

CONSTRUCTION INDUSTRY INSTITUTE MODEL PLANT

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Construction Industry Institute Model Plant

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Productivity Measurements Task Force
Model Plant Subcommittee**

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SUMMARY

This report is an introduction to the CII Model Plant Project. The Model Plant is a typical facility physical baseline against which to measure construction productivity.

A need for an industry-wide construction productivity measurement baseline has been recognized for a number of years. Construction productivity data for nationwide use is either not available or considered unreliable. The Business Roundtable Construction Industry Cost Effectiveness (CICE) Project Report A-1, "Measuring Productivity in Construction," included a recommendation to measure site-level productivity in selected private construction segments. The report suggested a logical segment scheme based on construction volume.

The CII Productivity Measurements Task Force proposes the establishment of industry standard baseline construction labor estimates for logical segments of the industry. With consideration of the demographics of the CII membership, a large percentage of which is heavily involved in the petrochemical industry, a typical petrochemical facility has been chosen as the initial physical baseline facility.

The primary goal of the Model Plant Project is to develop a basic petrochemical model plant, simple and generic in nature, such that the construction industry can have a physical base against which to measure productivity. Data from collection of direct labor estimates for a "typical" petrochemical processing facility have been chosen as the foundation of the baseline, hence the name "Model Plant."

Future plans include developing similar model projects for other segments of the industry.

The Model Plant represents a petrochemical process plant that costs in the range of \$75-85 million to construct. It consists of nine areas, including a tank farm, underground piping, pipe bridge, fractionation unit, and others. Material takeoffs defining the labor scope of work have been performed from design documents that were supplied by several CII member companies. A code of accounts has been established for the various scopes of work at a detail and summary level. Contractors and owners, based on actual experience, have estimated the amount of construction labor that would be required to build selected parts of the Model Plant. These estimates form a "Baseline One." Estimates in the future for the identical scopes of work will be performed at one- to two-year intervals and compared to "Baseline One."

A tremendous amount of effort has been exerted over the years toward identifying construction standards or common measurements. The variables are vast in number, and have seemed elusive and nearly insurmountable. The code of accounts established for the Model Plant could serve as a standard index to existing codes of accounts, simplifying comparison of project performance within the petrochemical industry.

The data (estimated work-hours of labor) that establish the productivity measurement "Baseline One" will be published separately. The code of accounts, including specific definitions of items included in each activity or cost classification, will be published as a CII source document.

In addition to its use as a standard for productivity measurement, the CII Model Plant is intended to provide a point of reference for other construction research activities. For example, it can be used as a base for impacts of constructability or technology innovation. The Model Plant also can be used as a demonstration example for new concepts or ideas.

INTRODUCTION

In the search for a useful productivity measurement system for owners and contractors, the CII Productivity Measurement Task Force was confronted with several difficult problems — realities of the construction industry.

The construction industry is extremely complex, highly segmented, and essentially a custom-order production activity which is noted for its myriad of specialized fields.

Within the industry, terminology and concepts, unlike manufacturing, are difficult to define or measure due to customization of output, nonrepetitive operations, and a large number of variables with relationships unique to each project.

The Business Roundtable CICE studies show that much of the information for deriving reasonably sound productivity indexes for selected construction segments already exist. It is collected at construction sites by individual owners and contractors. Thus, the need is not to develop new site productivity measurement systems, but rather to find a way to define a norm for comparison of data from existing systems.

The Roundtable reports suggest a logical segment scheme based on construction volume (Table 1).

Table 1
Construction Volume by Segment for 1979

Construction Segment	1979 Construction Volume \$ Billions
Petrochemical industry	40
Other manufacturing industries	29
Office and commercial buildings	37
Electrical power & gas utilities	18
Communication	8
Other	5
	137

The primary goal of the Model Plant Project is to develop a basic petrochemical model plant such that the construction industry can have a physical base against which to measure productivity. Future plans include developing similar model projects for other logical segments of the construction industry.

OBJECTIVES

The objective of this publication is to provide a project that will establish:

- A site-level construction productivity measurement baseline for the petrochemical industry.
- A standardized method of collecting site productivity data from owners and contractors for analysis and reporting.

A secondary objective is to provide a standard code of accounts to permit owners and contractors to compare the performance of their projects to a productivity measurement baseline.

MODEL PLANT PROJECT

This publication serves as an introduction to the data-gathering tools and and some of the necessary strategies to realize the goals of the Model Plant Project. A description of the physical characteristics, including location and labor assumptions, introduces the Model Plant itself. A bid document description, including an explanation of the code of accounts, introduces the Model Plant as a data-gathering tool. Sections on data analysis and application for Model Plant data serve as introductions to research methods and strategies for achieving the goals of the Model Plant Project.

This publication is directed to the membership of the CII and to persons in construction and construction-related concerns, universities, and research institutions in hopes of increasing the awareness of the Model Plant Project, particularly among members of CII task forces. Awareness will increase appreciation for the magnitude of this project and for its present and future utility. Hopefully, it will generate additional ideas for application of the information to be gleaned from the Model Plant Project.

This unique approach has several advantages over the more elementary "market basket" approach in which a database is compiled by sampling unit work-hour rates throughout the industry for different work items. The Model Plant approach allows comparison of improvement suggestions in construction methods (e.g., induction pipe bending), diagnosis of productivity trends, and evaluation of the impact of location, schedule, regulations, or other independent variables.

Development of the Model Plant concept began with the definition of the plant components and the study variables. The Model Plant consists of the nine components listed in Table 2 and shown in Figure 1. They are considered to be representative of typical petrochemical processing facilities.

Table 2
Model Plant Components

Area	Name
100	Tank Farm
200	Underground Piping
300	Control & Instrumentation
400	Primary Distribution
500	Power Area
600	Export Gas Compressor
700	Fractionation Unit
800	Pipe Bridge
900	Plant Road Network

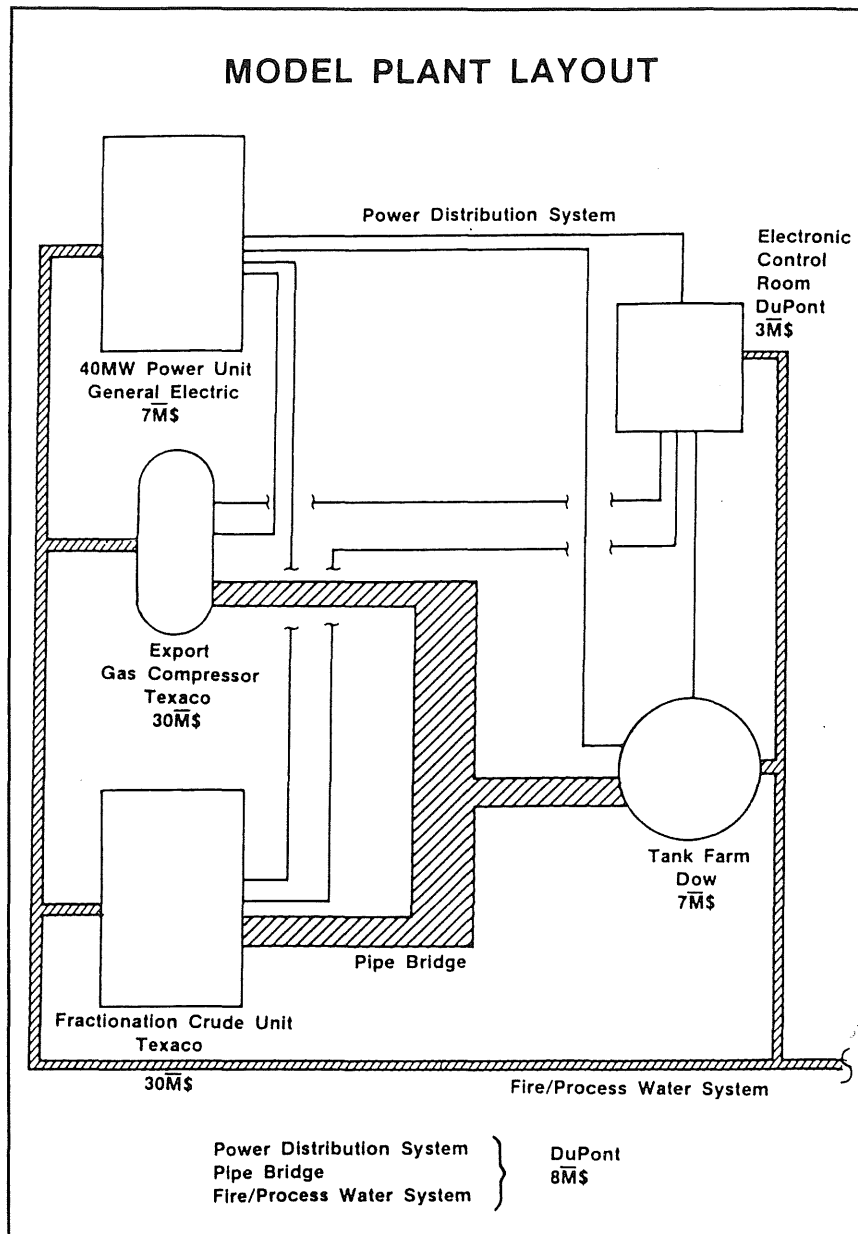


Figure 1. Model Plant Components

From drawings and specifications of the nine components or areas supplied by CII member companies (see Appendix A), a material takeoff has been generated using a code of accounts developed specifically for the Model Plant. Because a direct labor productivity measurement is sought, all independent variables are identified and held constant according to a list of bidders' assumptions. Volunteer bidders are informed of the assumptions and will use the material takeoff and representative drawings from each area to estimate direct work-hours to the detail and summary account level. An example is shown in Table 3.

Table 3
Material Takeoff Extract

Account Code	Description	Qty	Unit	Total* WH	Unit* WH
0811	Foundations < 3cy	1699	CY	26094	15.4
0812	Foundations 3cy-50cy	552	CY	7461	13.5
0813	Foundations > 50cy	4249	CY	22316	5.3
0814	Special Slabs on Grade	96	CY	1330	13.9
0840	Elevated Structures	122	CY	1981	16.2
0850	Civil Structures	10	CY	204	20.4
0860	Walled Structures	1460	CY	25232	17.3
0870	Drilled Footings	21	CY	180	8.6
		8209	CY	84798	10.3

*Data supplied by bidders

Following collection and analysis of initial bid submittals, the Model Plant Subcommittee will meet with the bidders to reconcile estimating data and to assure an understanding of and compliance with the stated assumptions.

The result of these pioneering efforts is a methodology model which is still being refined. The model serves not only as a baseline labor productivity estimate, but also may provide industry, in a quick and efficient manner, reliable information that is useful in numerous ways.

Eight bidders prepared estimates for the initial baseline. Each estimating participant is capable of actually constructing a plant the size of the Model Plant and is normally involved in industrial construction. Representation of union and merit shop organizations are approximately equal. Finally, all initial bidders have worked extensively in the Gulf Coast region, which was chosen as the first hypothetical location. The results of the initial estimates will be reported in a following publication.

DESCRIPTION

To provide an accurate, realistic picture of construction labor productivity, the Model Plant has to be a fair representation of a typical real-life project. A petrochemical processing facility has been chosen because of the critical state of industrial construction labor productivity and the demographics of the CII membership, a large percentage of which is heavily involved in industrial construction.

The Model Plant is a hypothetical installation valued at about \$85 million to be constructed in 78 weeks. The scale and schedule (see Figure 2) are typical of industrial projects.

To simplify and reduce the estimating of work-hours to construct an \$85 million petrochemicals facility, some parts of the process facilities were not included in the material takeoff. The material takeoff represents approximately \$65 million of facilities. Many of its areas or components are common in some form to industrial facilities outside the petroleum industry and many are on similar scales. The nine components and their costs are described in Table 4.

Table 4
Model Plant Components and Costs

Area	Name	Approximate Cost \$Millions
100	Tank Farm	\$ 7
200	Underground Piping	*
300	Control & Instrumentation	3
400	Primary Distribution	*
500	Power Area	7
600	Export Gas Compressor	30
700	Fractionation Unit	30
800	Pipe Bridge	*
900	Plant Road Network	1
	Total	\$85

* The cost of the Underground Piping, Primary Distribution and Pipe Bridge together is approximately \$8 million.

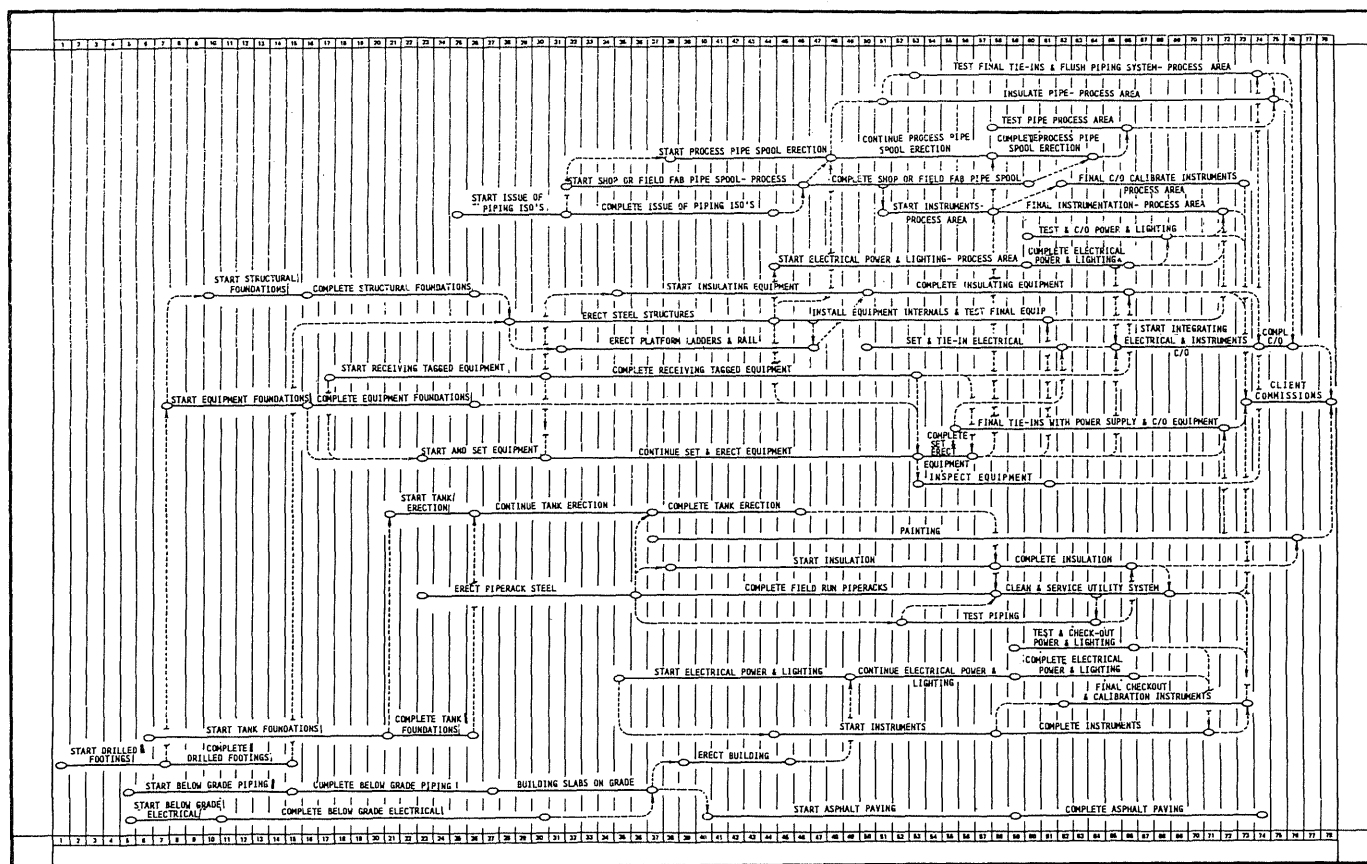


Figure 2. Model Plant Schedule