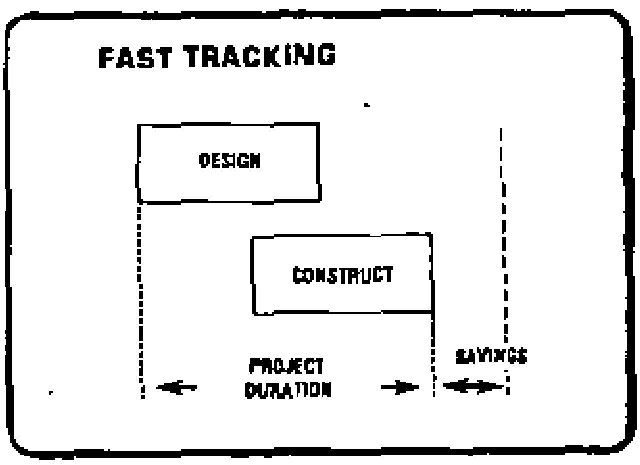
"MANAGING INDUSTRIAL PROJECTS" (MIPS)

SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING

Audio-Visual 79-751

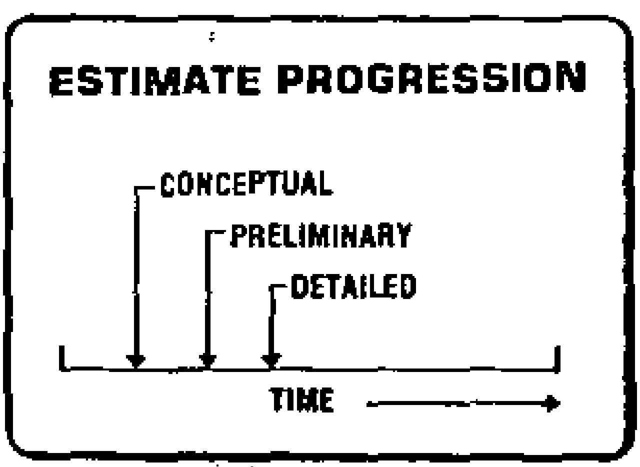


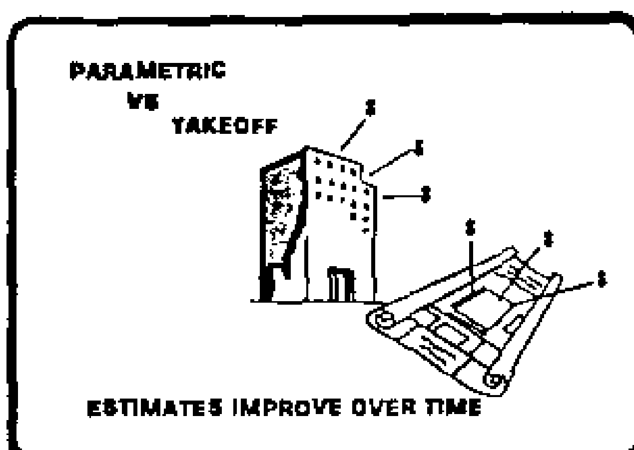




ESTIMATING

DETERMINING THE EXPECTED QUANTITIES, WORKHOURS AND COSTS IN ORDER TO BE ABLE TO ARRANGE FOR THEM.





“MANAGING INDUSTRIAL PROJECTS” (MIPS)

SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING

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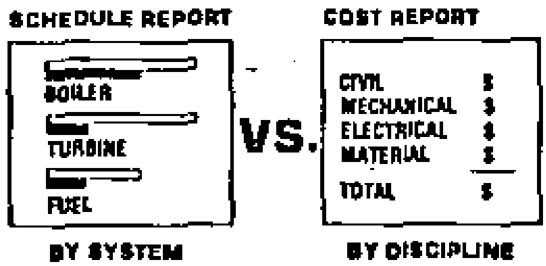
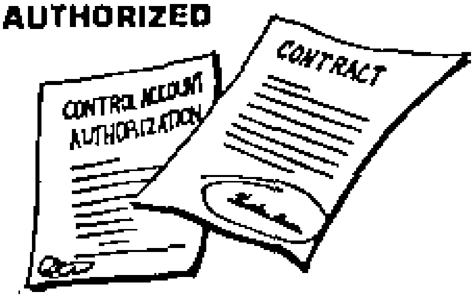
COST/SCHEDULE MISMATCH



PERFORMANCE BUDGETING

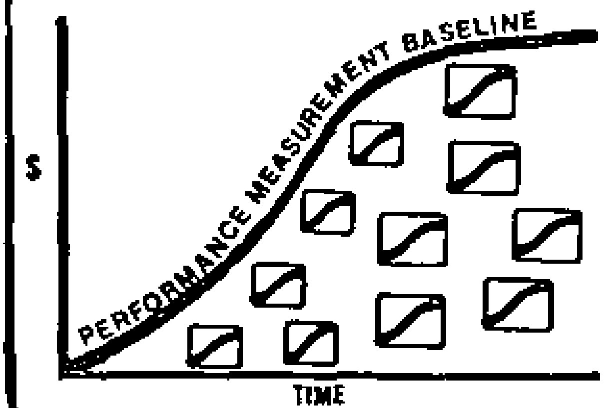
PROVIDING A TIME-PHASED RESOURCE PLAN AGAINST WHICH ACCOMPLISHMENT AND RESOURCE EXPENDITURE CAN BE MEASURED.

ESTIMATES BECOME BUDGETS WHEN THEY ARE FORMALLY AUTHORIZED



PROJECT RESERVES

PART OF THE TOTAL PROJECT BUDGET INTENDED TO BE USED TO MEASURE WORK ANTICIPATED BUT NOT CURRENTLY KNOWN. CONSISTS OF SPECIFIC AND GENERAL RESERVES.



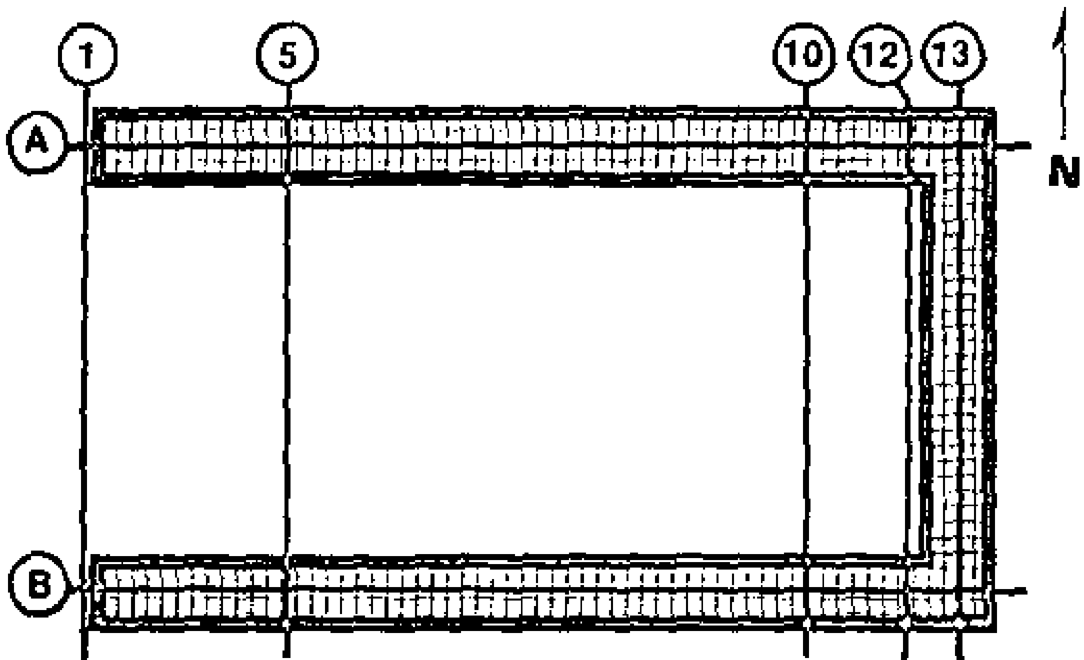
CONTROL ACCOUNT #68

TURBINE BUILDING SUPERSTRUCTURE

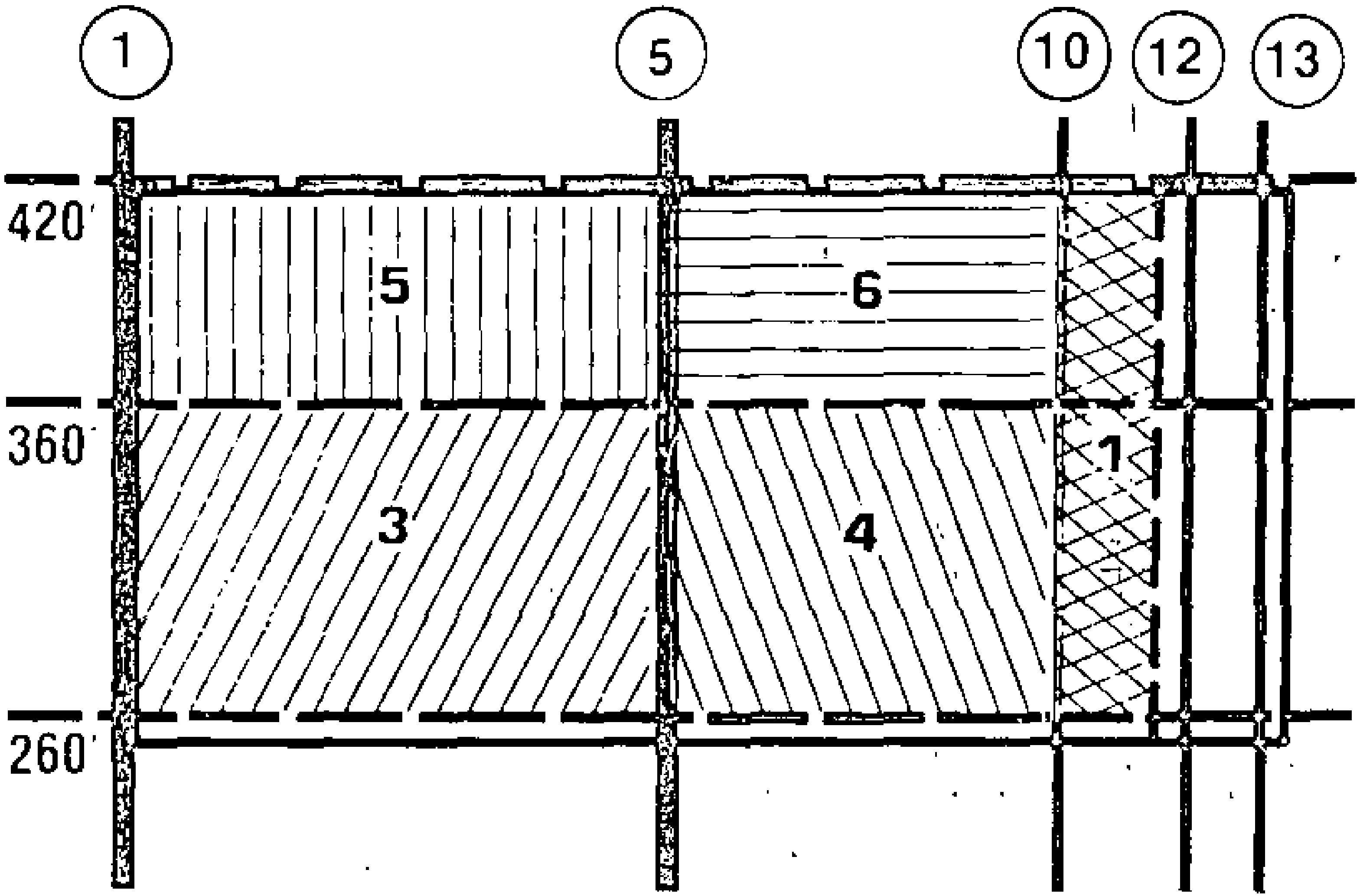
Boundaries N-"A" Line Wall, S-"B" Line Wall
E-"B" Wall W-Column 1 Elevation 260′-420′

BEF: Engineering Design Drawings
D2 134, D3 115,
D2 136, D3 116,
D2 135, D3 120.

Remarks: Includes Main Stream Tunnel —
Structure Work Only. Also CIRC
Water Lines/Encasements.



TURBINE BUILDING *edificio*
SUPERSTRUCTURE

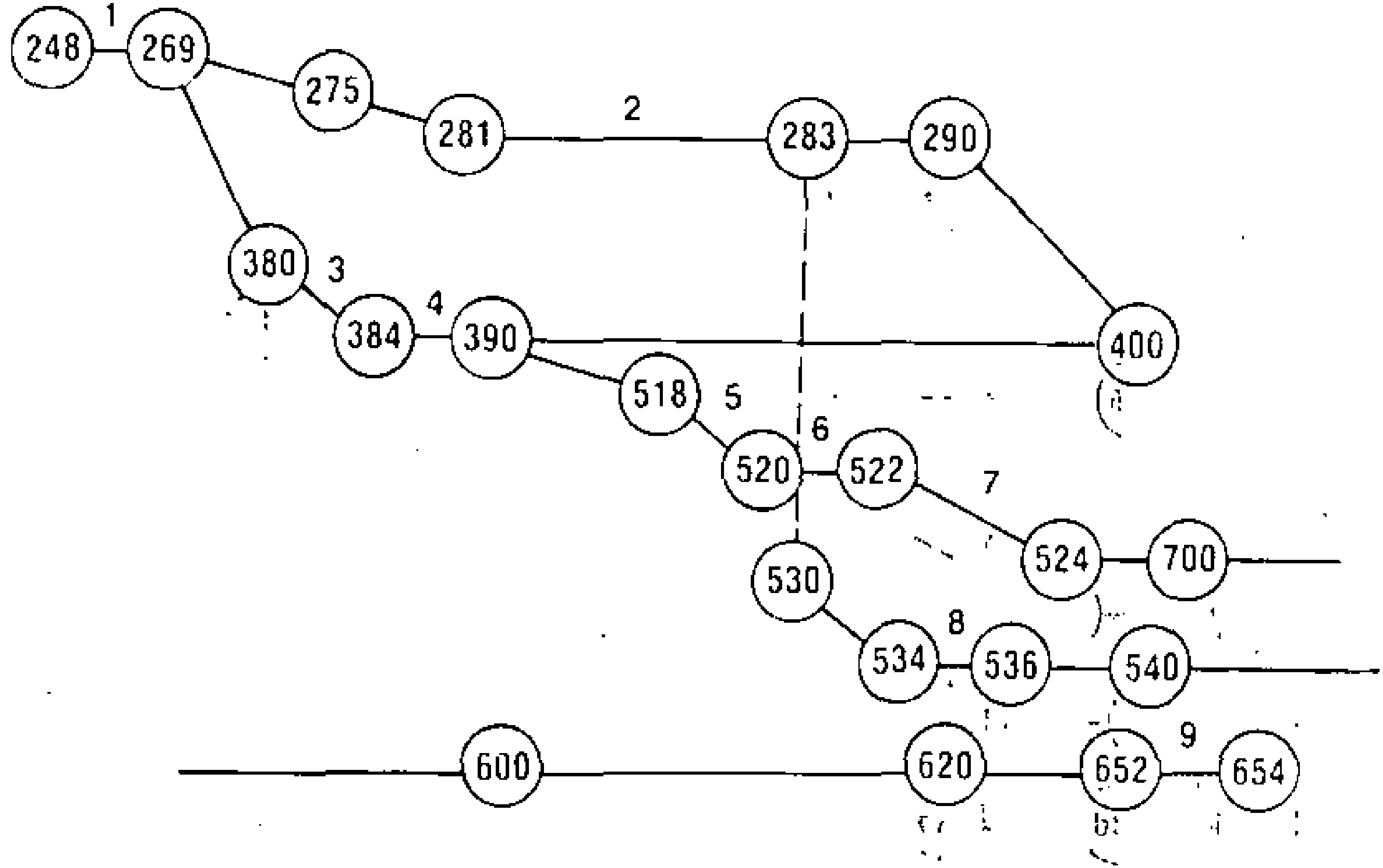


TURBINE BUILDING SUPERSTRUCTURE

CONTROL ACCOUNT

CODE	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ UNIT	LABOR HR. UNIT	LABOR $ HR.	MATERIAL $	LABOR $	LABOR HRS.
2810M	REINFORCING BAR	200	TN	400.00	—	—	80,000	—	—
2810M	REINFORCING TIES	200	TN	10.00	—	—	2.000	—	—
2810L	REBATE PLACEMENT	200	TN	—	40.00	12.00	—	96.000	8 000
2850M	FORMS	80.000	SF	2.00	—	—	160.000	—	—
2850L	FORMS PLACE	80.000	SF	—	0.75	10.00	—	600.000	60 000
2890M	CONCRETE	4.000	CY	40.00	—	—	160,000	—	—
2890L	CONCRETE POUR	4.000	CY	—	2.00	10.00	—	80.000	8 000
3002M	EMBED IRON	60.000	LB	1.50	—	—	90.000	—	—
3002L	EMB IRON SET	60.000	LB	—	0.10	10.00	—	60 000	6.000
3004M	ANCHOR BOLTS	80	LB	1.50	—	—	120	—	—
3004L	ANCHOR BOLTS PL.	80	LB	—	0.25	11.00	—	220	20
3008M	PIPE SLEEVES	200	EA	60.00	—	—	12,000	—	—
3008L	SLEEVES PLACE	200	EA	—	10.00	10.00	—	20.000	2.000
				TOTAL CONTROL ACCOUNT			504,120	856,220	84,020

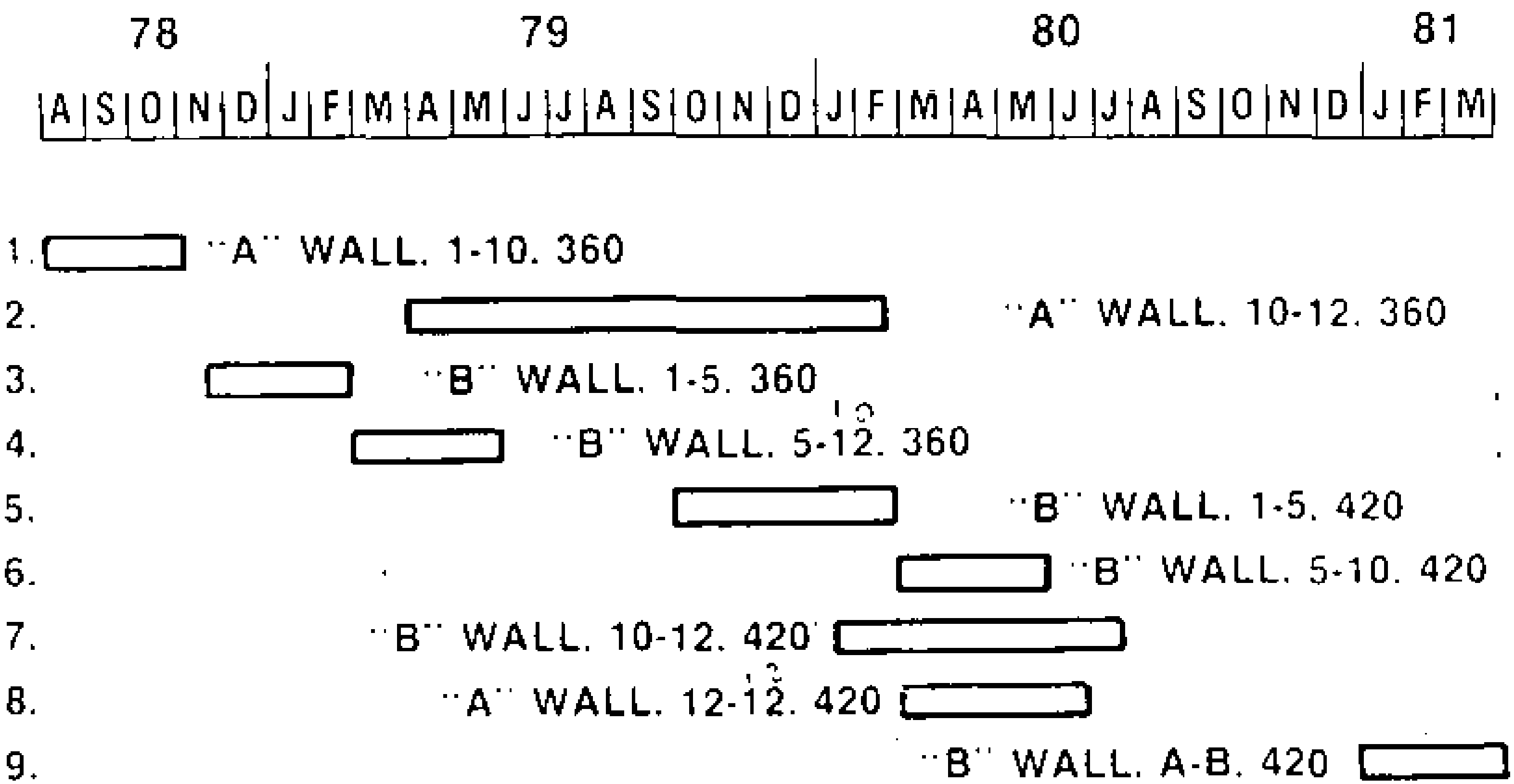
NETWORK SCHEDULE



CONTROL ACCOUNT

TASK	PREC EVENT	SUCC EVENT	DESCRIPTION	DURATION	START	COMPLETE
1	248	269	"A" WALL. 1-10. 360'	9.0	1 AUG. '78	10 OCT. '78
2	281	283	"A" WALL. 10-12. 360	43.0	24 APR. '79	19 FEB. '80
3	380	384	"B" WALL. 1-5	10.0	19 DEC. '78	27 FEB. '79
4	384	390	"B" WALL. 5-12. 360	16.0	27 FEB. '79	19 JUN. '79
5	518	520	"B" WALL. 1-5. 420	13.0	6 NOV. '79	12 FEB. '80
6	520	522	"B" WALL. 5-10. 420	6.0	12 FEB. '80	26 MAR. '80
7	522	524	"B" WALL. 10-12. 420	25.0	26 FEB. '80	17 SEP. '80
8	534	536	"A" WALL. 1-12. 420	12.0	26 MAR. '80	18 JUN. '80
9	654	654	"B" WALL. A-B. 420	10.0	31 DEC. '80	3 MAR. '80

CONTROL ACCOUNT SCHEDULE



2. "A" WALL, 10-12, 360'

SUBTASK

#	DESCRIPTION	QTY	UNIT	MTL $	LABOR $	LABOR HR.
1.	REBAR PLACE	5	TN	2.200	2,400	200
2.	FORMS PLACE	2,000	SF	4.000	15.000	1.500
3.	PLACE SLEEVES	110	EA	6.600	11,000	1.100
4.	CONCRETE PLACE	100	CY	400	2.000	200
5.	EMBED IRON	200	LB	300	200	20
				$13,500	$30,000	3,020

START	COMPLETE	DURATION
24 APR. '79	11 FEB. '80	43.0 WEEKS

3. "B" WALL, 1-5, 360′

SUBTASK

#	DESCRIPTION	QTY	UNIT	MTL $	LABOR $	LABOR HR.
1.	REBAR PLACE	15	TN	6.600	7.200	600
2.	FORMS PLACE	5.000	SF	10.000	37.500	3.750
3.	CONCRETE POUR	300	CY	1.200	6.000	600
4.	EMBED IRON	600	LB	900	600	60
				$18.700	$51.300	5.010

START	COMPLETE	DURATION
19 DEC. '78	27 FEB. '79	10.0 WEEKS

600 Megawatt Fossil Unit

PERFORMANCE MEASUREMENT BASELINE ESTABLISHMENT
FOR CONTROL ACCOUNT
CASE PROBLEM #5

The General Construction Manager has issued a schedule for the condenser erection. See Exhibit 1.

Mr. Wagner, the Project Manager, has had a Control Account work statement prepared for each Control Account. See Exhibit 2.

Since you are responsible for the Control Account, it is your job to establish a baseline plan for the Control Account. Use the Baseline Plan Worksheet, Exhibit 3, to record your work task Earned Value techniques and to develop your baseline. Refer to Exhibit 4 for the recommended Earned Value techniques.

Assume that each man-hour costs $20.

EXHIBIT 1

CONDENSER ERECTION SCHEDULE

TASK	REMARKS
1. Install Waterbox #1	Start February 1, 1981, finish July 30, 1981, continuous operation, no intermediate milestones. Takes 2,400 man-hours.
2. Install Waterbox #2	Start January 1, 1982, finish February 28, 1982, same as #1 above. Takes 800 man-hours.
3. Erect Hot Wells	Start February 1, 1981, finish February 28, 1981; takes 1,000 man-hours, no intermediate milestones.
4. Tubes	Start June 1, 1981, finish September 30, 1981, 4 equal tube quadrants, 3,000 man-hours per quadrant.
5. Tube Sheets	Start April 1, 1981, finish June 30, 1981. 300 man-hours total. 1st month--2 sheets, 100 man-hours 2nd month--3 sheets, 150 man-hours 3rd month--2 sheets, 50 man-hours
6. Transitions, Necks	Start February 1, 1982, finish June 1, 1982. Continuous work, no intermediate milestones, 1,000 man-hours.

CASE PROBLEM #5
CONTROL ACCOUNT WORK STATEMENT

EXHIBIT 2

ORGANIZATION:	SUPERINTENDENT:	WBS:	REV.
GENERAL CONTRACTOR Boiler/Cooling Tower	initials ______ date 1.31.80 B.S. Master	CONDENSER	(0)
BUDGET: Labor $350,000	SYSTEM SUPT. initials ______ date 1.31.80 J. Smart	PARENT WBS: CONDENSING SYSTEM	
	PROJECT: 600 MW Fossil Unit	CONTRACT: C—10	
SCHEDULE START: 02.01.80	SCHEDULE COMPLETE: 06.01.82	PROJECT CONTOL MANAGER	Date Prepared: 12.1.79

STATEMENT OF WORK

1. Erect Hot Wells
2. Erect Water Boxes
3. Install Tube Sheets
4. Install Tubes
5. Install Transitions, Necks

CLOSELY RELATED WORK NOT INCLUDED

1. Condenser fabrication and shipment.
2. Receive, unload and store material at site.
3. Erect Condenser Shell.
4. Crossover Piping (HP, IP, LP)
5. Condenser piping connections.
6. Vacuum System.
7. Tube Cleaning System.
8. Electrical, I & C installation and connections.
9. Hydro test.

CONTROL ACCOUNT BASELINE PLAN WORKSHEET
CONDENSER

No.	TASK	TYPE EVT	F (1981)	M	A	M	J	J	A	S	O	N	D	J (1982)	F	M	A	M	Total Manhours
1	INSTALL WATER BOX 1	B	Δ					Δ											240
2	INSTALL WATER BOX 2	A-3												Δ	Δ				800
3	ERECT HOT WELLS	A-4	ΔΔ																1000
4	TUBES	A-2					Δ			Δ									12000
5	TUBE SHEETS	A-11			Δ		Δ												300
6	TRANSITIONS NECKS	B												Δ				Δ	1000
Current Cost (thousands)																			
Cumulative Cost (thousands)																			

EXHIBIT 4

EARNED VALUE TECHNIQUES

A. <u>DISCRETE</u>

1. Incremental Milestone
2. Units Complete
3. 50/50
4. 0/100

B. <u>SUBJECTIVE MEASUREMENT</u> (Percent complete)

600 Megawatt Fossil Unit

EARNED VALUE CALCULATION
CASE PROBLEM #6

Since you are the Condenser Erection Control Account Manager, it is your job to evaluate the status of work each month and develop the Earned Value. Attached you will find the status of your control account. See Exhibit 1. Using the Baseline Plan Solution from Problem #4, and the status, determine the Earned Value for each task within your control account. Record your results on the Earned Value Worksheet.

Exhibit 1

600 Megawatt FOSSIL UNIT

Case Problem #6

CONDENSER - CONTROL ACCOUNT STATUS

Month of July, 1981

No.	TASK	CURRENT	CUMULATIVE
1	Waterbox #1	800 MH used 10% complete	4000 MH used 50% complete
2	Waterbox #2	No activity	No activity
3	Hotwells	No activity	Completed 800 MH used
4	Tubes	Quandrant #1 completed 4000 MH used	Quad. #1 complete 4000 MH used
5	Tube Sheets	No activity	5 Sheets complete 350 MH used
6	Transitions, Necks	No activity	No activity

CASE PROBLEM #5

SOLUTION

CONTROL ACCOUNT BASELINE PLAN WORKSHEET
CONDENSER

No.	TASK	EVT	1981 F	M	A	M	J	J	A	S	O	N	D	1982 J	F	M	A	M	Total Manhours
1	Waterbox #1	% Compl	△1 400	400	400	400	400	△2 400											2,400
2	Waterbox #2	50/50												△1 400	△2 400				800
3	Hot Wells	0/100	△1 1000																1,000
4	Tubes	Units Compl					▽1 3000	▽2 3000	▽3 3000	▽4 3000									12,000
5	Tube Sheets	Increm. Milestones			▽1 100	▽2 150	▽3 50												300
6	Transitions, Necks	% Compl													△1 250	250	250	△2 250	1,000
																			17,500
Current Cost (thousands)			28	8	10	11	69	68	60	60	0	0	0	8	13	5	5	5	
Cumulative Cost (thousands)			28	36	46	57	126	194	254	314	314	314	314	322	335	340	345	350	

MILESTONES:

1–1 Begin Waterbox 1
1–2 Complete Waterbox 1
2–1 Begin Waterbox 2
2–2 Complete Waterbox 2
3–1 Install Hot Wells.
4–1 to 4–4 Complete Tube Quadrants 1, 2, 3 & 4.
5–1 Complete Tube Sheet 1 & 2
5–2 Complete Tube Sheets 3, 4 & 5
5–3 Complete Tube Sheets 6 & 7
6–1 Begin Transitions, Necks
6–2 Complete Transitions, Necks

CASE PROBLEM #6

EARNED VALUE WORKSHEET
CONDENSER

No.	TASK	CURRENT			CUMULATIVE		
		ACTUAL	BUDGET	E V	ACTUAL	BUDGET	E V
1	WATERBOX 1	16,000	8,000	4,800	80,000	48,000	24,000
2	WATERBOX #2	0	0	0	0	0	0
3	HOT WELLS	0	0	0	16,000	20,000	20,000
4	TUBES	80,000	60,000	60,000	80,000	120,000	60,000
5	TUBE SHEETS	0	0	0	7,000	6,000	5,000
6	TRANSITIONS, NECKS	0	0	0	0	0	0

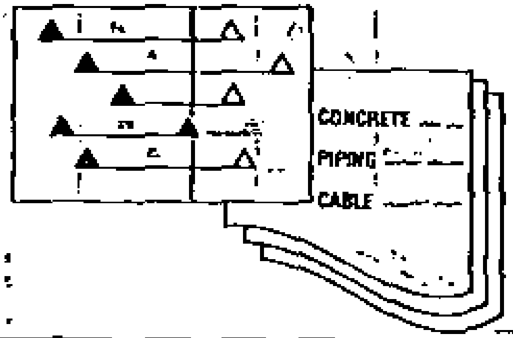
CASE PROBLEM #6

EARNED VALUE WORKSHEET
CONDENSER

No.	TASK	CURRENT ACTUAL	CURRENT BUDGET	CURRENT E V	CUMULATIVE ACTUAL	CUMULATIVE BUDGET	CUMULATIVE E V
1	WATERBOX 1	800	400	240	4000	2400	1200
2	WATERBOX # 2	0	0	0	0	0	0
3	HOT WELLS	0	0	0	800	1000	1000
4	TUBES	4000	3000	3000	4000	6000	3000
5	TUBE SHEETS	0	0	0	350	300	250
6	TRANSITIONS, NECKS	0	0	0	0	0	0

MEASURING ACCOMPLISHMENT

MEASURING ACCOMPLISHMENT



MEASURING ACCOMPLISHMENT

- ☑ PROVIDE A METHOD FOR MEASURING WORK ACCOMPLISHMENT
- ☑ DEMONSTRATE THE APPLICATION OF METHOD TO THE UTILITY ENVIRONMENT

WHAT HAS BEEN ACCOMPLISHED?

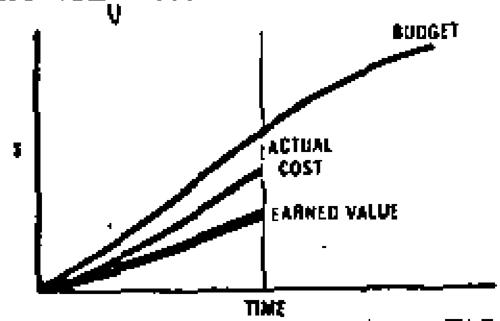
- DRAWINGS COMPLETED
- FEET OF CABLE PULLED
- FEET OF PIPE INSTALLED

WHAT IS THE VALUE OF THE WORK ACCOMPLISHED?

BUDGETED VALUE FOR THE WORK ACCOMPLISHED =

EARNED VALUE

EARNED VALUE



IS A GOOD APPROXIMATION

"MANAGING INDUSTRIAL PROJECTS" (MIPS)
MEASURING ACCOMPLISHMENT

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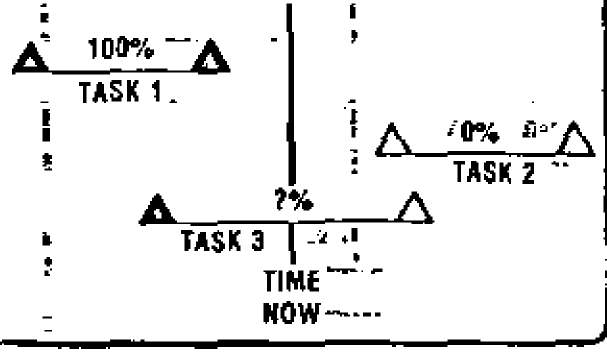
EARNED VALUE

- AN OBJECTIVE MEASURE OF WORK ACCOMPLISHED
- BASED ON THE BUDGETED VALUE

EARNED VALUE OF A TASK

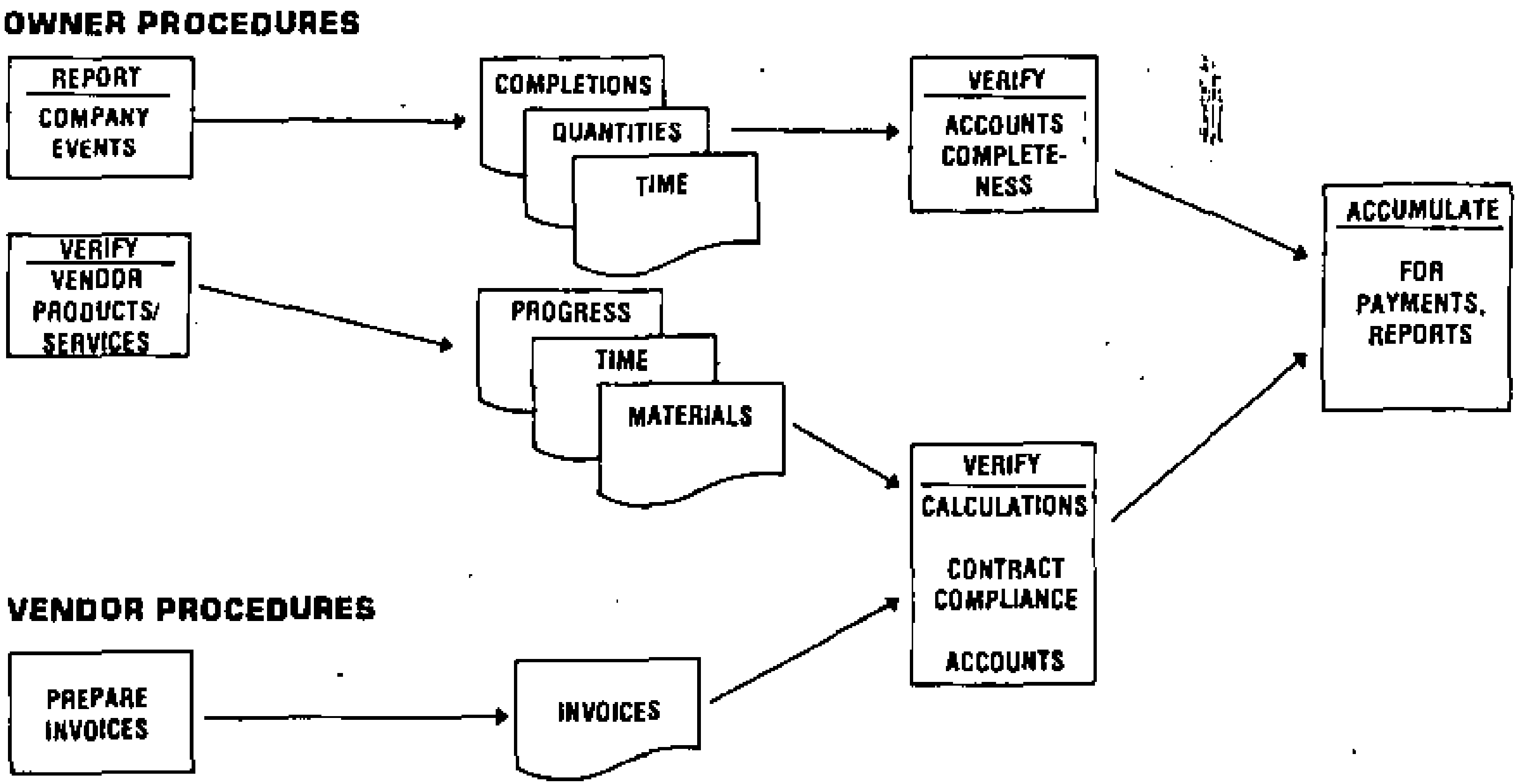


UNITS COMPLETE — PLANNING

MONTH	JAN.	FEB	MAR.	APR	TOTAL
BUDGET FEET	1,500	2,000	2,200	1,000	6,700
BUDGET @ $100 PER FOOT	$150,000	$200,000	$220,000	$100,000	$670,000

ACCUMULATING ACTUAL DATA

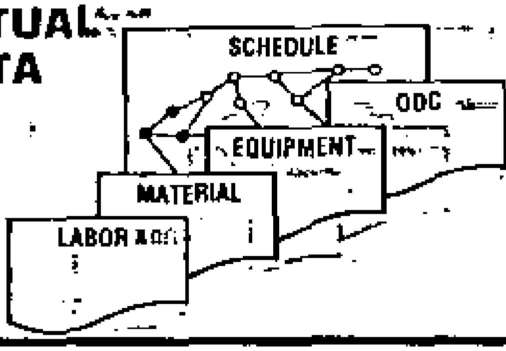
VERIFICATION FOR ACCURACY



"MANAGING INDUSTRIAL PROJECTS" (MIPS)

ACCUMULATING ACTUAL DATA

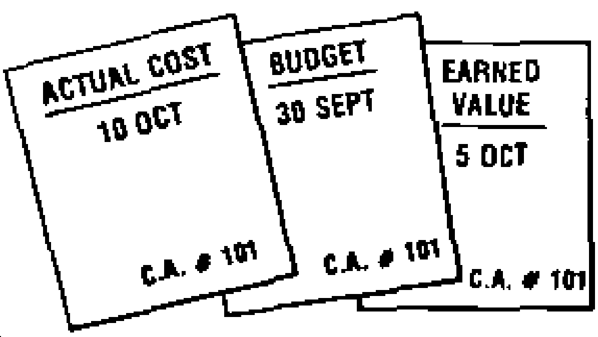
ACCUMULATING ACTUAL DATA



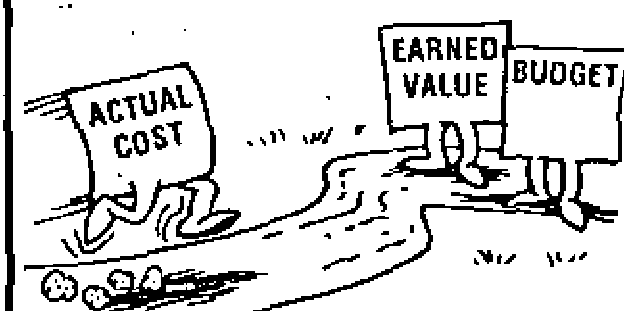
ACCUMULATING ACTUAL DATA

- ☑ DISCUSS WHAT DATA WILL BE NEEDED THROUGHOUT PROJECT
- ☑ DISCUSS WHEN AND HOW TO COLLECT AND VERIFY DATA

INCONSISTENT CUTOFF



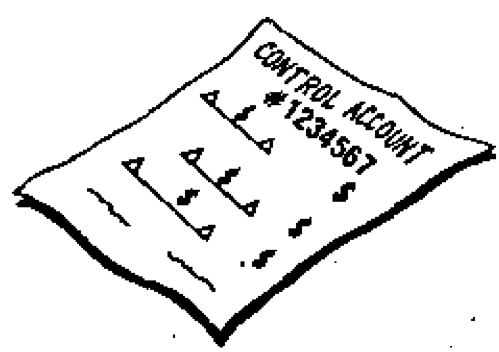
LATE REPORTING



TYPES OF DATA NEEDED

- ACTUAL COSTS
- COMMITMENTS
- CHANGE ORDERS
- PRODUCTION
- ESTIMATE TO COMPLETE

IDENTIFYING THE DATA



"MANAGING INDUSTRIAL PROJECTS" (MIPS)

ACCUMULATING ACTUAL DATA

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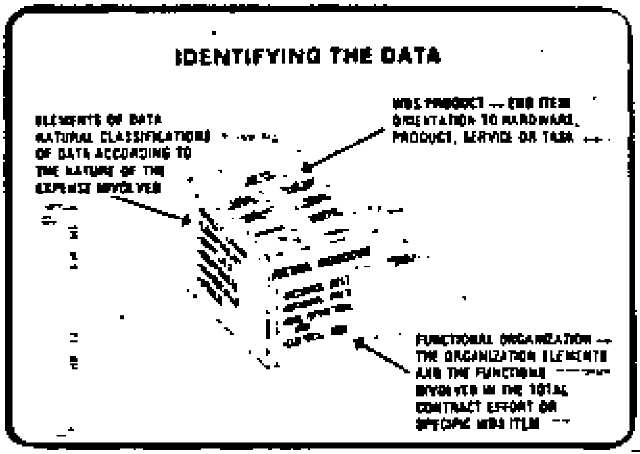

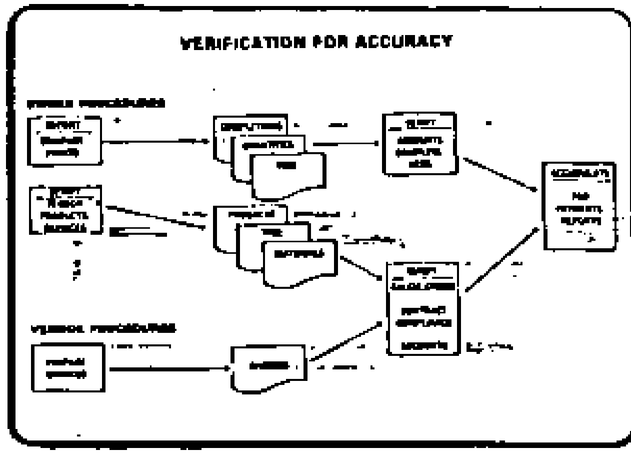

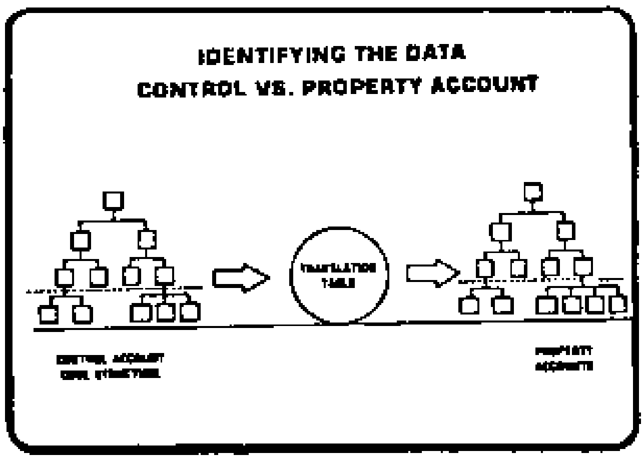

PLAN AHEAD FOR ORDERLY DATA COLLECTION

- IDENTIFY NEEDED DATA
- DETERMINE LEVEL OF DETAIL
- DETERMINE SOURCE OF EACH DATA ITEM
- DEFINE DATA IDENTIFICATION CODES
- DESIGN FORMS
- DESIGN AND WRITE PROCEDURES
- TRAIN PERSONNEL

COMPARING PLANNED AND ACTUAL PERFORMANCE

COST = EV - AC
SCHEDULE = EV - B

VARIANCE CALCULATION EXERCISE

	COMPARISONS			MEANING	
	SCHEDULE COST			SCHEDULE	COST
	Budget	Earned Value	Actual Cost	(On/Ahead/Behind)	(On/Over/Under)
A.	$100	$100	$100	✓	✓
B.	100	150	150	150-100 = 50	0
C.	150	100	100	-50	0
D.	100	100	150	0	-50
E.	100	150	200	50	-50
F.	150	100	150	-50	-50
G.	150	150	100	0	50
H.	100	150	100	50	50
I.	200	150	100	-50	50

EARNED VALUE - ACTUAL COST = COST VARIANCE

EARNED VALUE - BUDGET = SCHEDULE VARIANCE

Case Problem #7

SV= EV- B

CASE PROBLEM # 8

VARIANCE CALCULATION WORKSHEET

(COST & SCHEDULE VARIANCES)

CONDENSER

No.	TASK	CURRENT (JULY '81) ACTUAL	BUDGET	EV	CV	SV	CUMULATIVE ACTUAL	BUDGET	EV	CV	SV
1	WATERBOX #1	16,000	8,000	4,800	(11200)	(3200)	80,000	48,000	24,000	(3000)	(24000)
2	WATERBOX #2	0	0	0	0	0	0	0	0	0	0
3	HOT WELLS	0	0	0	0	0	16,000	20,000	20,000	4000	0
4	TUBES	80,000	60,000	60,000	(20000)	0	80,000	120,000	60,000	(20000)	(60000)
5	TUBE SHEETS	0	0	0	0	0	7,000	6,000	5,000	(2000)	(1000)
6	TRANSITIONS, NECKS	0	0	0	0	0	0	0	0	0	0
	TOTAL	96,000	68,000	64,800	(31200)	(3200)	183,000	194,000	109,000		

COMPARING PLANNED AND ACTUAL PERFORMANCE

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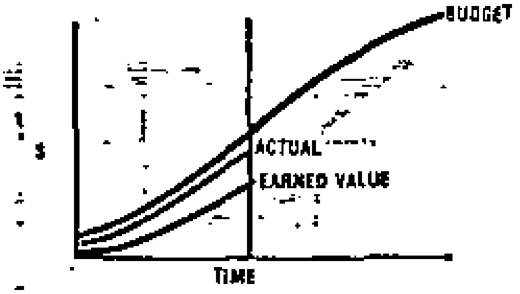
COMPARING PLANNED AND ACTUAL PERFORMANCE



COST VARIANCE

- EARNED VALUE MINUS ACTUAL COST
- DOLLAR VALUE OF WHAT YOU ACCOMPLISHED – MINUS WHAT IT COST YOU

SCHEDULE VARIANCE

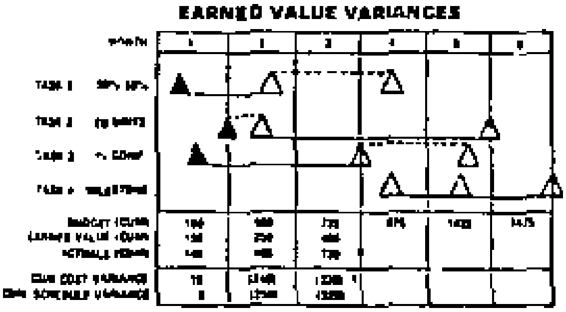
- EARNED VALUE MINUS BUDGET
- DOLLAR VALUE OF WORK AHEAD/BEHIND SCHEDULE
- ONLY AN INDICATOR

VARIANCE CALCULATION

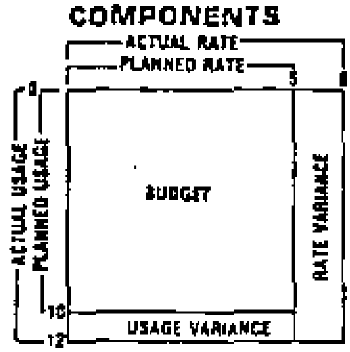
COST VARIANCE = EARNED VALUE – ACTUAL COST

SCHEDULE VARIANCE = EARNED VALUE – BUDGET

SAMPLE CONTROL ACCOUNT EARNED VALUE VARIANCES



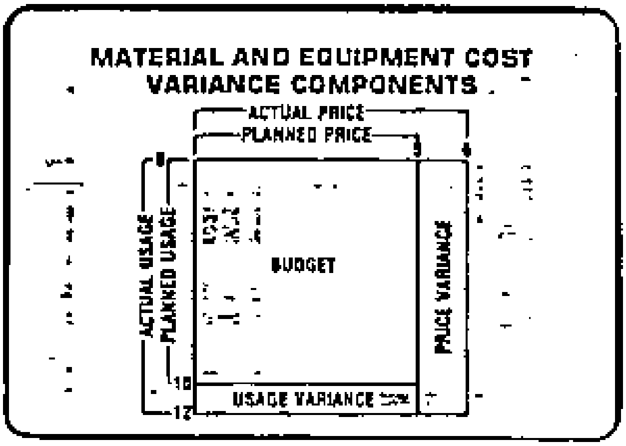
LABOR COST VARIANCE COMPONENTS

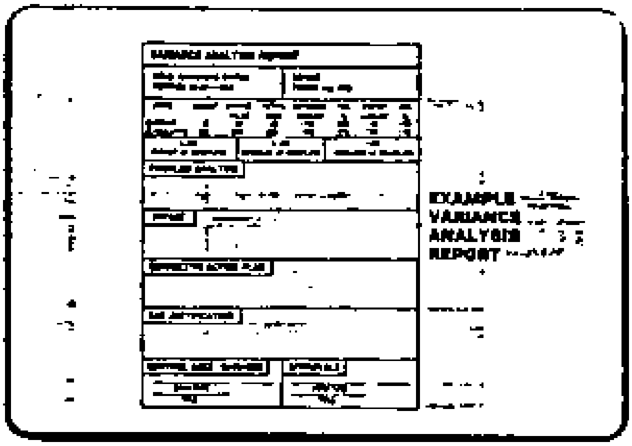


"MANAGING INDUSTRIAL PROJECTS" (MIPS)

COMPARING PLANNED AND ACTUAL PERFORMANCE

Audio-Visual 79-751





REPORTING AND ANALYSIS

PERFORMANCE REPORT—WORK BREAKDOWN STRUCTURE

WBS ELEMENTS	CUMULATIVE TO DATE					AT COMPLETION		
	BUDGET	EARNED VALUE	ACTUAL COST	SCHEDULE VARIANCE	COST VARIANCE	BUDGET	ESTIMATE	VARIANCE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FOSSIL UNIT								
STRUCTURES & IMPROVEMENTS	20,000	22,000	18,000	2,000	4,000	50,000	46,000	4,000
BOILER PLANT EQUIPMENT	40,000	37,000	39,000	(3,000)	(2,000)	200,000	210,000	(10,000)
TURBINE GENERATOR EQUIPMMENT	10,000	10,000	12,000	—	(2,000)	50,000	50,000	—
ACCESSORY ELECTRICAL EQUIPMENT	3,500	3,000	2,800	(500)	200	35,000	35,000	—
MISC. POWER PLANT EQUIPMENT	500	700	600	200	100	5,000	5,000	—
PROJECT SERVICES	29,000	27,000	31,000	(2,000)	(4,000)	70,000	75,000	(5,000)
PERFORMANCE MEAS. BASELINE	103,000	99,700	103,400	(3,300)	(3,700)	410,000	421,000	(11,000)
PROJECT RESERVE						30,000	19,000	11,000
TOTAL	103,000	99,700	103,400	(3,300)	(3,700)	440,000	440,000	—

PERFORMANCE REPORT — PROJECT ORGANIZATION

PROJECT ORGANIZATION	CUMULATIVE TO DATE					AT COMPLETION		
	BUDGET	EARNED VALUE	ACTUAL COST	SCHEDULE VARIANCE	COST VARIANCE	BUDGET	ESTIMATE	VARIANCE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AJAX EXCAVATION	6,000	5,000	4,900	(1,000)	100	12,000	12,000	—
ACE SITE SERVICES	4,000	4,000	3,700	—	300	16,000	22,000	(6,000)
AIRBORNE SURVEYORS	2,000	1,500	1,800	(500)	(300)	3,000	3,000	—
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
PERF. MEAS. BASELINE	103,000	99,700	103,400	(3,300)	(3,700)	410,000	421,000	(11,000)
PROJECT RESERVE						30,000	19,000	11,000
TOTAL	103,000	99,700	103,400	(3,300)	(3,700)	440,000	440,000	—

600 MEGAWATT FOSSIL UNIT

VARIANCE ANALYSIS REPORT CRITIQUE
CASE PROBLEM #9

DO THEY LOOK FAMILIAR?

Attached are four different versions of a Variance Analysis Report on the same Performance Measurement data. Using the checklist (Attachment 1), spend 15 minutes analyzing these reports, using the attached critique.

The seminar leader will then lead a discussion of the questions below:

1. Choose the best Variance Analysis Report. Why did you reject the other three reports? Be specific and note comments on each report.

2. Are there any weaknesses in the report you have chosen? What are they?

VARIANCE ANALYSIS REPORT

WBS: Condenser NO.: 62–091–1–82–6	REPORT PERIOD: July, 1981

($000)	BUDGET	EARNED VALUE	ACTUAL	SCHEDULE VARIANCE	%	COST VARIANCE	%
CURRENT	68	64.8	96	(3.2)	(5)	(31.2)	(48)
CUMULATIVE	194	109	167	(85)	(44)	(58)	(68)

TOTAL BUDGET 350	ESTIMATE AT COMPLETE 350	VARIANCE AT COMPLETE 0

PROBLEM ANALYSIS

IMPACT

CORRECTIVE ACTION PLAN

EAC JUSTIFICATION

CONTROL ACCOUNT MANAGER		APPROVAL	
R.S. Master Condenser Supt.	8–4–81	Jack Smart Cooling System Supt.	8–5–81
TITLE	DATE	TITLE	DATE

VARIANCE ANALYSIS REPORT

WBS: Condenser NO.: 62–091–1–82–6	REPORT PERIOD: July, 1981

($000)	BUDGET	EARNED VALUE	ACTUAL	SCHEDULE VARIANCE	%	COST VARIANCE	%
CURRENT	68	64.8	96	(3.2)	(5)	(31.2)	(48)
CUMULATIVE	194	109	167	(85)	(44)	(58)	(68)

TOTAL BUDGET 350	ESTIMATE AT COMPLETE 350	VARIANCE AT COMPLETE 0

PROBLEM ANALYSIS

Current period CV is $31,200 and cumulative CV is $74,000. Both are caused by more labor time being expended in the troublesome installation of waterbox No. 1. The problem is not in our labor use, but in poor fabrication of the waterboxes by the condenser vendor. This is also the cause of schedule slippage.

IMPACT

Cost impact is substantially unknown at this time. If we don't get better waterboxes from this vendor, we should take them off the bidders list. This problem causes our company to virtually redesign the boxes in the field by our engineers who are working outside their expertise. A lot of time is wasted talking to vendor reps.

CORRECTIVE ACTION PLAN

Extensive weld prep. and welding is being done to assure tolerances for proper fit-ups and alignment. This problem has the personal attention of Mr. Baily, QC engineer.

EAC JUSTIFICATION

No update of EAC at this time. Will have a better idea as to additional costs in the future.

CONTROL ACCOUNT MANAGER		APPROVAL	
R.S. Master Condenser Supt.	8–4–81	Jack Smart Cooling System Supt.	8–5–81
TITLE	DATE	TITLE	DATE

VARIANCE ANALYSIS REPORT

WBS: Condenser

NO.: 62–091–1–82–6

REPORT PERIOD: July, 1981

($000)	BUDGET	EARNED VALUE	ACTUAL	SCHEDULE VARIANCE	%	COST VARIANCE	%
CURRENT	68	64.8	96	(3.2)	(5)	(31.2)	(48)
CUMULATIVE	194	109	167	(85)	(44)	(58)	(53)

TOTAL BUDGET	ESTIMATE AT COMPLETE	VARIANCE AT COMPLETE
350	450	(100)

PROBLEM ANALYSIS

Both cost and schedule-variances are caused by distortions due to unrealistic scheduling for July, and we're still behind for June's work.

IMPACT

No impact on condensing system schedule milestones.

CORRECTIVE ACTION PLAN

Completion of overdue installation will be attempted as soon as possible.

EAC JUSTIFICATION

New EAC = 350 + 100 = 450

CONTROL ACCOUNT MANAGER		APPROVAL	
B.S. Master Condenser Supt.	8–4–81	Jack Smart Cooling System Supt.	8–5–81
TITLE	DATE	TITLE	DATE

VARIANCE ANALYSIS REPORT

WBS: Condenser NO.: 62–091–1–82–6	REPORT PERIOD: July, 1981

($000)	BUDGET	EARNED VALUE	ACTUAL	SCHEDULE VARIANCE	%	COST VARIANCE	%
CURRENT	68	64.8	96	(3.2)	(5)	(31.2)	(48)
CUMULATIVE	194	109	167	(85)	(44)	(58)	(53)

TOTAL BUDGET	ESTIMATE AT COMPLETE	VARIANCE AT COMPLETE
350	350	0

PROBLEM ANALYSIS

Waterboxes aren't on schedule because of problems with shop fabrication of plates.

IMPACT

None.

CORRECTIVE ACTION PLAN

Will work as much overtime as the men can stand in order to catch up.

EAC JUSTIFICATION

No change. VAC is already lost as it is.

CONTROL ACCOUNT MANAGER		APPROVAL	
B.S. Master Condenser Supt.	8–4–81	Jack Smart Cooling System Supt.	8–5–81
TITLE	DATE	TITLE	DATE

VARIANCE ANALYSIS REPORT

WBS: Condenser

NO.: 62–091–1–82–6

REPORT PERIOD: July, 1981

($000)	BUDGET	EARNED VALUE	ACTUAL	SCHEDULE VARIANCE	%	COST VARIANCE	%
CURRENT	68	64.8	96	(3.2)	(5)	(31.2)	(48)
CUMULATIVE	194	109	167	(85)	(44)	(58)	(53)

TOTAL BUDGET 350 — ESTIMATE AT COMPLETE 470 — VARIANCE AT COMPLETE (120)

PROBLEM ANALYSIS

Unacceptable fabrication tolerances of waterbox components have left no tolerences for installation. Field fit-up has been extremely difficult and costly. Extensive rework – drilling, grinding, welding, has consumed manhours and time in waterbox installation.

IMPACT

Cost – Variance to date is unrecoverable.

Schedule – Schedule slippage is unrecoverable without special effort. This delay could further impede tube sheet installation and put tubing on the critical path of the condensing system installation.

CORRECTIVE ACTION PLAN

Manufacturer's engineers have been called in and are on site. Expediting of design information with the vendor has improved. Additional welders have been assigned. Cost records are being maintained for eventual backcharge to the condenser manufacturer.

EAC JUSTIFICATION

New EAC: 350 + 120 = 470

CONTROL ACCOUNT MANAGER		APPROVAL	
R.S. Master, Condenser Supt.	8–4–81	Jack Smart, Cooling System Supt.	8–5–81
TITLE	DATE	TITLE	DATE

ATTACHMENT 1

VARIANCE ANALYSIS REPORT CHECKLIST

HEADING

1. Are all the heading blocks complete?

PROBLEM ANALYSIS

2. Have I clearly explained and quantified the effect of any errors on the data elements?

3. Have I clearly explained and quantified the effect of any distortion on the data elements?

4. Have I identified and quantified any significant labor usage rate variances? Material usage and price variances?

5. Have I given a clear concise explanation of the reason for the variance, including any significant variances which are evident after the elimination of errors and distortion?

6. Have I avoided simply restating that there is a variance?

TASK/PROJECT IMPACT

7. Have I considered the impact on:

   A. The immediate tasks;
   B. Other work in the control account;
   C. Work in other control accounts;
   D. The project as a whole?

8. Have I considered cost, schedule and technical impact? Long- and short-range?

9. Is my explanation specific? Does it include dates, schedule estimates and cost estimates?

10. If there is no impact or no project impact, have I clearly supported that view?

CORRECTIVE ACTION PLAN

11. Have I discussed a specific action or set of actions which will correct a problem or minimize the effect of that problem? Have I included what, who and when?

12. Have I put my estimates of future performance in the impact block and avoided substituting optimistic forecasts for specific corrective action plans?

CORRECTION ACTION PLAN RESULTS

13. Have I included the results of new correction action plans which have already been completed?

14. Have I included the results of new corrective action plans from prior Variance Analysis Reports?

EAC JUSTIFICATION

15. If I have a significant Cost Variance, have I examined my Estimate at Completion?

16. Have I either justified why the Estimate at Completion should be changed or explained why it should not?

SIGNATURES

17. Are all of the required signatures present?

600 Megawatt Fossil Unit

PERFORMANCE EFFICIENCY FACTORS
AND
ESTIMATE AT COMPLETION METHODS

CASE PROBLEM #10

PROBLEM STATEMENT:

Control Account (1):

Slopit Concrete Inc. has been awarded the contract for furnishing and installing elevated concrete decks for the turbine building. The contract amount is $116,000. After their first full month of work, Slopit's job superintendent invoices $20,000 for a progress payment. According to quantity installed reports for that period, Slopit has installed at a less productive rate, earning only $16,000 value for work performed.

Control Account (2):

Wrapup Insulation Contractors has a $900,000 contract line item for insulating 8.52 miles (45,000 linear feet) of 12" #6 oil piping.

After three months of work, Wrapup has completed 4,500 feet and been paid $100,000.

Control Account (3):

Clifford Resistance, electrical engineer, is responsible for having our utility's work crews install all yard subsurface grounding. With $100,000 budgeted, he has accomplished 75% of the work, while charging the job only $60,000.

Your company has previously prepared the estimate at complete shown on the attached work sheet. Now that control account status shown above has been gathered, it is your job to review and validate these EAC's.

OBJECTIVE:

1. Calculate the Cost Performance Index (CPI) and the To Complete Performance Index (TCPI) for each of the above Control Accounts. Use these calculations as the basis for a discussion of the probable validity of the EAC.

2. Calculate the EAC for each control account, using the two sample EAC prediction methods shown below. Use these predictions to discuss the probable validity of the EAC.

   A. $$EAC = \frac{BAC}{CPI} = \frac{\text{TOTAL BUDGET}}{\text{COST PERFORMANCE INDEX}}$$

   (assumes that performance will continue at the rate that has been experienced in the past)

   B. EAC = ACTUAL COST + (BAC − EARNED VALUE)

   ACTUAL COST + REMAINING = BUDGET

   (assumes planned performance for remaining effort)

The formulas are:

$$CPI = \frac{\text{EARNED VALUE}}{\text{ACTUAL COST}} = \frac{\text{WORK ACCOMPLISHED}}{\text{ACTUAL COST}}$$

$$TCPI = \frac{\text{BAC - EARNED VALUE}}{\text{EAC - ACTUAL COST}} = \frac{\text{BUDGET FOR REMAINING WORK}}{\text{ESTIMATE FOR REMAINING WORK}}$$

PERFORMANCE EFFICIENCY FACTORS AND ESTIMATE-AT-COMPLETE

(Data in $ Thousands)

	Earned Value	Actual Cost	BAC	EAC	CPI	TCPI	Predicted EAC Method A	Predicted EAC Method B
(1)	16	20	116	120	0.8	1.0	145	120
(2)	90	100	900	1000				
(3)	75	60	100	90				

Case Problem #10

PERFORMANCE EFFICIENCY FACTORS AND ESTIMATE AT COMPLETION

($ Thousands)

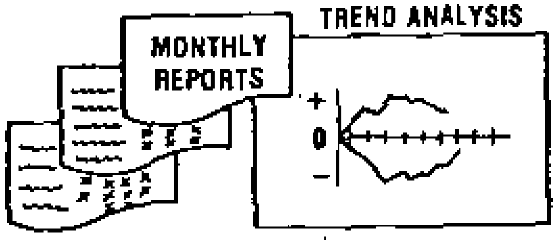
Earned Value	Actual Cost	BAC	EAC	CPI	TCPI	Predicted (A)	EAC (B)
(1) 16	20	116	120	.8	1.0	145	120
(2) 90	100	900	1000	.9	.9	1000	910
(3) 75	60	100	90	1.25	.83	80	85

“MANAGING INDUSTRIAL PROJECTS” (MIPS)

REPORTING AND ANALYSIS

Audio Visual 79-751

REPORTING AND ANALYSIS



REPORTING AND ANALYSIS

- ☑ REVIEW REPORTS AVAILABLE TO MANAGEMENT
- ☑ PROVIDE A REPORT TO RELATE COST AND SCHEDULE PERFORMANCE
- ☑ PROVIDE TECHNIQUES FOR ANALYZING PERFORMANCE

KEY INDICATOR REPORTS

CASH FLOW

COMMITMENTS

SCHEDULE

PROCUREMENT STATUS

RESERVE APPLICATION

CHANGES

PERFORMANCE

COMMITMENT REPORT

[illegible]	CONTRACT [illegible]	CONTRACT [illegible]	CHANGES	ACTUAL [illegible]	[illegible]
BOILER	—	—	—	—	—
...					
ABC CONSTRUCTION	—	—	—	—	—

MILESTONE REPORT

DESCRIPTION	PLAN START	ACTUAL START	PLAN COMPLETE	ACTUAL COMPLETE	ESTIMATE COMPLETE
ELEMENT					
~ ~					
ORGANIZATION					

SCHEDULE

ID	ACTIVITY	ORGANIZATION CONTRACTOR	J	J	A	S	O	N
16	PURCHASE & DELIVER PUMPS	PROCUREMENT ACME PUMPS						
17	...	...						
:								

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

REPORTING AND ANALYSIS

Audio-Visual 79-751

LABOR HOURS

SUBSYSTEM ACTIVITY	CURRENT ESTIMATE	ACTUAL HOURS MONTH	ACTUAL HOURS TO DATE	FORECAST	VARIANCE AT COMPLETION
CONVECTION PASS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PURCHASE ORDER

[illegible]	PO/CONTRACT #	DATE	DESCRIPTION	COMMITTED	AMOUNT
CONVECTION PASS					
[illegible] HARDWARE	—	—	—	—	—
[illegible] SUPPLY	—	—	—	—	—
[illegible] SUPPLY	—	—	—	—	—

ANYONE CAN DO THE REPORTING & ANALYSIS

AS LONG AS THE OWNER GETS WHAT HE NEEDS

TRADITIONAL APPROACH

PLANNED	−	ACTUAL	=	VARIANCE
76,000	−	80,000	=	(4,000)

PERFORMANCE MEASUREMENT APPROACH

EARNED VALUE	−	BUDGET	=	SCHEDULE VARIANCE
$70,000	−	$76,000	=	($6,000)
EARNED VALUE	−	ACTUAL COSTS	=	COST VARIANCE
$70,000	−	$80,000	=	($10,000)

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

REPORTING AND ANALYSIS

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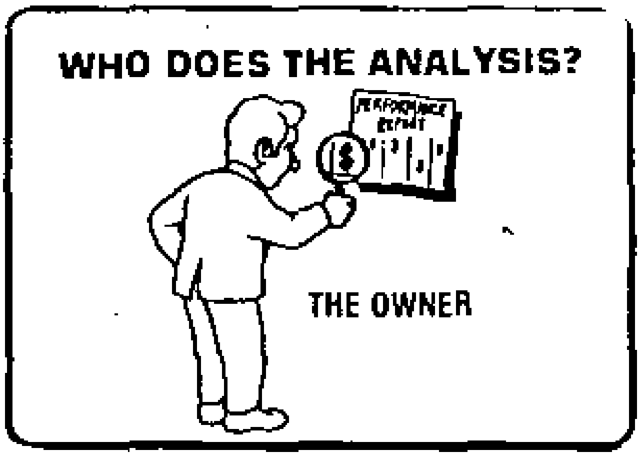
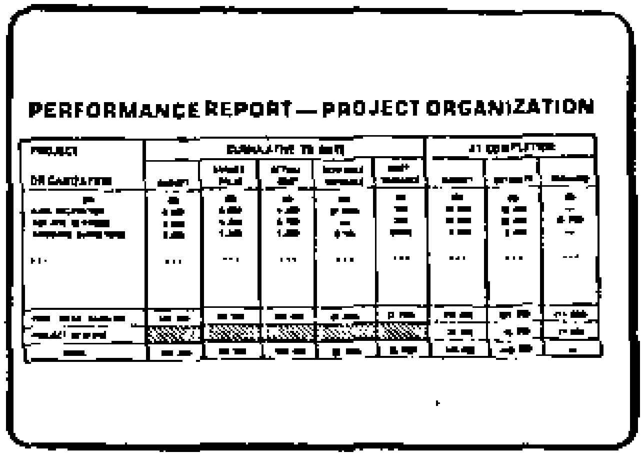
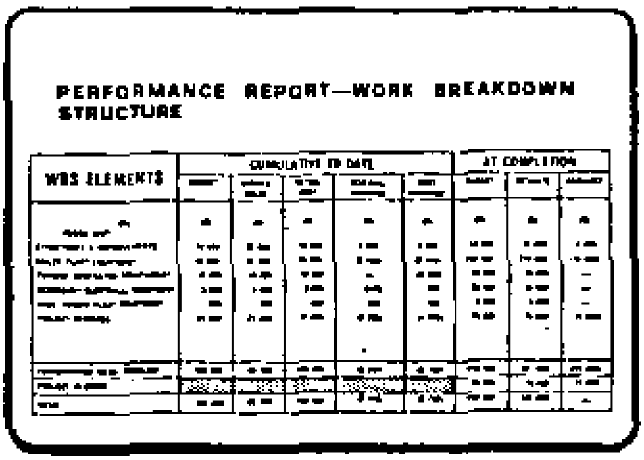






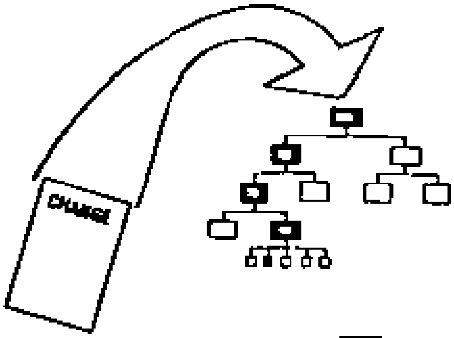
CHANGE CONTROL

"MANAGING INDUSTRIAL PROJECTS" (MIPS)

CHANGE CONTROL

Audio-Visual 79-751

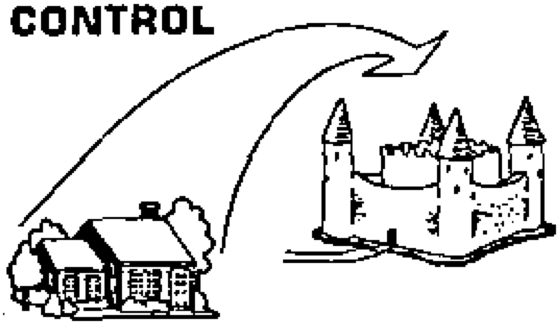
CHANGE CONTROL



CHANGE CONTROL OBJECTIVES

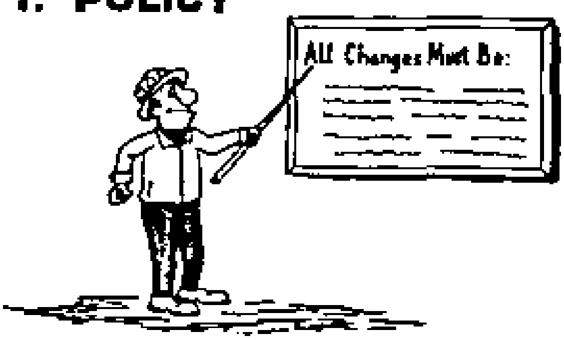
- DESCRIBE A CHANGE CONTROL PROGRAM
- REVIEW TYPICAL CAUSES OF CHANGES
- SUGGEST WAYS TO CONTROL CHANGES
- DISCUSS IMPACT OF CHANGES ON A PERFORMANCE ORIENTED APPROACH

CHANGE CONTROL

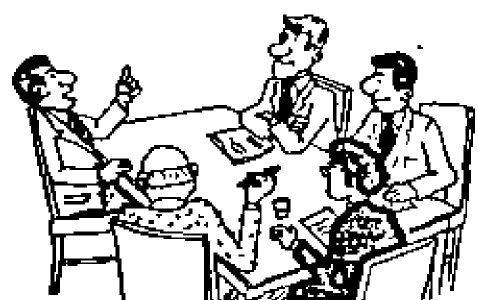


ELEMENTS OF A CHANGE CONTROL PROGRAM

1. POLICY



2. MANAGEMENT PARTICIPATION



"MANAGING INDUSTRIAL PROJECTS" (MIPS)

CHANGE CONTROL

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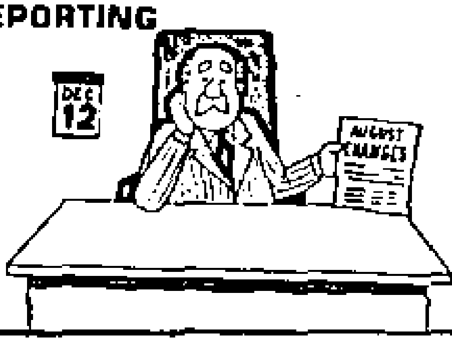
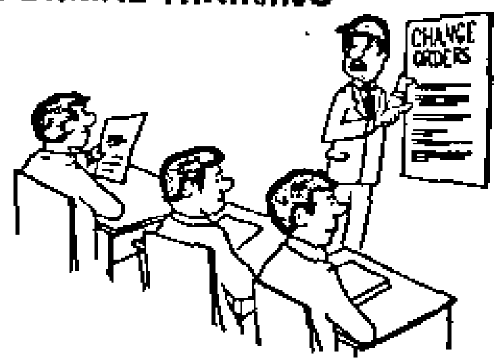
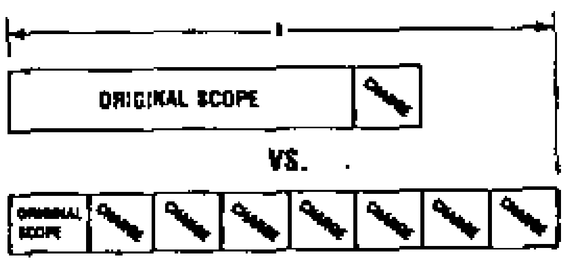
3. TIMELY & ACCURATE REPORTING



4. FORMAL TRAINING

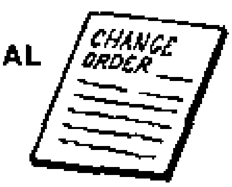


5. EFFECTIVE PLANNING, NEGOTIATION & ADMINISTRATION OF CONTRACTS

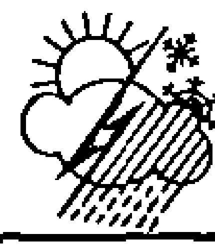


TYPES OF CHANGES

1. FORMAL

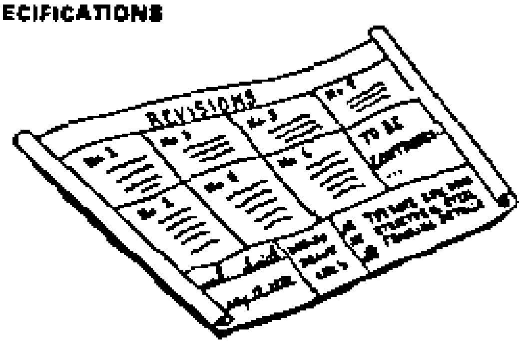


2. INFORMAL (CONSTRUCTIVE)



SOME TYPICAL CAUSES OF CHANGES

DEFECTIVE OR INCOMPLETE DRAWINGS AND SPECIFICATIONS

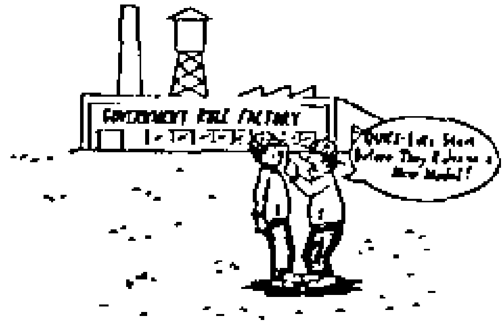


"MANAGING INDUSTRIAL PROJECTS" (MIPS)
CHANGE CONTROL

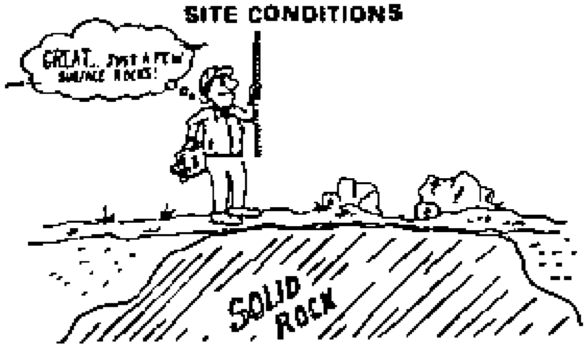
Audio-Visual 79 751

LATE OR DEFECTIVE OWNER-FURNISHED MATERIALS AND EQUIPMENT

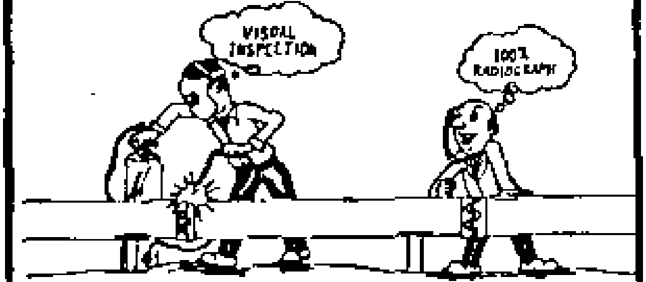
CHANGES IN REGULATORY REQUIREMENTS



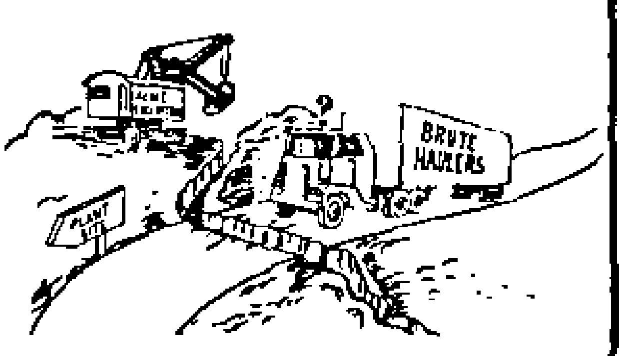
CHANGED OR UNKNOWN SITE CONDITIONS



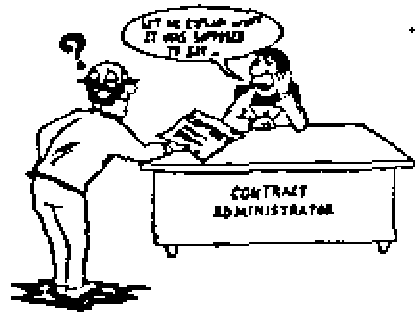
INCREASED INSPECTION OR ACCEPTANCE CRITERIA



COLLATERAL WORK — "RIPPLE EFFECT"



AMBIGUOUS CONTRACTS OR CONTRACT INTERPRETATIONS



"MANAGING INDUSTRIAL PROJECTS" (MIPS)

CHANGE CONTROL

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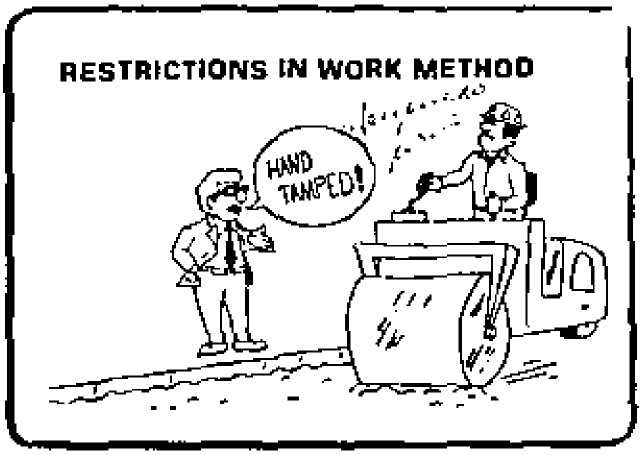
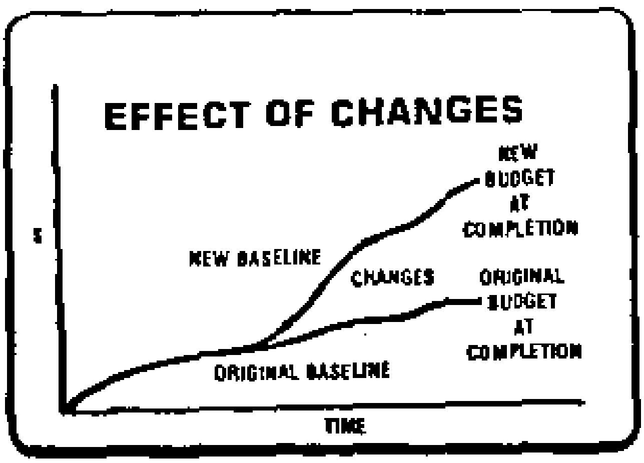
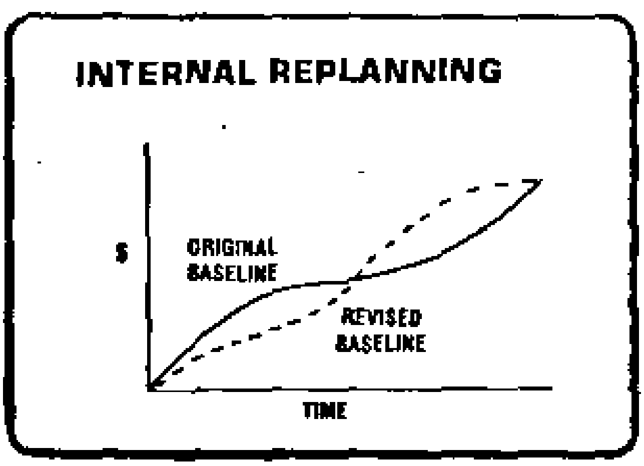


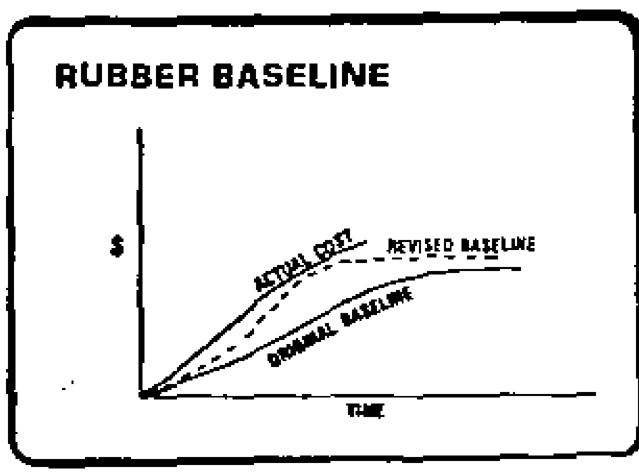
DEFINE SCOPE OF WORK CLEARLY IN THE CONTRACT



VISIBILITY OBJECTIVES

- MAINTAIN A BASELINE WHICH REPRESENTS THE WORK BEING DONE
- MAINTAIN PERFORMANCE TRENDS





"MANAGING INDUSTRIAL PROJECTS" (MIPS)
IMPLEMENTATION

Audio-Visual 79-751

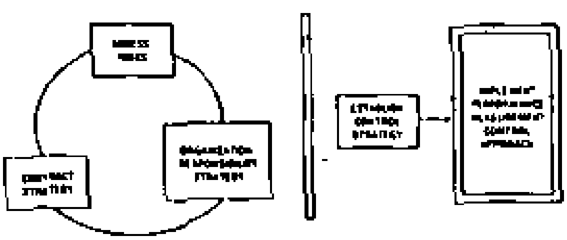
PERFORMANCE ORIENTED APPROACH

IMPLEMENTATION

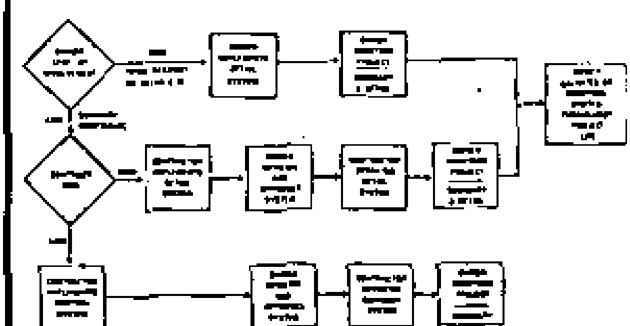
IMPLEMENTATION

- ☑ DESCRIBE A TYPICAL PROCESS
- ☑ DISCUSS IMPLEMENTATION CONSIDERATIONS
- ☑ DISCUSS IMPLEMENTATION CHALLENGES AND CONCERNS

IMPLEMENTATION PROCESS



IMPLEMENTATION CONSIDERATIONS



IMPLEMENTATION EFFORT
OWNER IMPLEMENTS DETAIL SYSTEM

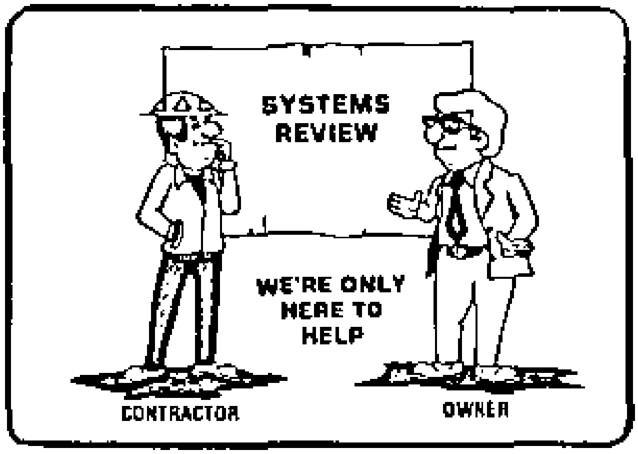
- WORK DEFINITION
- RESPONSIBILITY ASSIGNMENT AND CONTROL ACCOUNT ESTABLISHMENT
- SCHEDULING, ESTIMATING AND PERFORMANCE BUDGETING
- MEASURING ACCOMPLISHMENT
- ACCUMULATING ACTUAL DATA
- COMPARING PLANNED AND ACTUAL PERFORMANCE
- REPORTING AND ANALYSIS
- CHANGE CONTROL

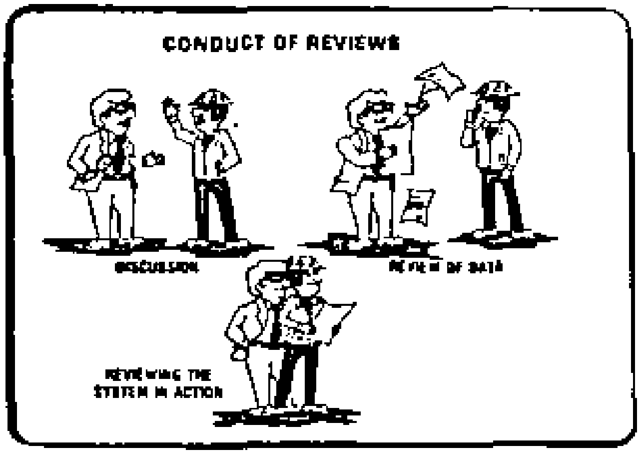
IMPLEMENTATION EFFORT
HIGH RISK CONTRACTS OR PROJECTS

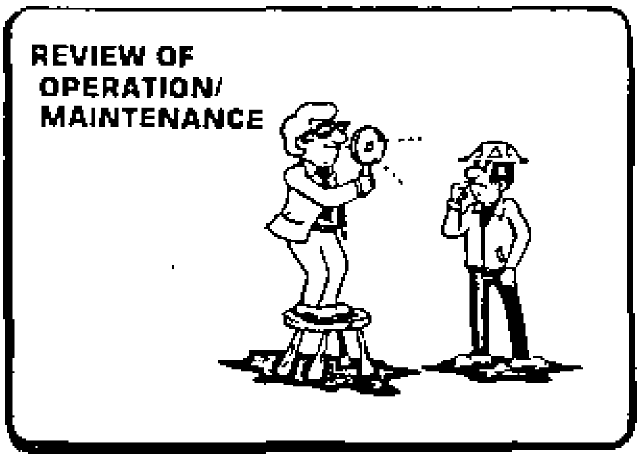
- CONTROL SYSTEM REQUIREMENTS IN REQUEST FOR PROPOSAL (RFP)
- REVIEW OF BIDDERS RESPONSES
- IMPLEMENTATION REVIEW

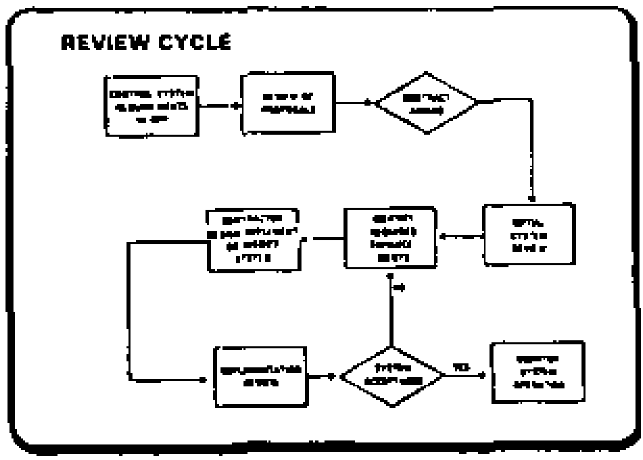
"MANAGING INDUSTRIAL PROJECTS" (MIPS)
IMPLEMENTATION

Audio-Visual 79-751



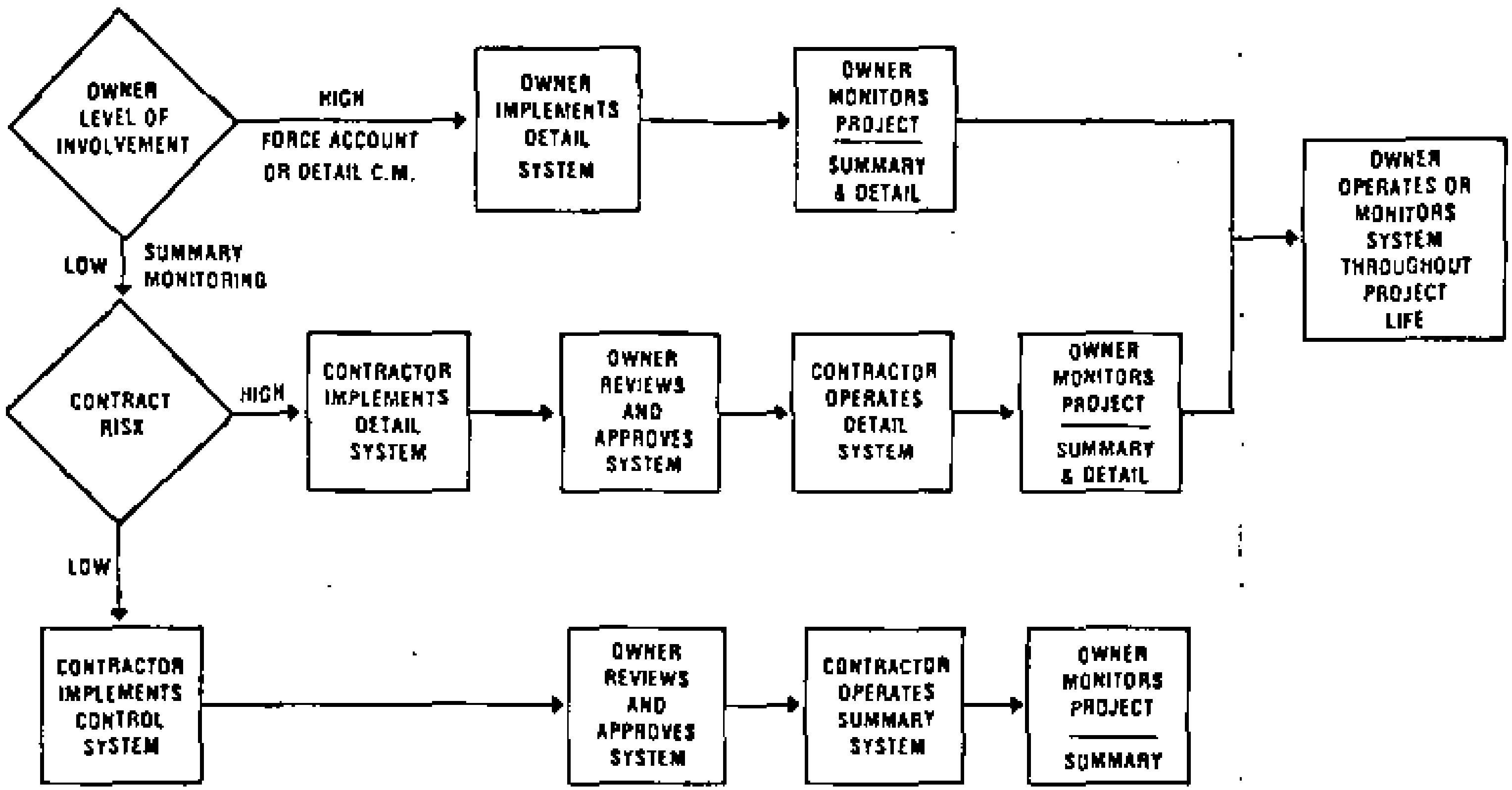






AUTOMATION

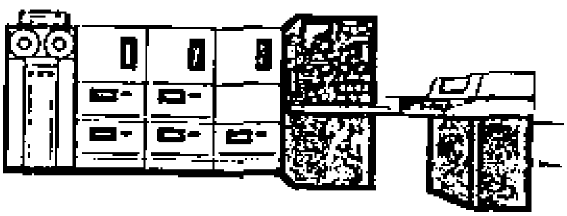
IMPLEMENTATION CONSIDERATIONS



"MANAGING INDUSTRIAL PROJECTS" (MIPS)
AUTOMATION

Audio-Visual 79-751

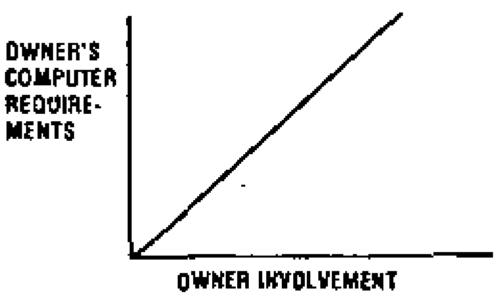
AUTOMATION CONSIDERATIONS



AUTOMATION CONSIDERATIONS

- ☑ IDENTIFY FUNCTIONS THAT BENEFIT FROM AUTOMATION
- ☑ DEFINE AN OVERALL AUTOMATION SCHEME
- ☑ DISCUSS AUTOMATION ALTERNATIVES
- ☑ PROVIDE APPROACH FOR USE OF A COMPUTER

REQUIREMENTS INCREASE

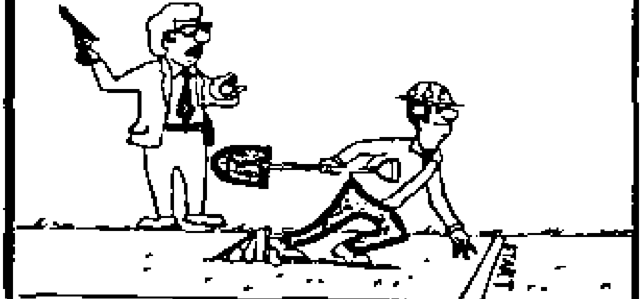


WITH OWNER INVOLVEMENT

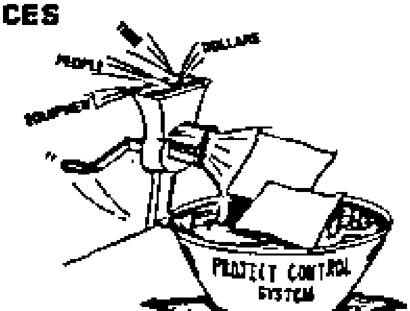
AUTOMATION ALTERNATIVES

- USE EXISTING SYSTEMS OF A/E, CONSTRUCTION MANAGER OR CONTRACTOR
- DEVELOP CUSTOMIZED OWNER SYSTEM
- UTILIZE SOFTWARE PACKAGES
- COMBINATION OF ABOVE

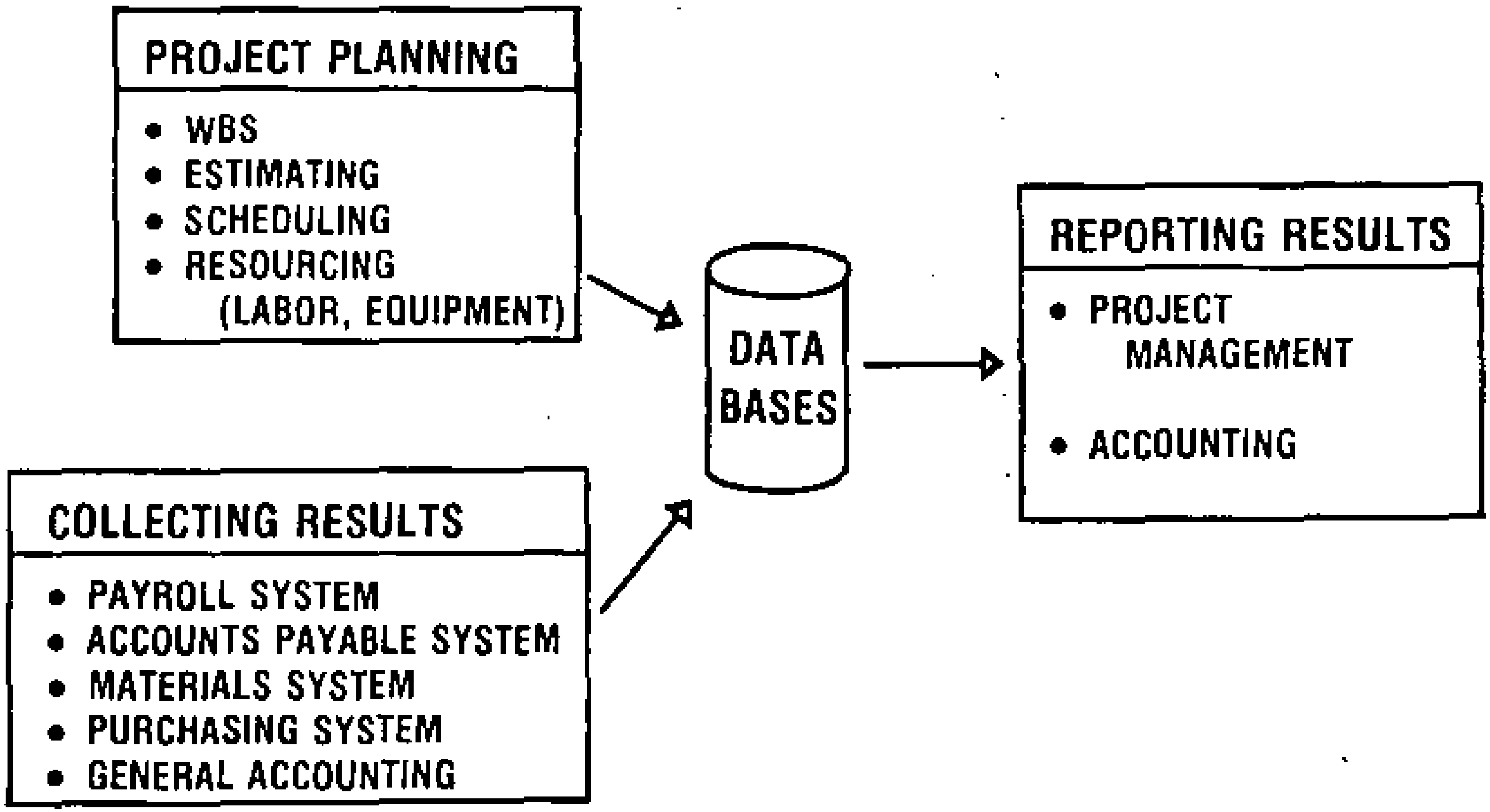
CONTROL SYSTEMS MUST BE IN PLACE BEFORE MOBILIZATION



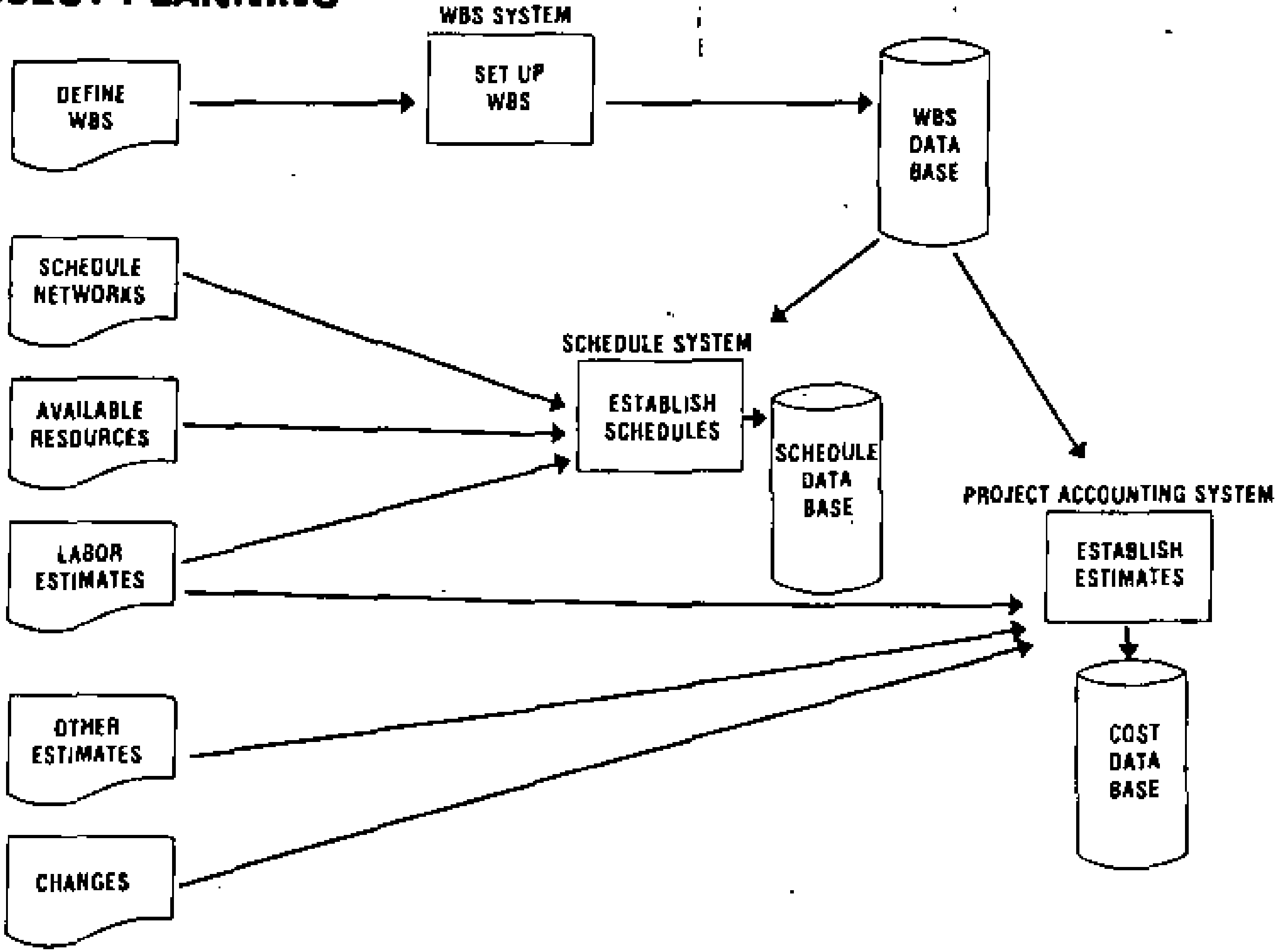
SYSTEM ESTABLISHMENT MAY REQUIRE SUBSTANTIAL RESOURCES



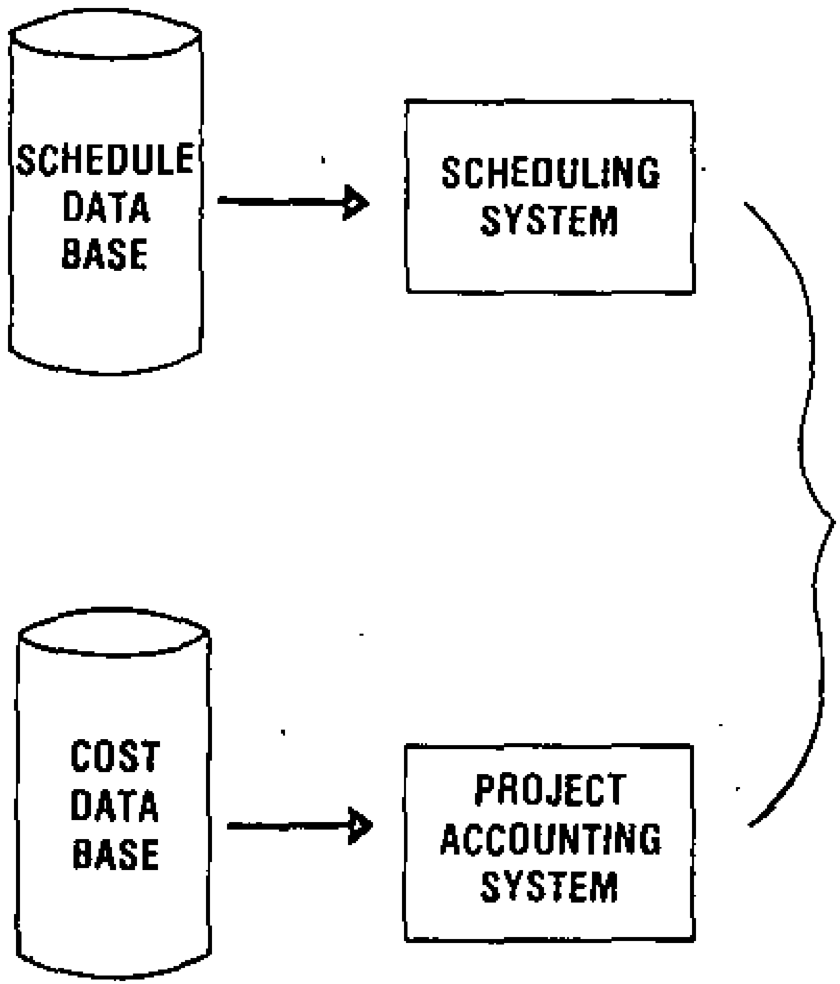
FUNCTIONS WITH AUTOMATION POTENTIAL



PROJECT PLANNING



REPORTING RESULTS



- MANAGEMENT STATUS SUMMARIES
- DETAILS BY RESPONSIBILITIES
- EXCEPTIONS
- SPECIAL ANALYSES

SOFTWARE PACKAGES — SCHEDULE

PACKAGE	VENDOR	MINIMUM CORE SIZE	LANGUAGE
MSCS	McAUTO	140K	FORTRAN
PREMIS	SUN INFORMATION SYSTEMS	200k	BAL
PROJECT 2	PROJECT SOFTWARE DEVELOPMENT, INC.	200k	BAL/ICETRAN
PMS IV	IBM	75-100k	BAL
PROJACS	IBM	144k	PL1/ASSEMBLER
PMCS/66	HONEYWELL	104k	FORTRAN

SOFTWARE PACKAGES — COST

PACKAGE	VENDOR	MINIMUM CORE SIZE	LANGUAGE
COPES	McAUTO	190k	BAL COBOL FORTRAN
PICOM	SUN INFORMATION SYSTEMS	200k	BAL
FINPAC	AA&Co.	120k	COBOL BAL
CCES	CONSTRUCTION INFORMATION SYSTEMS	256k	BAL
PCP	PROJECT SOFTWARE DEVELOPMENT, INC.	256k	BAL ICETRAN
PMCS 66	HONEYWELL	104k	FORTRAN
CMAS	IBM	16k	RPG II
PMS IV	IBM	75k-1000k	BAL
PROJACS	IBM	144k	PL1 ASSEMBLER

SUMMARY

GLOSSARY OF TERMS AND ACRONYMS

Actual Cost (AC) - Actual costs which are recorded for work performed on an applied cost basis (see Applied Direct Costs) and reported in internal cost reports and summarized into the Performance Report (PR).

BAC - See Budget at Completion.

Budget at Completion (BAC) - The BAC is equal to the sum of all cost account budgets.

Burden - See Indirect Cost.

CA - See Control Account.

Chart of Accounts - A formally maintained and controlled identification of the cost elements (labor by type, material, allocation overhead, etc.).

Contract Target Cost (CTC) - The estimated cost negotiated in a cost-plus- or fixed-fee contract, or the negotiated Contract Target Cost in either a fixed-price-incentive contract or a cost-plus-incentive fee contract.

Control Account (CA) - An identified level within the WBS and organization structure at which costs are collected in order to compare planned and actual direct labor, material, and other direct costs with earned budget for management control purposes. It is formed by the intersection of the organizational structure and the WBS. It is the focal point of cost/schedule control, with a specific responsible manager.

Control Account Manager (CAM) - A manager who is directly responsible for the performance of the CA task.

Cost Element - Synonymous with Elements of Cost. Cost elements are types of costs: direct labor, direct material and indirect costs.

Cost Performance Index (CPI) - The value earned for every measurable unit of actual cost expended.

Cost Variance (CV) - The algebraic difference between Earned Value and Actual Cost within a reporting time period (CV = Earned Value - Actuals).

CTC - See Contract Target Cost.

CV - See Cost Variance.

Discrete Milestone - A milestone which has a definite, scheduled occurrence in time, signaling the finish of an activity, such as "release drawings," pipe inspection complete," and/or signaling the start of a new activity.

EAC - See Estimate At Completion.

Earned Value (EV) - The sum of the budgets for completed work packages and completed portions of open work packages, plus the appropriate portion of the budgets for level of effort and apportioned effort.

Estimate At Completion (EAC) - The estimated total cost for the authorized work.

ETC - See Estimate To Completion.

Estimate To Completion (ETC) - Estimate of costs to complete all work from a point in time to completion.

Functional Organization - An organization or group of organizations with a common operational orientation, such as Quality Control, Engineering, Purchasing, Accounting.

Indirect Cost - Resources expended and not directly identified with any specific WBS product or service.

Internal Replanning - Replanning actions performed for remaining effort within the recognized total allocated budget and schedule.

Labor Rate Variances - Difference between planned labor rates and actual labor rates. Labor rate variances are derived by subtracting from (actual hours X planned rates) the (actual hours X actual rates).

Milestone - An explicitly definable accomplishment in a program schedule which can be identified at a precise instant in time.

Objective Indicator - See Discrete Milestone.

ODC - See Other Direct Costs.

Other Direct Costs (ODC) - The remaining direct costs, other than labor and material, which carry administrative burden.

Overhead - See Indirect Cost.

Percent Complete Earned Value Technique - Tasks that do not have a definitive measurable output for cost and schedule performance measurement and are consequently controlled by time-phased budgets established for that purpose. The amount of Percent Complete should be kept to a minimum.

Performance Measurement Baseline (PMB) - The time-phased budget plan against which project performance is measured. It is performed by the budgets assigned to scheduled costs accounts and the applicable indirect budgets. For future effort, not planned to the control account level, the Performance Measurement Baseline also includes budgets assigned to higher-level WBS elements. It equals the total allocated budget less Management Reserve.

Performing Organization - The organizational element expending resources to accomplish a task.

Price Variance - Difference between the planned cost of a purchase item and its actual cost. Price variance is derived by subtracting from (actual quantity X planned cost) the (actual quantity X actual cost).

Rolling Wave Concept - The progressive refinement of detailed work definition by continuous subdivision of downstream activities into near-term tasks.

Schedule Variance (SV) - The difference between Earned Value and budget within a reporting time period (SV = Earned Value - budget). Not an accurate measure of project schedule performance.

Task - A task has the following characteristics:

(1) It represents units of work at levels where work is performed.
(2) It is clearly distinguished from all other tasks.
(3) It is assignable to a single organizational element.
(4) It has scheduled start and completion dates and, as applicable, interim milestones, all of which are representative of physical accomplishment.
(5) It has a budget or assigned value expressed in terms of dollars, man hours or other measurable units.
(6) Its duration is subdivided into discrete value milestones to facilitate the objective measurement of work performed.
(7) It is integrated with detailed engineering, construction and/or other schedules.

To Complete Performance Index - The projected value to be earned for every measurable unit to be expended in the future.

Usage Variance (UV) - The UV is the difference between planned quantity of materials and actual quantity used, expressed in dollars. UV is derived by subtracting from (planned quantity X planned unit cost), the (actual quantity X planned unit cost).

VAR - See Varience Analysis Report.

Variance Analysis Report (VAR) - A report made by the responsible manager to explain a significant cost/schedule variance, its probable impact on the project, and the corrective actions taken to resolve the problem(s).

Variance Threshold - The amount of variance beyond which a Problem Analysis Report is required. Variance parameters differ, depending on the function, level and stage of the project.

Work Breakdown Structure (WBS) - The WBS is a product-oriented family tree division of hardware, software, services and other program-unique tasks.

FACULTY RESUMES

OTHER RELEVANT MATERIALS

DESIGN AND/OR IMPLEMENTATION ASSISTANCE

COMPANY	Evaluation of Practices	Detail Definition of Work	Risk Analysis & Control Strategy	Organization & Responsibility Assignment	Scheduling	Estimating/ Performance Budgeting	Collecting Actual Information	Measuring Accomplishment	Management Reporting	Detail Reporting & Analysis	Change Control	Procurement Bid Packaging & Evaluation	Contract Auditing
ALABAMA POWER	X		X	X			X		X		X	X	
ARGONNE NATIONAL LABORATORIES (DOE PROJECT OFFICE)	X	X		X	X	X	X	X	X	X	X	X	X
ARIZONA PUBLIC SERVICE				X									
BALTIMORE GAS & ELECTRIC	X	X	X	X	X		X		X		X	X	
BURNS & ROE	X	X		X	X	X	X	X	X	X	X		X
CENTRAL ILLINOIS LIGHT CO.	X	X	X	X			X		X		X	X	X
CLARK EQUIPMENT COMPANY	X	X		X		X	X	X	X	X	X	X	
COMMONWEALTH EDISON	X												
DU QUESNE LIGHT CO.	X		X	X	X		X	X	X	X	X		
HACKENSAK WATER COMPANY	X		X	X		X			X	X	X	X	
LONG ISLAND LIGHTING COMPANY	X												
LOUISVILLE GAS & ELECTRIC	X	X		X	X	X	X	X	X	X	X		
MORRISON-KNUDSEN SAUDI ARABIA CONSORTIUM (MKSAC)	X	X		X	X	X	X	X	X	X	X		
NIAGARA MOHAWK POWER COMPANY	X		X										
NORTHERN INDIANA PUBLIC SERVICE CO.	X		X	X			X		X		X		X
PROJECT MANAGEMENT CORPORATION	X												
TOLEDO EDISON	X		X	X		X	X		X	X	X	X	
WASHINGTON PUBLIC POWER SUPPLY SYSTEM	X												
WESTINGHOUSE ADVANCED REACTOR DIVISION (ARD)	X	X		X	X	X	X	X	X	X	X	X	X

John Smith
— ref. Shell

CLIPPINGS

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Illinois Utility Sparks Widespread Interest With Its Videotape

• • •

Show Is Rebuttal to Coverage Of Firm's Nuclear Plant By '60 Minutes' on CBS

By SANDY GRAHAM
Staff Reporter of THE WALL STREET JOURNAL

When Illinois Power Co. decided to produce its own version of the "60 Minutes" coverage of the utility's new nuclear power plant, the company never dreamed thousands of people would be fascinated by the outcome.

"This crazy thing doesn't seem to quit," says a spokesman for Illinois Power, referring to the demand for "60 Minutes: Our Response," a videotape it produced after the documentary program lambasted management and cost control at the new Clinton nuclear power plant. The Decatur, Ill.-based utility has distributed more than 600 copies on request the past few months.

A look at the letters to the editor in any newspaper will show reporters' and companies' news judgments don't always jibe. Some companies routinely "co-tape" their executives' TV interviews. Illinois Power's "counter program" goes a step further.

What became a "point-counterpoint" between the utility and Columbia Broadcasting System began as a precaution when it became clear to Illinois Power that CBS "didn't come out to do a love story," the company spokesman says. The utility charged the "60 Minutes" piece, seen in about 24 million homes on Nov. 25 last year, was full of errors and inadequacies. Taking the "60 Minutes" segment and interspersing its own tape and comment, the utility put together a 42-minute show, destined at first for just employes, stockholders and customers.

But word spread, and soon Illinois Power was buried in requests for copies, which it has provided to anyone who sent in a blank tape.

Such big companies as Chevron USA, a unit of Standard Oil Co. of California, and Union Carbide Corp. have copies, along with dozens of utilities, the company says. Copies have been sent as far as Germany and Australia, and in turn have been made available to others. "It's like rabbits. It multiplies," says a Dayton Power & Light spokesman, who says its copy of the Illinois Power program has been shown to 2,500 people, mostly employe and community groups.

The idea is intriguing to Commonwealth Edison Co., the Chicago-based utility that generates more nuclear power than any other. Simultaneously taping news coverage "is something we'd give strong consideration to," a spokesman says after seeing Illinois Power's tape. The counter-program "certainly served Illinois Power well, and it's something we'd think about."

The "60 Minutes" news team, meanwhile, hasn't had any other companies it interviews follow Illinois Power's example, a spokeswoman says. She says "60 Minutes" always has allowed simultaneous audiotaping of its interviews. While Illinois Power was the first company to request videotaping, the program allowed it, and will continue to do so, she said.

PROJECT RESERVES
A KEY TO MANAGING COST RISKS

John W. Murray
and
William F. Ramsaur,
Arthur Andersen & Co.,
Washington, D. C.

INTRODUCTION

Historically, cost estimates for specific long-term projects have included a contingency amount to cover - hopefully - the cost of uncertain risks or "unknowns". The amount of the contingency varies by project depending on such variables as the "state of the art", firmness of project design scope, and for other "undocumented" reasons.

We will describe procedures that have been proven to provide a basis to help aid in the control of cost risks. Our approach differs from the historical approach by establishing project cost reserves in the project cost estimate for specific cost risks. Project reserves provide the opportunity for management to focus attention and resources on the major risks. The use of project reserves should be a key factor in a project cost control program.

Project reserves are special provisions for uncertainties affecting the cost of the project. A variety of reserves should be included in the total planned cost for a long-term project as contingencies against inaccurate preliminary estimates, schedule slippage, technical problems, potential minor changes in project scope, specific events which may or may not occur, etc., and as an overall hedge against problems not anticipated at the time when the preliminary project costs were approved.

The use of the term "reserve" as defined in this project management sense is not the same as and should not be equated with that term as it is often defined and used in a financial accounting and reporting sense. In addition, the project reserve should not be considered as part of original legal requirements of any specific contract (i.e., anticipating formal change orders, informal changes, delays, suspensions of work, etc.).

It is imperative that reserves be given proper visibility and that their establishment, use, and rate of consumption be monitored closely at the proper level in the project organization. The sections that follow describe procedures to create, utilize, and monitor project reserves. These procedures are being used by the project management department of a utility on a project to design and construct two large electric generating units.

Terminology

Following is a definition of specific terms which are used to describe the project reserve procedures.

- **Planned Cost**

  The approved budgeted cost for the project. Project reserves are included in the total planned cost.

- **Committed Cost**

  The planned cost for project segments which have been committed to contractors and vendors based on awarded contracts and purchase orders.

- **Forcasted Cost**

  The current best estimate of costs at completion. The use of forecasted cost in the project cost control reports does not require the formal approval associated with planned costs.

- **Contract Reserves**

  Two types of contract reserves are used - Specific and General. Specific contract reserves are established for specific cost risks for project segments or contracts. In some cases there will be multiple specific reserves associated with a contract. General contract reserves are established for minor changes which may occur during the contract.

- **Management Reserve**

  A reserve for the project not associated with specific project segments or contracts.

MAJOR PRINCIPLES OF PROJECT RESERVES

There are four major principles associated with project reserves. These principles, which are described below, are. (1) Assess Risks, (2) Establish Reserves Which Are as Specific as Possible, (3) Develop Project Cost Estimates, and (4) Assign Specific Reserve Responsibility to Individuals.

1. **Assess Risks**

The project must be reviewed to determine the risks associated with each segment or contract. The level of detail for risk identification should reflect the magnitude of the risk and the phase of the project. On many projects, this risk assessment merely formalizes an informal project procedure.

A major factor in assessing risk is determining the degree in which the design, manufacture, construction, or installation of a certain segment of the project represents an advance in the state of the art. In our experience, these risks are typically understated to a significant degree. A second factor in risk assessment is to identify materials or equipment which are in short supply or which are particularly susceptible to inflationary pressures. Closely related is the identification of long lead time materials and equipment which, by their extended procurement cycles, may represent a high degree of cost uncertainty. These procurement uncertainties can often be minimized through effective purchasing policies and practices, including obtaining quotes and finalizing contracts for long lead or short supply items at the earliest practical point in the project. However, a key to material and equipment control in the early planning and budgeting phase of a project is to identify potentially sensitive items so that the requirement for reserves can be determined.

The nature of the contracts anticipated for each segment of a project must also be considered when evaluating reserve requirements. From an owner's standpoint, for example, any segments of the project which may be performed on a cost-plus-fixed-fee (CPFF) basis or under a price subject to escalation would generally involve greater cost uncertainty than those segments performed on a firm price, lump-sum basis. The CPFF and escalation contracts, therefore, would normally require larger reserves to cover the increased cost uncertainty.

2. **Establish Reserves Which Are As Specific As Possible**

The more specific the reserve can be defined, the greater will be management's ability to monitor the use and evaluate the adequacy of the reserve as the project progresses. For example, a specific contract reserve could be established for extra backfill charges to cover the risk that the fill material shrinkage allowance would be exceeded in an earthwork contract.

When specific reserve requirements are combined with other contingency amounts, it is far more difficult to monitor the reserve usage as the work progresses.

If the reserve is not required for its intended use, it is automatically returned to the overall management reserve for the project. Conversely, if problems develop, the specific reserve would provide the visibility necessary to evaluate the additional cost requirements.

A normal procedure is to identify general contract reserves as well as specific reserves. For example, most long-term contracts on a project which overlap engineering and construction work will incur changes. Thus, a general contract reserve for change orders would be established for the other contract cost risks that are not provided for in a specific reserve. Exhibit 1 illustrates types of contract reserves.

CONTRACT RESERVES

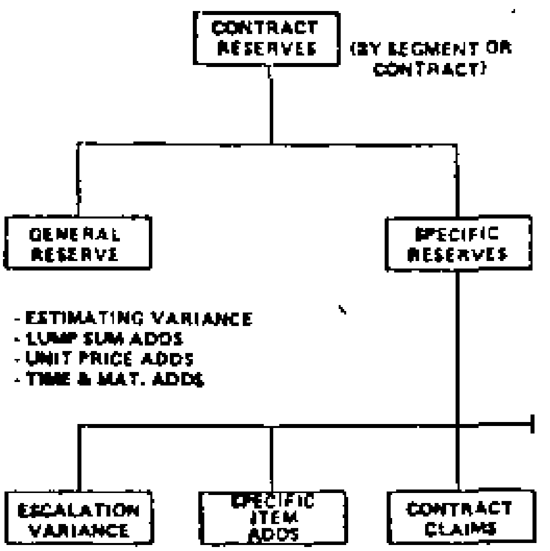

EXHIBIT 1

The establishment of contract reserves does not, however, preclude the need for a management reserve for the project. The management reserve is needed to cover events which invariably occur during long-term projects but which cannot be specifically anticipated when project costs are approved. The management reserve should be established, however, only after the reserves for specific segments and contracts have been defined, evaluated, and approved.

3. Develop Project Cost Estimates

It is critical that the major assumptions used to develop the reserve estimates be thoroughly documented and retained for reference. This documentation of the estimating logic provides management with a basis for review and approval of the estimates, allows for subsequent reassessment of the estimates as the project progresses, and provides a historical data base for developing estimates on similar projects in the future. The level of detail may vary substantially by project segment. Estimating of a reserve requirement for a state-of-art task, for example, may be less refined than those developed for more conventional construction work. In any event, the estimating logic should be retained for subsequent analysis.

The project reserve procedures must be integrated with the cost estimating function. To be effective, cost estimates must be organized the way that the work will be constructed and managed. In addition, cost estimators and project management must work closely together to identify the risks associated with special project segments and their respective cost estimates.

It is essential that the format for presenting the project cost estimate identify the reserves associated with each project segment contract. A summary cost estimate report is shown below.

SUMMARY OF DEFINITIVE ESTIMATE
(Dollars in $000)

	Base Cost	Reserves ①	Planned Cost
Contract No. 1	$ 1,900	$ 380	$ 2,280
Contract No. 2	3,000	450	3,450
Contract No. 3	1,500	50	1,550
⋮	⋮	⋮	⋮
Total Contracts	380,000	100,000	480,000
Owner Charges	8,000	—	8,000
Total	388,000	100,000	488,000
Management Reserve	—	28,000	28,000
Total	$388,000	$128,000	$516,000

① The details of reserves for each contract are shown in a separate cost estimate report.

EXHIBIT 2

It is very important that the management reserve be independently analyzed and approved at periodic project cost estimate reviews. The state of drawings, commitments, actual expenditures, and physical construction completion percentage are key factors in this management reserve analysis.

4. Assign Specific Reserve Responsibility To Individuals

Each reserve must be assigned to an individual. At the lowest level, reserves should be assigned to individuals having line responsibility for a specific segment or contract for the project. Higher level reserves should be assigned to higher levels of management.

Each individual having responsibility for a project reserve should perform the following functions:

a. Review and approve the reserve estimates and their underlying assumptions.

b. Approve the transfer of reserve amounts.

c. Monitor the status of the reserves and their rate of usage, using project cost control reports to aid in this analysis.

d. Participate in estimating the amount of additional reserves which may be required to complete the total project or a specific segment of the project.

In most cases, the actual transfer of reserve amounts results from the completion of a prior event, such as the awarding of a contract or the approval of a change order. An integral part of the contract or change control approval process is a determination of its impact on reserves, including the need to utilize part of the management reserve. Therefore, responsibility for control of reserves should rest with those who have line responsibility for project decisions in the segment involved. In all areas of a project, periodic and independent analyses of reserve usage should be performed to help ensure maximum control and prudent use of project funds. In addition, all transfers are evaluated in relation to budget availability and constraints.

Assigning specific responsibilities for the control of project reserves is a prerequisite to the control of cost risks. Affixing specific responsibility for each reserve including the management reserve and separately identifying each at the appropriate level in the project control reports will provide the visibility necessary to monitor their adequacy and control the rate of use. An example of reserves assigned to project personnel is shown in Exhibit 3.

RESPONSIBILITIES FOR CONTROLLING PROJECT RESERVES

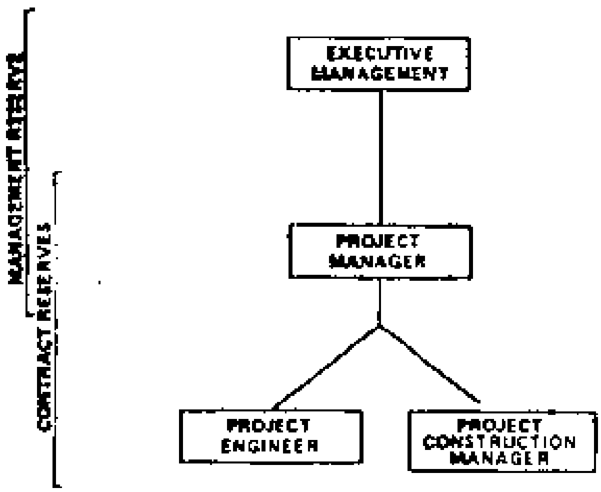

EXHIBIT 3

Reserves and the Contract Life Cycle

Exhibit 4 describes the project reserve procedures over the life of a planned, open, and finally completed contract.

CONTRACT LIFE CYCLE SUMMARY

Project Phase/Event	Action
Design	o Assign responsibilities. o Establish reserve requirements for contract and management reserves. o Approve planned cost for reserves. o Based on more detailed information update forecasted costs as appropriate. o Reassess reserve requirements and transfer planned costs for reserves as approved.
Design Changes	
- Design Change Identified	o Revise forecasted cost as appropriate.
- Design Change Approved	o Reassess reserve requirements and transfer reserves as approved.
Contract Duration (For each contract)	
- Potential Contract Change/Claim Identified	o Revise forecasted cost as required (It is imperative that early change recognition be stressed).
- Change Order/ Claim Approved	o Transfer reserves to reflect the negotiated price, using contract and management reserves as approved.
- Periodic Reserve Review	o Reassess contract reserve requirements and update forecasted cost as appropriate. o Transfer reserve amounts to or from management reserve as approved.
- Contract Materially Complete	o Assess contract "settlement" costs and transfer reserves as approved.

EXHIBIT 4

The present reserve procedures, also, can be applied in the project planning phases that precede design. As would be expected, its application in the project planning phase may be at a higher level because of the lack of detailed information.

Exhibit 4 indicates the importance of reserves in the cost management process. The reserve transfer process should be tightly controlled and based on actual events (e.g., design changes, contract awards), as much as possible. Frequent and unnecessary reallocation of reserves can cloud the cost visibility on a project.

Exhibit 4 also reflects the necessity of periodically reassessing reserve requirements. Generally, it is preferable to establish specific guidelines when these reviews must be made. Examples of guidelines for a contract would be:

- When a contract is 70 percent physically complete.

- If percent usage of a contract general reserve exceeds the physical percent complete by more than 20 percentage points.

- At least once a year.

Lastly, an important element of reserve control is that reserves can only be used for the purposes for which they were established. Reserves that are not used will be eliminated from the planned cost estimate.

Management Reporting

A comprehensive reporting system is necessary to the effective monitoring of planned costs and reserves. It can provide early warning of potential problems and identify reserve transfers and uses. The reports would also be used to evaluate the rate at which reserves are being consumed over the course of contracts and the project.

An example of a summary project cost status report for executive management is shown in Exhibit 5.

MONTHLY PROJECT COST SUMMARY
(Dollars in $000)

	Planned Cost ①	Forecasted Cost	Potential Impact On Management Reserve
Completed Contracts	$100,000	$100,000	$ 0
Open Contracts	230,000	270,000	(10,000)
Estimated Contracts	120,000	130,000	(10,000)
Total Contracts	480,000	500,000	(20,000)
Owner Charges	8,000	8,500	(500)
Total	488,000	508,500	(20,500)
Management Reserve	28,000	—	28,000
Total At Completion	$516,000	$508,500	$ 7,500

① Planned Cost includes Committed Cost and Reserves.

EXHIBIT 5

In this report the forecasted cost is compared to the planned cost for each contract to determine the potential impact on the management reserve.

The Monthly Project Cost Summary is presented in more detail for each lower level of management. For example, the project manager would have a line item for each "High Risk" Open Contract. In addition, the columns of the project manager's report would separate Planned Cost into the Committed Cost, General Contract Reserve, and Specific Contract Reserve for each line item.

The need to identify forecasted costs was highlighted in the Contract Life Cycle Summary (Exhibit 4). For example, the costs of potential change orders and claims are estimated and included in the forecasted cost for the appropriate item.

Two additional key reports which support the Monthly Project Cost Summary are.

- **Early Warning Report**

  This report shows the contracts and reserves which will potentially impact the management reserve by more than a selected amount. It allows management to direct project resources to critical areas to resolve problems and minimize costs.

  The early warning report should also reflect projected balances for reserves which have potential change order and claims identified.

- **Management Reserve Usage Report**

  This report shows management reserve transfers over a selected amount with a description of the reason for each transfer. This report allows executive management to monitor, after the fact, the actions that have been delegated to project management.

Perhaps the most important, yet difficult aspect of reserve management is the need to evaluate the rate at which reserves are being consumed and to assess the adequacy of the unused reserve to cover the uncompleted portions of the project. Too often, reserves or contingencies are allowed to be virtually depleted before it is recognized that additional funding will be required to complete the project. A reserve usage graph can assist in addressing this problem. Exhibit 6 illustrates a simple graphic approach to management reporting of reserve status.

RESERVE STATUS GRAPH

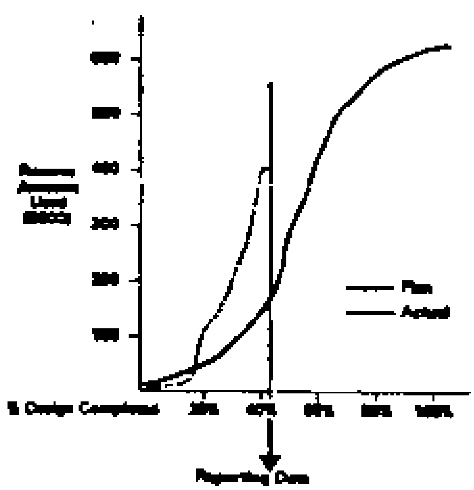

EXHIBIT 6

Exhibit 6 shows that the design and detail takeoffs are approximately 40% complete but over 60% of the reserve has been used. This could mean that the estimating variance (difference between amounts in the order of magnitude estimate and the estimates resulting from detail takeoffs) will cause the reserve to be exceeded. On the other hand, the areas for which takeoffs have been completed might represent the most complex segments and therefore the same variance or reserve consumption rate might not continue. In either case, specific evaluation of the reason for higher-than-planned reserve consumption must be made.

The reserve control concepts here offered still rely on the necessary underpinning that total planned costs before completion are the best estimate available of what it will take to do the job under circumstances as they exist.

Lessons Learned in Using Project Reserves

Effective implementation of the project reserve procedures requires good design and specific estimate documentation. It also requires that the estimating function become project segment and contract oriented, as opposed to end-product or accounting oriented. In many industries the effective implementation of contract oriented estimates will have a learning curve associated with it.

Care must be exercised that too many levels of reserves (e.g., contract, discipline, functional area) are not established. Although a several level approach may seem theoretically correct, it lessens problem visibility and can cause a large number of transfers between reserves with little meaning and a lot of confusion.

In addition, the creation of reserves at too detailed a level can provide good information but in reality little control at a high cost. For example, creating a specific reserve for (1) lump-sum, (2) unit-price, and (3) cost-plus changes, respectively, on a contract could provide good information but little control from a reserve standpoint. In this case, a change order plan by contract term and reporting against the plan would be a better procedure for monitoring this project activity than the project reserve procedure.

SUMMARY AND CONCLUSIONS

The principal objective of the reserve control procedure is to provide management with the early and continuing visibility necessary to evaluate the total cost status of each project. This can best be accomplished by applying each of the major control tasks as follows:

1. Assess the various project risk factors.
2. Develop and document logical estimating assumptions.
3. Assign specific responsibility for reserves.
4. Emphasize the early recognition of potential changes and claims.
5. Control the use of reserves with specific approvals of transfers.
6. Report reserve changes in the project control system.
7. Analyze the rate of reserve consumption in relation to the project status.

Earliest possible visibility provides management with maximum flexibility in reacting to potential cost problems. The steps which can be taken, if potential problems are recognized early, include the following.

1. Adjust project scope.
2. Defer portions of the project.
3. Request additional funding.
4. Concentrate management resources on the most sensitive elements of the project.

Project reserves are not intended to be a vehicle for absorbing or concealing cost performance problems at any level in the project organization. This includes contractors, subcontractors, architect/engineers, construction managers or owner personnel with project responsibilities. Reserves, developed in a logical manner, are intended to provide protection against the many uncertainties associated with complex, high-cost projects spanning long periods of time.

The major benefit from applying the project reserve procedures is the discipline it forces at various levels of project management. The project estimate identifies contract reserves and management reserves. These, in turn, are approved as part of the management approval process. Transfer between reserves requires management approval and post approval reporting to the next higher level of management. This visibility enables project and executive management to be informed. An informed management is far less subject to cost problem surprises!

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