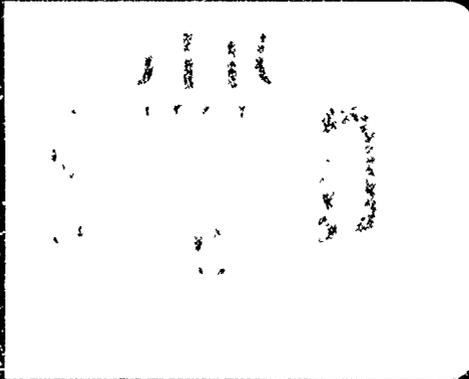


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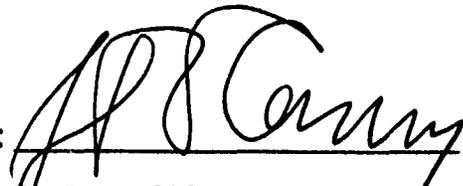


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**SPECIFICATION IMPROVEMENTS FOR ENGINEERED PROJECTS**

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**SPECIFICATION IMPROVEMENTS FOR ENGINEERED PROJECTS**

by

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

The construction of almost any project of any size follows a relatively fixed cycle. Someone has an idea for a project, the scope of work for the project is defined, the project design is accomplished and the project is built. The contractor in the field is concerned with the primary product of the design phase, the project execution plan, which allows him to put the project together. The project execution plan typically includes the contract documents, the plans, specifications and drawings necessary to take the idea and build the finished project.

The specifications are a key element in the project execution plan. "Construction specifications are written instructions distinguishing or limiting and describing in detail construction work to be undertaken."<sup>1</sup> Specifications have a profound impact on the construction process, from the establishment of contract prices during bidding through the project start up and into the operation and maintenance of the finished work. The content and structure of the specifications will impact the total

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<sup>1</sup> H. Griffith Edwards, Specifications (Princeton, N.J.: D. Van Nostrand Co., Inc., 1961), 3

project; well written, straightforward specifications help keep bid prices reasonable and bid proposals easier to assemble, as well as assist the supervisor, foreman and craftsman in the field. Poorly organized specifications lead to errors and omissions in bidding as well as in the actual construction. Overly conservative specifications, often referred to as "gold plated" specifications, needlessly raise construction prices. These potential problems, and many more indeed, clearly point to the importance of specifications to the overall success of construction projects.

The advent of computers to automate the process of writing or assembling specifications has made modification of existing specifications easier. This, when coupled with the proliferation of standard specifications, such as CSI's SPECTEXT, has set the stage for the true standardization of specifications.

## 1.2 Problem Areas

One major problem in the construction industry is the lack of a true industry-wide standard format or structure of specifications. A standard format could greatly assist the construction industry in construction communications. The diverse groups which must communicate on a single project include design firms, consultants, owners, regulatory agencies, construction contractors, product manufacturers and vendors, estimators, and sales representatives. The use of standard formats to assist in organizing and communicating specification information could greatly reduce the potential for miscommunication and lack of understanding of what is actually communicated. A standard format

could be an aid in the transfer of information between the design offices and the construction firms doing the work, as well as assist individual firms to better organize their internal operations. There are several widely accepted approaches, which will be addressed in detail in subsequent chapters, but no single format or pattern prevails across the industry. This is due in part to a number of causes.

The variety of project types which exist naturally poses some problems in standardizing specifications. It is difficult indeed to create a format which can accommodate projects as dissimilar as earthen dam construction and polyethylene plant construction. Some highly repetitive types of construction, such as housing units or perhaps shopping malls lend themselves to creating a standardized format which the projects will easily fall into. The same can be said for all petrochemical plants for instance, as the basic materials, processes, layout and requirements are similar. The difficulty lies in creating a structure which is as appropriate for the construction of the house as it is for the petrochemical plant. The very different nature of what may be categorized as architectural building projects versus engineered projects creates tremendous difficulties in establishing and using a common format. Initially, standardization would consist mainly of establishing a structure or hierarchy which would allow the elements of the diverse project types to be organized in a specific, uniform manner. Later standardization efforts could include such items as specific formats for the specification elements (divisions of the work), standard nomenclature and other items upon which an industry consensus can be reached. Today, the most wide-

ly accepted format very efficiently accommodates the architectural building projects; but is not as convenient or appropriate for engineered projects.

A related difficulty encountered by specification writers arises when the appropriate type of specification to be used is considered. Performance specifications; that is specifications which mandate the performance of the finished product or structure are put together very differently than proprietary specifications or descriptive specifications, which are much more detailed concerning the pieces and parts which go into the project. These two approaches make using a single standard difficult and none of the current approaches handle this very well.

Another difficulty with specifications and their organization arises when addressing at what phase of a construction project the specification is being used or evaluated. Early in a project's life, during the scope definition and initial design conceptualization phase, the project has many questions which have not yet been addressed. Decisions concerning the use of steel versus concrete structural members, or the final roofing type for example, have not been answered, but the work of the estimators and planning must continue on some basis. During this early phase, projects are often organized along an elemental approach; that is by major elements (substructure, superstructure, roofing, etc.). Later, as the project is better defined and more decisions have been made, the project is typically organized into components of the actual construction (metals, concrete, etc.). These two approaches are not easily compatible under current specification formatting schemes, creating undue coor-

dination problems as well as double work in filing and data handling during the transition from one structure to the other by estimators and others. Certainly, other specification problem areas and potential improvements exist, and a complete enumeration is not attempted in this work.

It can be seen then, that there is room for improvement in construction specifications. Improving construction specifications has benefits far beyond making the job of the specification writer easier, or making the preparation of bids a more straightforward matter. As improved specifications mean better quality projects, with better schedules and lower costs, this is an area which deserves more attention.

### 1.3 Objectives

The primary objective of this study is to review the Construction Specifications Institute (CSI) 16 Division format and through analysis of a sample of construction specifications currently in use, propose a new divisional structure which would better accommodate typical engineered projects. The types of projects which initially were selected for inclusion in this study included airports, treatment plants, roads and bridges, waterways and tunnels, power plants and petrochemical plants. By testing the proposal and refining it, a better, more applicable structure will be proposed which will better suit the overall needs of the construction industry.

To achieve the stated primary objective a number of sub-objectives were considered. These included:

- Including advantages of other formats in the proposed structure,
- Capturing insightful ideas generated by individuals in the industry, professional groups and academics,
- Including both public and private sector specifications in the study sample,
- Recommending changes which are both meaningful and reasonably implemented.

#### **1.4 Structure of the Thesis**

The following chapters will begin by describing the process undertaken to review the current state of construction specification structures, and comparing these structures with the requirements of several different project types in Chapter 2. The study methodology will be discussed in Chapter 3. Work Breakdown Structures (WBS) for these project types will be compared in Chapter 4 against the primary specification format currently in use, to view the extent of compatibility and search for potential problem areas. After analyzing a selection of actual project specifications and comparing them against the most popular format (CSI), a proposal for modification of that format will be discussed in Chapters 5 and 6. Finally, conclusions and recommendations concerning this study and its potential applicability will be covered in Chapter 7.

## CHAPTER 2

### ESTABLISHMENT OF A MULTI-PROJECT SPECIFICATION

#### STRUCTURE: CONSIDERATIONS

##### 2.1 Introduction

To establish a truly comprehensive structure for all specifications may seem somewhat contradictory. As the structure becomes truly comprehensive, that is more and more detailed, it loses flexibility which in turn may make it less appropriate for some projects. This reduction in flexibility does not mean that comprehensive structures exclude some projects, but rather that it will formalize how that project type is integrated into the structure. The loss of flexibility comes from the specification writer being bound to the rules thus imposed within the structural framework. The key is to determine what the balance should be to allow the standard to be as detailed as possible while not becoming too difficult to implement for certain project types. This will require a trade-off between the efficiencies of a very comprehensive structure and those associated with a flexible, easily modified structure. Either extreme, total inflexibility or absolute flexibility, would present difficulties for actual use. A compromise between the two is required. To arrive at this optimum structure, a great number of influences must be considered, some of which were briefly introduced in the previous

chapter. This chapter attempts to describe some of the important influences and considerations which must be weighed in the process of developing a multi-project specification structure.

## **2.2 Product or Component System**

The traditional means of structuring specifications is through the organization of the components or products making up the entire project. This approach combines the components of the project (earthwork, metals, concrete, etc.) and establishes its structure around them. The 16 division format adopted by the Construction Specifications Institute (CSI) offers the most obvious example of project component classification. It is already assumed by many to be the industry standard for specification structure.

Although no industry wide standard has been accepted by all, the Construction Specifications Institute (CSI) has produced the nearest thing to a true standard in the United States and Canada. After its introduction in 1963, and the merger of the U.S. and Canadian formats in 1972 with the publishing of the Uniform Construction Index (U.C.I.), the CSI format has achieved wide spread acceptance. In 1978, Construction Specifications Canada joined with CSI to produce the first edition of MASTERFORMAT, which incorporated a complete organizational format for project manuals by including bidding requirements, contract forms and conditions of the contract in addition to the 16 division U.C.I. format. (Table 2.1) In 1983, CSI published a revision of MASTERFOR-

<u>DIVISION #</u>	<u>TITLE</u>
	Bidding Requirements, Contract Forms & Conditions of the Contract
1	General Requirements
2	Site Work
3	Concrete
4	Masonry
5	Metals
6	Wood and Plastics
7	Thermal and Moisture Protection
8	Doors and Windows
9	Finishes
10	Specialties
11	Equipment
12	Furnishings
13	Special Construction
14	Conveying Systems
15	Mechanical
16	Electrical

Table 2.1: CSI MASTERFORMAT Structure (Broadscope Level)

MAT which included the use of "mediumscope" titles and numbers. This was revised again in 1988.

The MASTERFORMAT's 16 Divisions, (actually 17 divisions through the de facto inclusion of Division 0 Bidding Requirements, Contract Forms and Conditions of the Contract), are further divided into three levels of detail. The "broadscope" level has broad categories of work and provides the widest latitude in describing the work. Next, "mediumscope" titles include units of work of a more limited scope and finally "narrowscope" titles are used to cover extremely limited and very specific elements of work. The MASTERFORMAT uses five-digit numbers for the broadscope and mediumscope section titles, while leaving unused numbers between the assigned mediumscope numbers for narrowscope titles which may be required on specific projects. A block of numbers is left unassigned at the beginning of each division to be used for filing of general data and cost information applicable to the entire division.

If for example, a specification writer wished to use this system for open web steel joists and steel joist girders, he would have several options depending on the level of detail he might wish to achieve. These two items could both be specified under the broadscope title 05200-Metal Joists under Division 5-Metals. More detail could be achieved by using the mediumscope title 05210-Steel Joists. A third, more detailed approach would be to select two narrowscope titles below the mediumscope title, perhaps 05221-Open Web Steel Joists and 05222-Steel Joist

Girders. The authors of the MASTERFORMAT list the following as the main considerations in deciding which section numbers and titles to use:<sup>1</sup>

- Size of the project,
- Whether systems or products are being specified,
- Whether the project is a single or multiple prime contract.

The CSI system attempts to neatly create an orderly format by the establishment of major divisions based on the parts which make up the whole project. It is intended to allow specification users to rapidly retrieve information without searching through a chaotic organization. Hence, a mechanical contractor could quickly flip to Division 15 Mechanical to find the information he is searching for. This approach is logical, but problems arise in actual execution. It is difficult to divide the many varied activities or components into a small number of divisions. As the number must be kept small for simplicity and ease of use, it becomes more difficult to cleanly sort all of the components in to such "neat little packages". Additionally, ambiguities can arise which make it more difficult to properly locate an item. An example of this under the CSI format is concrete. It would appear obvious to the inexperienced user that all of the concrete entries would be in Div 3 Concrete, but this isn't true. Concrete for paving applications is located in Div 2 Sitework, under the paving and surfacing subdivision. Another

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<sup>1</sup> Construction Specifications Institute, Manual of Practice, (Alexandria, Virginia: The Construction Specification Institute, 1985), I-7-3

example of a grouping which is not all-inclusive is found in Division 5 - Metals. Again, one might assume that all metal products are located in this Division, but as with concrete reinforcing steel, metal flashing and other items, this is not the case.

For building projects this approach has proven adequate in the field, but is less useful early in the project life. During the initial stages of design, it is often necessary to describe or analyze the elements of the project from a functional perspective before the specific products or systems are selected. The CSI format does not allow for this, as it is geared only toward specific products and systems and not building components functions. Finally, with an increase in the use of performance specifications, other problems arise. Performance specifications lend themselves to elemental descriptions of the facility, and are difficult to properly organize under the CSI format as currently in use. For example, if a contractor has been awarded a contract to erect a building frame, based on a performance specification dictating final performance and not exactly what is to be built, he may consider the options of cast-in-place concrete, precast concrete, steel frame, glue-laminated wood or even load-bearing masonry systems. The CSI format, which is structured around specific components is not well suited to this freedom of choice, although it is addressed in the Manual of Practice.

### **2.3 Division Level Significance**

This study will focus on organization of specifications at the division level. The "Division" is the basic building block of a specifica-

tion, it serves as the key mechanism by which groupings of related construction information is accomplished. The basic organization of a set of specifications is driven by the divisions which are assigned to give it form.

To really make the organization of a specification format functional and efficient, the basic division title building block must be carefully established. An ideal division would display a number of essential attributes, some of which may be contradictory. First it must have the desired balance between flexibility and structure. If it is too detailed, it will cause difficulties when new products and techniques are introduced as there will be no room within it to accommodate change. Lack of adequate structure will result in anarchy, and defeat the purpose of trying to organize the specification at all. The divisions should be arranged or established in a logical manner. The division should allow the user to intuitively determine what belongs within each division. This would indicate a required utility in directing components into the correct division, as well as having the divisions mutually exclusive in nature to eliminate overlap problems. The divisions should lend themselves to easy subdivision to foster internal organization. Another factor which must be considered is that the number of divisions should be kept at a manageable level. The number must be kept small enough, and the titles simple enough to allow them to be committed to memory and easily managed by the users in the field who may be far from a reference manual.

The MASTERFORMAT is the best organized and most widely accepted structure for specifications in the private sector, and is used by the Department of Defense and enterprises such as McGraw-Hill Information Systems (the basis for Sweet's Catalog Files of Construction Products) and SPECTEXT.

#### **2.4 Engineered Projects vs. Architectural Building Projects: Shortcomings of CSI**

The CSI format, which has been used for many years for a wide variety of project types isn't necessarily perfect. Its strengths are many, but it isn't without its shortcomings.

A major concern is accommodation of engineered projects within the specification format. Engineered projects are projects which are driven or controlled by the engineering design required to do some particular function. Projects of this type would include a structure for carrying highway traffic over a river, or a power plant for producing electricity by burning fossil fuels. These are very different than building projects which are built to meet the architect's concept (office buildings, homes, etc.) which are often controlled by aesthetics or comfort. Another way to view the distinction between these two project types is to consider the diversity and complexity of the systems which compose the project. The specifications for the coatings of a process vessel are much more detailed, precise and critical than for the coatings for an office building. Although both a house and a power plant have electrical components, and safety is required in each, the power plant will require

the electrical components to be carefully designed and planned, where simple off-the-shelf components will be used in the house. The diversity required in the types of piping required in a petrochemical plant cannot be imagined by a builder of architectural projects. The CSI format is very easily utilized for architectural building projects which are accommodated within the 16 divisions without difficulty. No modification of the format is generally required for these projects.

This simply isn't true for engineered projects however. The 16 divisions used by CSI are not generally well suited to accommodating process-driven projects, which include projects like petrochemical plants, many manufacturing plants, and power plants. For other engineered projects, like road and bridge construction, Division 2 Sitework as used by CSI does not provide adequate utility or organizational depth for the many subordinate elements which comprise the project.

There are at least two reasons why the CSI format does not accommodate engineered projects as well as it should. The most obvious is that the CSI format was developed by architects and carries a natural bias toward architectural projects. The second may well be that engineered projects comprise less than half of the overall total number of construction projects, when all projects (including housing projects) are included. This is perhaps why the requirements of engineered projects and process engineering are not given adequate coverage within the CSI format. This is a false measure however. The high cost of these projects makes them a very significant portion of the total construction expendi-

tures annually, and therefore deserving of adequate attention and accommodation.

## 2.5 Other Formats

The CSI format's wide acceptance does not mean that it is the only system ever advocated. Several other organizational schemes were reviewed with an eye toward incorporating their advantages into the revision of CSI which is made in Chapter 4. In his work concerning specifications organization Edwards agreed with CSI stating that:

The sections of a set of specifications should be arranged in logical order. The customary sequence is based on an attempt to parallel the chronological development of the actual construction process.<sup>2</sup>

He proposed only 15 divisions, several of which are subdivisions in the CSI structure. These are depicted in Table 2.2. Watson, in his 1964 work, detailed a check list with 31 different divisions, subdividing many of the current CSI divisions<sup>3</sup> ( Table 2.3 ), and Small proposed only 8 in his structure.<sup>4</sup> (Table 2.4) AMOCO, Shell and DOW, among

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2 Edwards, Specifications, 49.

3 Donald A. Watson, Specification Writing For Architects and Engineers, (New York: McGraw-Hill Inc., 1964), 211-212

4 Ben John Small, Building Checklist (New York: Reinhold Publishing Corporation, 1954), 125

<u>DIVISION #</u>	<u>TITLE</u>
1	General
2	Work Prior to Construction
3	Concrete and Masonry
4	Waterproofing, Dampproofing and Termite Control
5	Metals
6	Wood and Hardware
7	Roofing
8	Miscellaneous Work
9	Interior Finish
10	Special Equipment
11	Final Outside Work
12	Conveyors
13	Plumbing
14	Heating
15	Electrical

Table 2.2: Edward's Specification Structure (Division Level)

<u>DIVISION #</u>	<u>TITLE</u>
1	Excavation, Grading & Site Work
2	Concrete Work
3	Masonry Work
4	Cut Stone
5	Dampproofing and Waterproofing
6	Structural Steel
7	Steel Joists
8	Roof Deck
9	Precast Floor Slabs
10	Miscellaneous Metals
11	Ornamental Metals
12	Miscellaneous Specialties
13	Hollow Metal
14	Metal Covered Doors
15	Metal Windows & Panel Walls
16	Sheet Metal

Table 2.3: Watson's Specification Checklist

<u>DIVISION #</u>	<u>TITLE</u>
17	Roofing & Roof Insulation
18	Carpentry and Millwork
19	Caulking
20	Lathing and Plastering
21	Ceramic Tile
22	Marble Work
23	Terrazzo
24	Composition Floor Coverings
25	Wood Flooring
26	Glass and Glazing
27	Accoustical Treatment
28	Finish Hardware
29	Painting and Decorating
30	Special Wall Finishes
31	Miscellaneous Equipment

Table 2.3: Watson's Specification Checklist (Con't.)

<u>DIVISION #</u>	<u>TITLE</u>
1	Sitework
2	Structural
3	Masonry
4	Weather Protection
5	Metal Work
6	Finishing
7	Equipment
8	Contracts

Table 2.4: Small's Specification Structure

many other large companies, each have their own functional divisions, based on their individual needs.

## **2.6 Division Formation: Influence Diagram**

Before any rigorous study of the structures of existing project specifications can be accomplished, it is necessary to look at the influences which determine the form a structures will take. The method selected in this work was to consider the prime influences which determine what should govern the establishment of a division. This approach included constructing an influence diagram to visually depict the most important determinants in the establishment of a division (Fig. 2.1). This analysis indicates that there are at least 5 primary elements which directly influence what elements should be given a division title in the specification. These include: organization of the work, common practice, project control requirements, project costs, and project time or schedule.

As the amount of time spent on any portion of the work (i.e. earthwork, structural steel erection) varies depending on a wide variety of inputs, the time variable is very flexible and does not exert an overriding influence on which elements should be identified as separate divisions. The same is true of the requirements of the project controls. The organization of the work has a great amount of influence on certain project types (i.e. waterway construction, dams, etc.), but it is controlled too much by a significant number of other factors. These other factors tend to cloud and complicate the seemingly straight forward nature of the work organization. This ambiguity is more of a problem on very

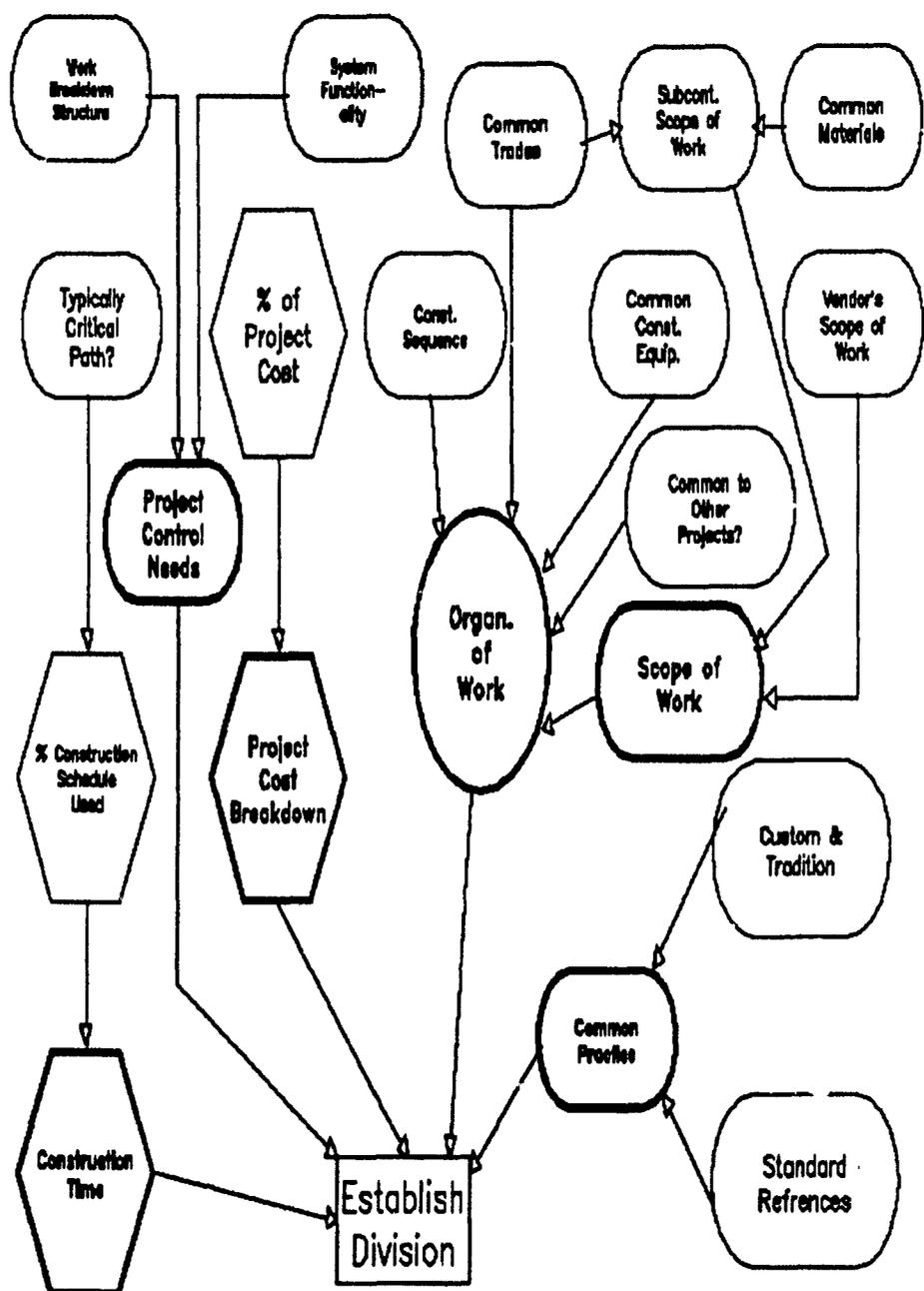


Figure 2.1: Influences on Establishment of Spec. Divisions

large, complex projects which employ a great number of different trades and speciality contractors, each of whom would seek equal treatment if craft alone determined what divisions are formed.

This process of elimination leaves only project cost breakdown and common practice as the primary influences on how divisions are organized. A tremendous argument can be made to lean heavily on the cost approach, since cost attracts much attention. Some threshold percentage, say 5% or 7% of the total project cost could be selected, which may justify designation of an item as a division. Items which do not require sufficient financial resources in the project to reach this level might be relegated to the Miscellaneous Division. One primary problem with this approach is that good cost data for a variety of project types and builders, in sufficient detail to allow this type of structuring is very difficult to obtain. A related problem is deciding what to combine into a single division. Should concrete pavement and structural concrete be added together to ensure that concrete costs exceed the threshold percentage for division establishment, thus forming a Concrete division? This approach invites incessant argument and unnecessary number juggling. Nevertheless, using cost data of the pieces and parts of a project to determine what should be a division or not seems initially the best approach if the information can be made available. Obtaining this data is the main problem with this approach. For the purpose of this study, it is assumed that this cost approach is too time consuming, and perhaps too difficult to be practical.

That leaves only common practice as the primary method or influence in selecting divisions for specifications. Currently there are two schools of thought concerning the basic format or structure of specifications as were previously addressed. The most wide spread format is the CSI format as discussed earlier in this chapter. This approach looks at projects as a combination of components; concrete, metals, equipment, etc. Another approach, which is gaining support is an "elemental" approach which looks at projects as a combination of the distinct systems or functions; substructure, superstructure, etc. These approaches each deserve attention when attempting to improve the industry wide standard. The CSI approach was detailed previously, and the elemental approach is described in the following section.

## **2.7 Elemental (Functional) Classification**

The need for elemental classification has been apparent for some time, and some of these formats do exist. The R.S. Means Company, Inc. has used an elemental classification based on UNIFORMAT in their Means Assemblies Cost Data for some years. The UNIFORMAT, first proposed by the General Services Administration (GSA) is depicted in its general form in Table 2.5. This structure follows closely with the work breakdown structure of many projects, and provides an orderly and logical arrangement of the elements. The United States Air Force, and now many of the U.S. Army Corps of Engineer Districts are adopting this UNIFORMAT approach for their specifications. The form of UNIFORMAT they have adopted is depicted in Tables 2.6 and 2.7. The

<u>Level 2</u>	<u>Level 3</u>
01 Foundations	011 Standard Foundations
	012 Special Foundations
02 Substructure	021 Slab on Grade
	022 Basement Excavation
	023 Basement Walls
03 Superstructure	031 Floor Construction
	032 Roof Construction
	033 Stair Construction
04 Exterior Closure	041 Exterior Walls
	042 Fenetration
05 Roofing	
06 Interior Construction	061 Partitions
	062 Interior Finishes
	063 Specialties
07 Conveying Systems	
08 Mechanical	081 Plumbing
	082 HVAC
	082 Fire Protection
	084 Special Mech. Systems
09 Electrical	091 Distribution
	092 Lighting and Power
	093 Special Electrical Systems
10 General Conditions & Profit	
11 Equipment	111 Furnishings
	112 Fixed Equipment
12 Site Work	121 Site Preparation
	122 Site Utilities
	123 Site Improvements

Table 2.5: GSA UNIFORMAT System

<u>Level</u>	<u>Nomenclature</u>
01	Substructure
02	Superstructure
03	Roofing
04	Exterior Closure
05	Interior Construction
07	Specialties
08	Plumbing
09	H.V.A.C.
10	Special Mechanical
11	Electrical
12	Special Electrical
13	Equipment
14	Conveying Systems

Table 2.6: Air Force UNIFORMAT System Level Structure

<u>SYSYEM</u>	<u>SUBSYSTEM</u>	<u>DESCRIPTION</u>
01		Substructure
01	01	Standard Foundation
01	02	Special Foundation Conditions
01	03	Slab on Grade
01	04	Basement Excavation
01	05	Basement Walls
02		Superstructure
02	01	Floor Construction
02	02	Roof Construction
02	03	Stair Construction
03		Roofing
03	01	Roofing
04		Exterior Closure
04	01	Exterior Walls
04	02	Exterior Doors
04	03	Exterior Windows
04	04	Exterior Overhead /Spec. Doors

Example of UNIFORMAT WBS

System: 04 Exterior Closure  
 Subsystem: 0404 Exterior Overhead & Special  
 Doors  
 Assembly Category : 040401 Overhead Doors  
 Assembly: 04040102 12'-0" x 12'-0" Heavy Steel  
 Overhead Door

Table 2.7: Air Force UNIFORMAT System, Structural Breakdown

American Society for Testing and Materials is developing a similar format.

Even this system is not without some duplication of efforts and overlap as to where an item belongs, but it does better accommodate performance specifications and life-cycle cost analysis during the project scope and definition phase. Also, estimators may find this format more "user friendly" for them to work with, as was reported by Mr. C. Coburn, the Chief, Estimating Division of the Fort Worth District of the Corps of Engineers, during an interview by the author.

## **2.8 Which System is Best?**

This question really doesn't have a simple A or B answer. Both of the two major formats currently in use, the CSI Format and UNIFORMAT have advantages and shortcomings. Just as no two projects are identical, no specification format will be perfect for all projects, or even for all stages of a single project. The wide spread popularity of the CSI format means that any change will logically necessitate its use as a starting point, if popular support is to be gained for the new format. That doesn't mean that the advantages of the UNIFORMAT system should be neglected either. Ideally, both approaches should be accommodated if the specification's divisional structure is to be appropriate for the widest array of project types and functional uses.

## CHAPTER 3

### STUDY METHODOLOGY

#### 3.1 Introduction

This chapter is intended to provide better insight into the methodology involved in the study. It also acts as a guide, showing where conclusions were drawn as well as introducing where changes in the approach or additional parameters or influences were injected and considered. Appendix 1 provides more detailed information concerning some of the information presented in this chapter, and is referenced accordingly.

The development of this study is depicted in Figure 3.1. This flowchart is provided to graphically display the methodology employed in the conduct of the study. A synopsis is provided in the following paragraphs.

The first step in any problem solving approach is the identification of the problem and the producing of a problem statement to work from. The starting point in this case then was identifying the problem, or primary goal of the study as being a review of current construction specification formats, (with emphasis on the CSI format), in light of accommodating all construction projects equally, and particularly considering engineered projects versus architectural building projects.

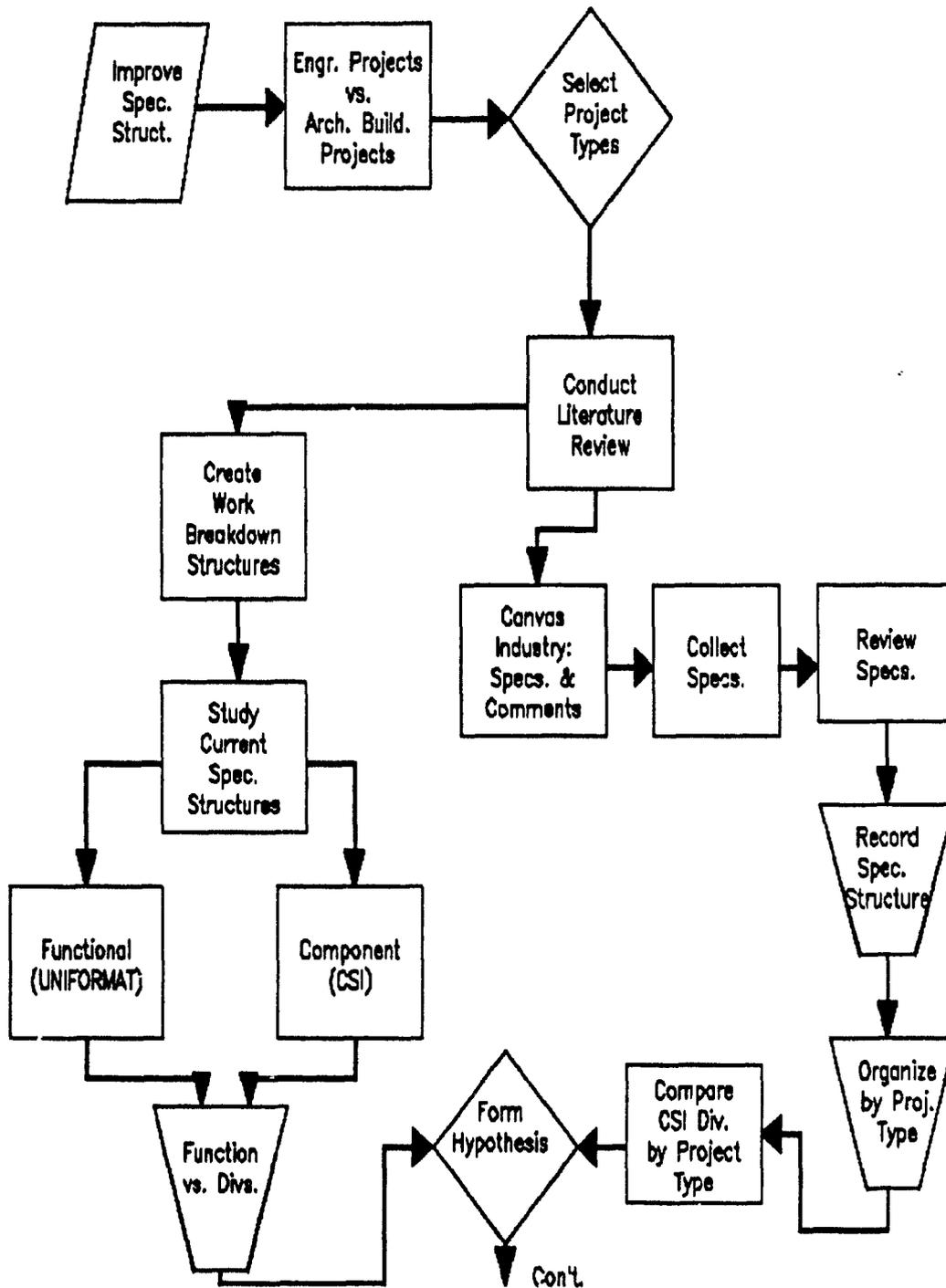


Figure 3.1: Study Flow Chart

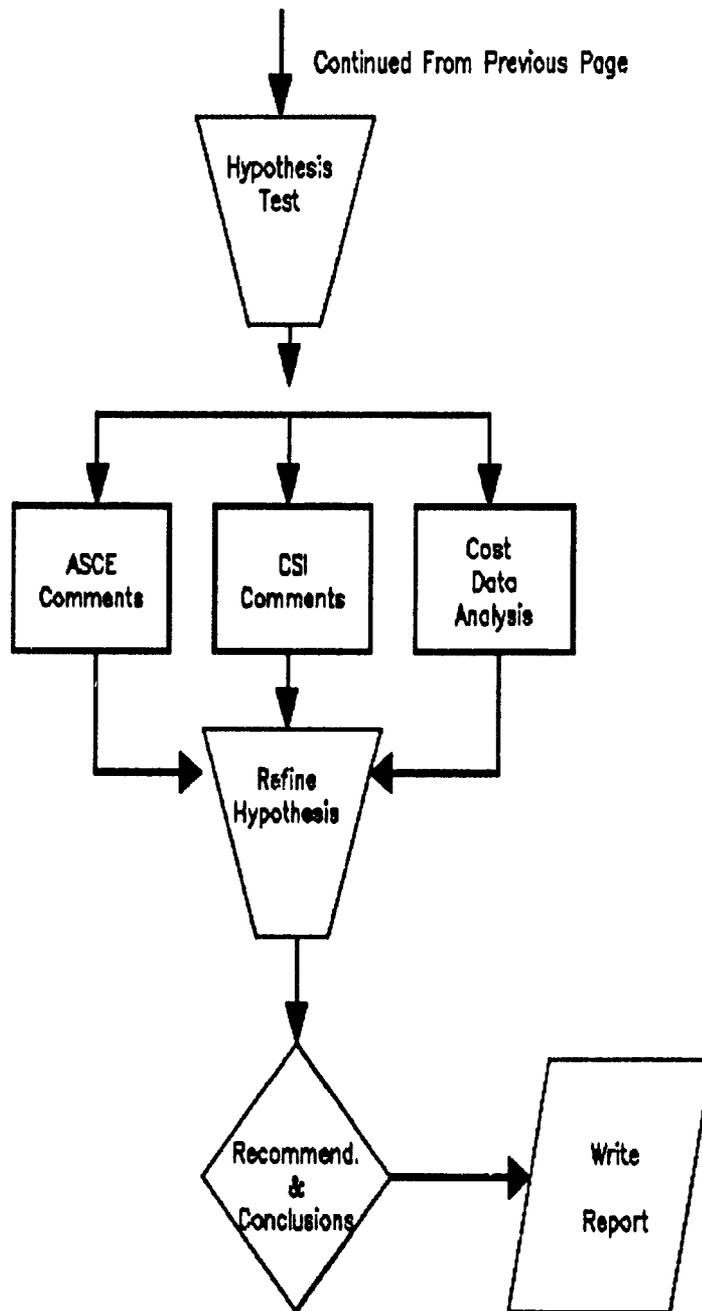


Figure 3.1: Study Flow Chart (Cont'd.)

After deciding where to go, the next step was in determining how to get there.

### **3.2 Project Types Selected For Study**

To narrow the scope to a manageable scale, a number of project types had to be selected which would be representative of the group of engineered projects which are of central importance to the study. These project types had to meet a number of criteria to be considered representative, including: being primarily an engineered project, being common enough so that data and sample specifications could be obtained, being designed and built by more than one company which would allow some comparison of the specifications, and being of sufficient cost to make their inclusion carry substantial impact with the industry. Based primarily upon these criteria, the project types initially chosen for inclusion in the study were: airports, treatment plants, roads and bridges, waterways and tunnels, utilities, power plants and petrochemical plants.

The next phase comprised a literature review. The topics focused upon included the formats for specifications, as well as detailing the component elements which comprise the project types selected for the study. The review of literature available quickly revealed that there has not been extensive research or writing concerning the topic of specification formats or structures. Several general references discuss what should be included in a specification, and these comments vary across the full scale of simplicity to very detailed and cumbersome, but there is practically no discussion of the structures to be used themselves. Noticeable excep-

tions to this are the CSI MASTERFORMAT and the UNIFORMAT systems as addressed in Chapter 2.

### **3.3 Work Breakdown Structures by Project Type**

The study of the component elements of the different project types led to the creation of work breakdown structures for these projects, and are depicted in Figures 3.2 - 3.8. (More detailed breakdowns are provided in Appendix 1 - Functional Breakdown by Project Type.) These breakdowns only include the essential elements of work for these projects, and indicate a general checklist of items which the specification format should accommodate for each individual project type. They were generated to provide a detailed listing of critical components of the project types selected, which in turn could be used to validate or measure the degree of accommodation which a specification format provides for each project type. The primary goal was to provide a type of check list which could be compared against the CSI format to determine the degree to which the project type could easily fit into that format, and look for specific problem areas as well. Although the terminology used in each work breakdown structure may not be identical to that used in another, due to the project-type influence on each, similarities can be examined, and a basic idea of how common or universal these components are, which indicates the importance of easy incorporation into the CSI system. It should be noted that Utility projects do not easily lend themselves to the work breakdown structures as created for the other project

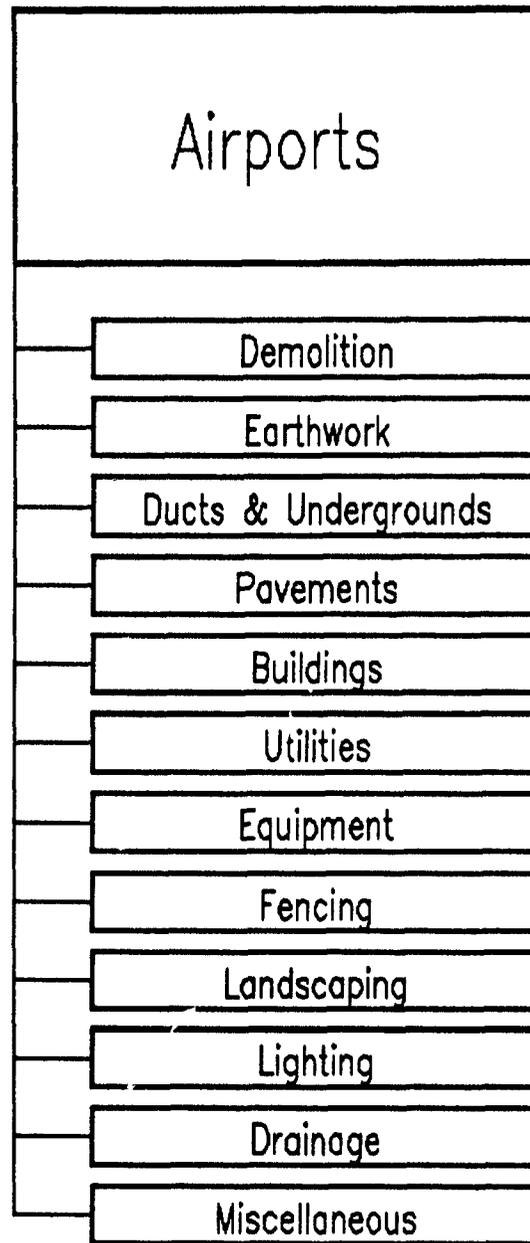


Figure 3.2: Functional Breakdown - Airports

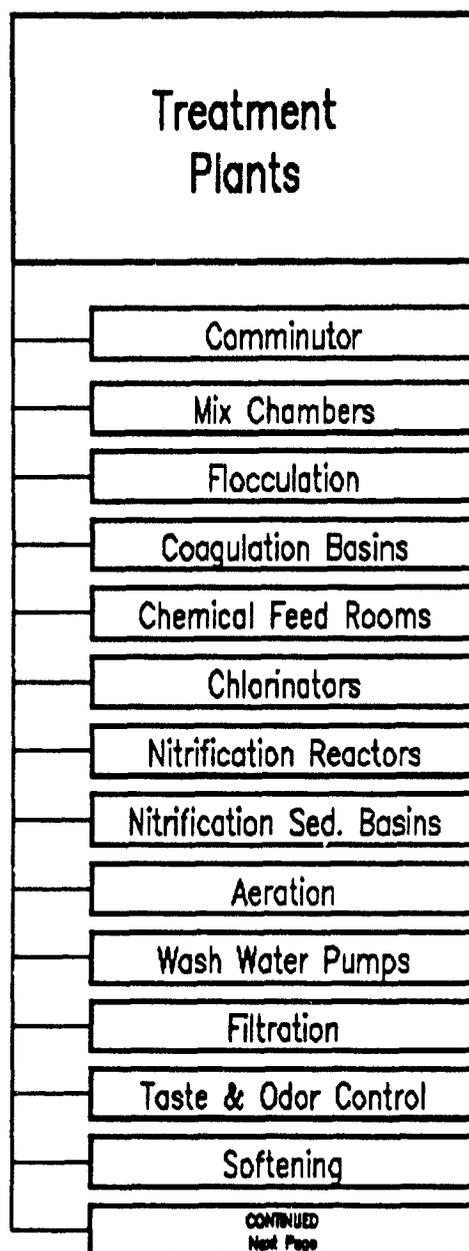


Figure 3.3: Functional Break downs - Water Treatment Plants

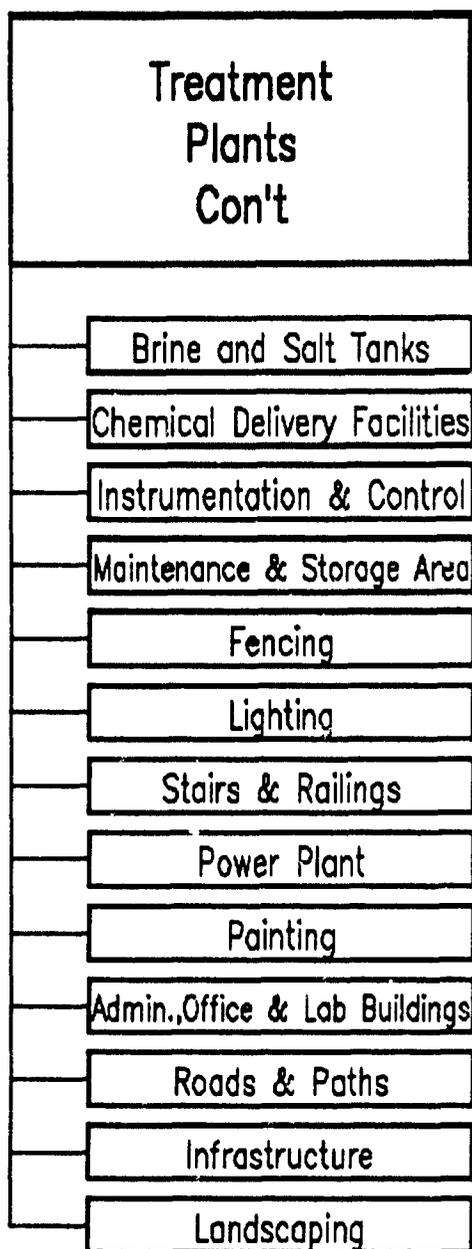


Figure 3.3: Functional Breakdowns-Treatment Plants (Cont'd.)

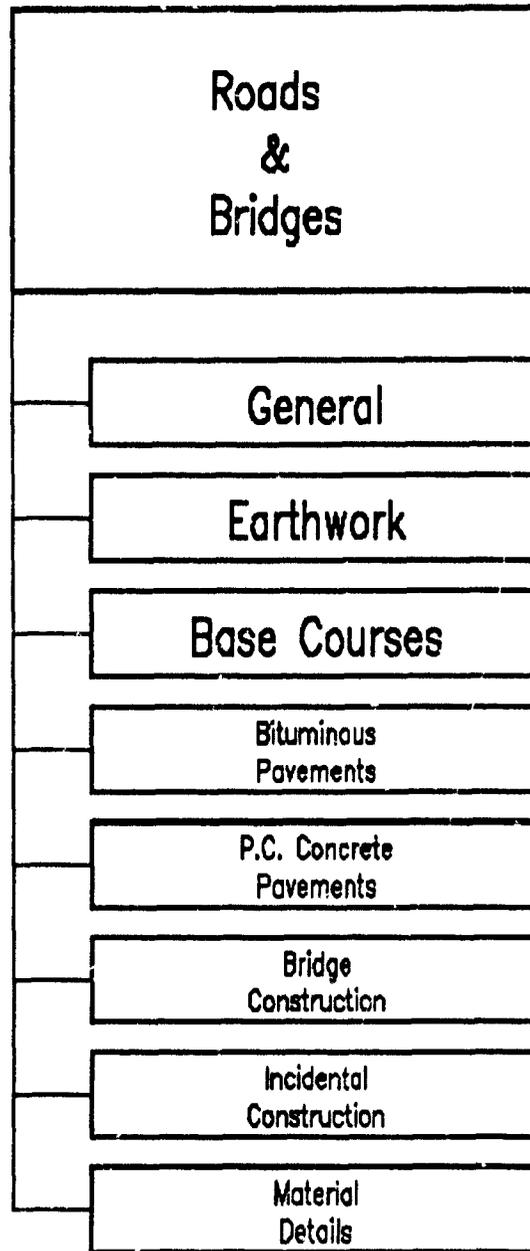


Figure 3.4: Functional Breakdowns - Roads & Bridges

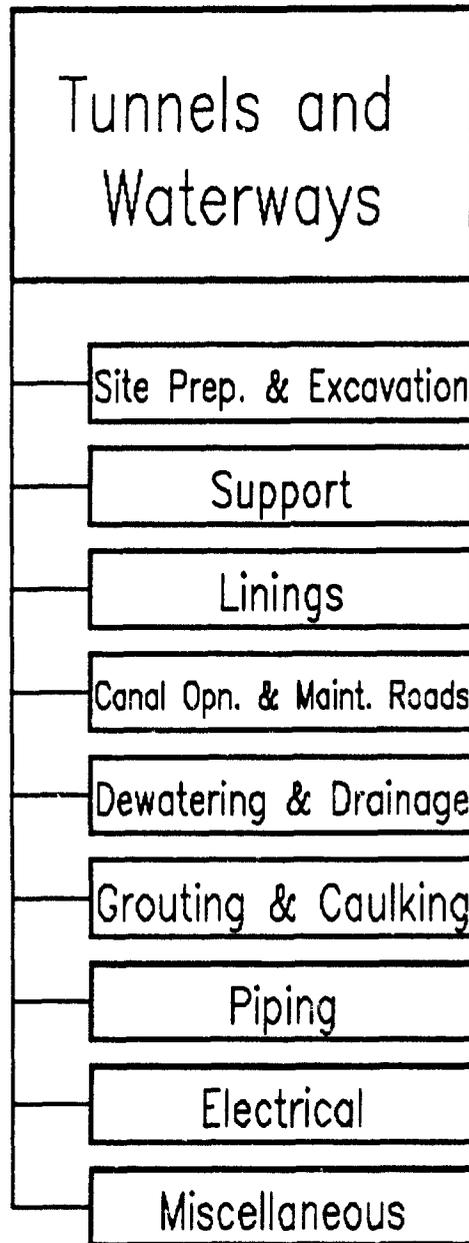


Figure 3.5: Functional Breakdowns - Tunnels & Waterways

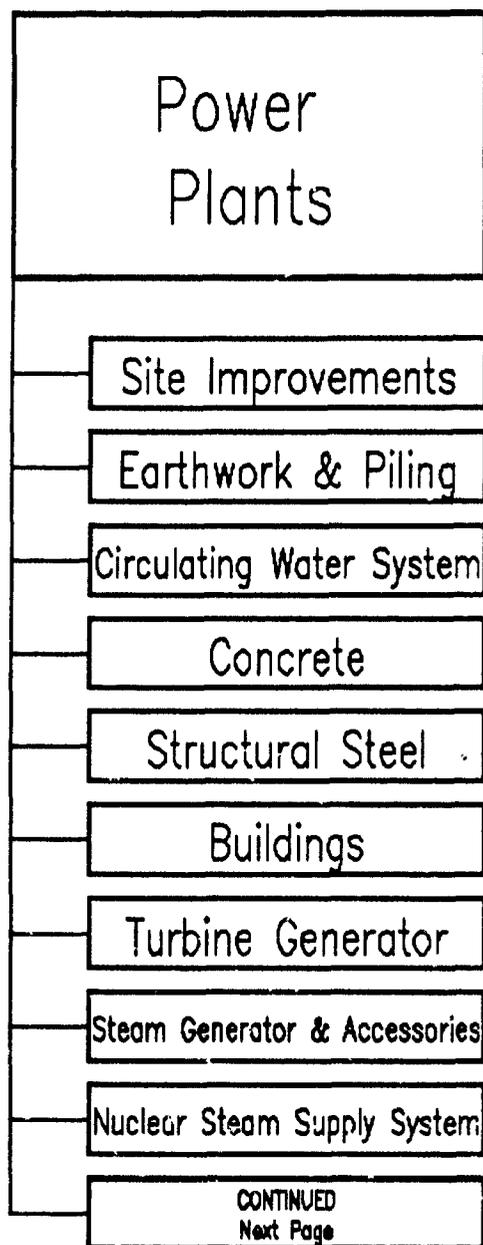


Figure 3.6: Functional Breakdowns - Power Plants

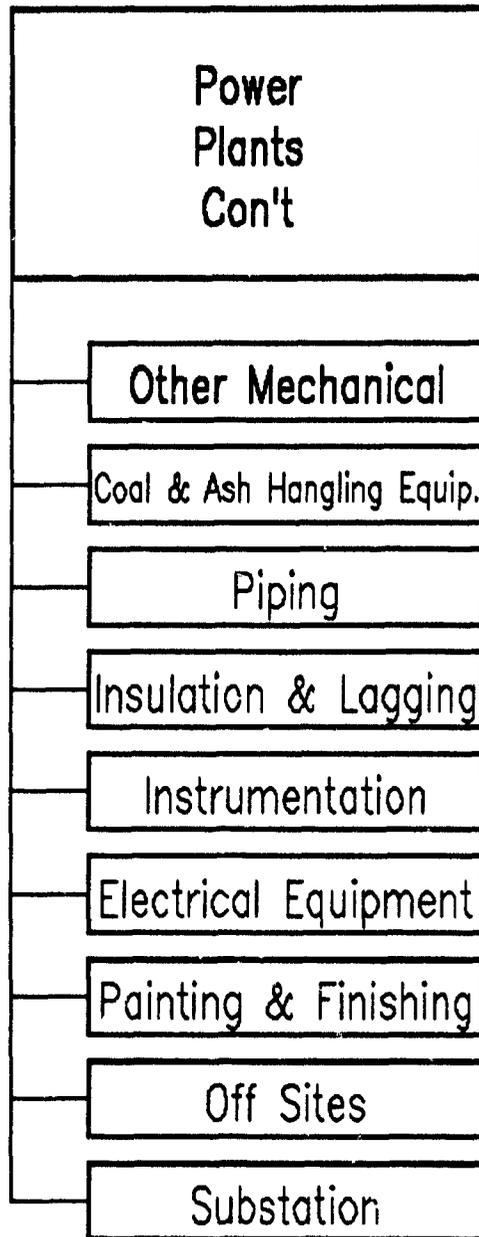


Figure 3.6: Functional Breakdowns - Plants Plants (Cont'd.)

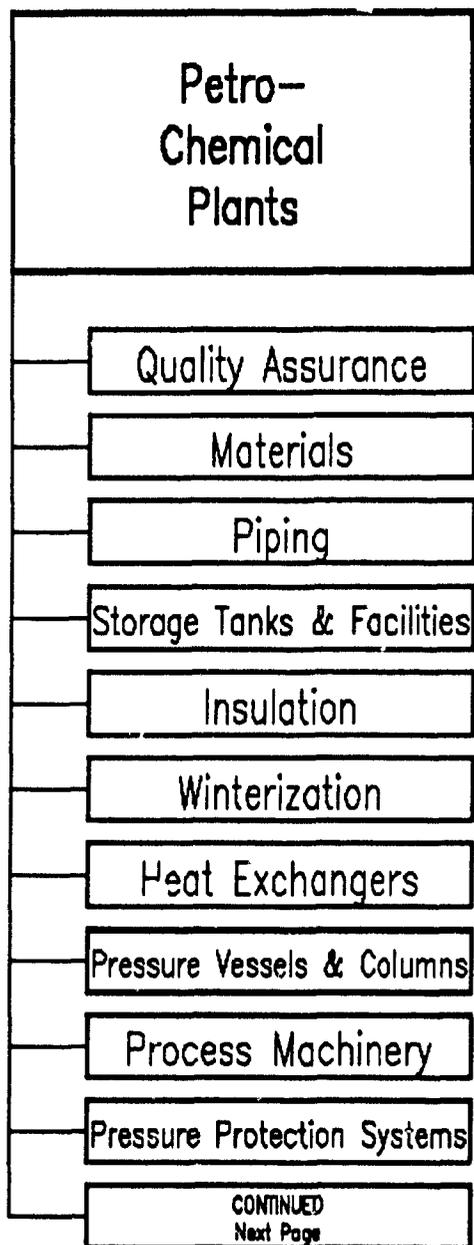


Figure 3.7: Functional Breakdowns - Petrochemical Plants

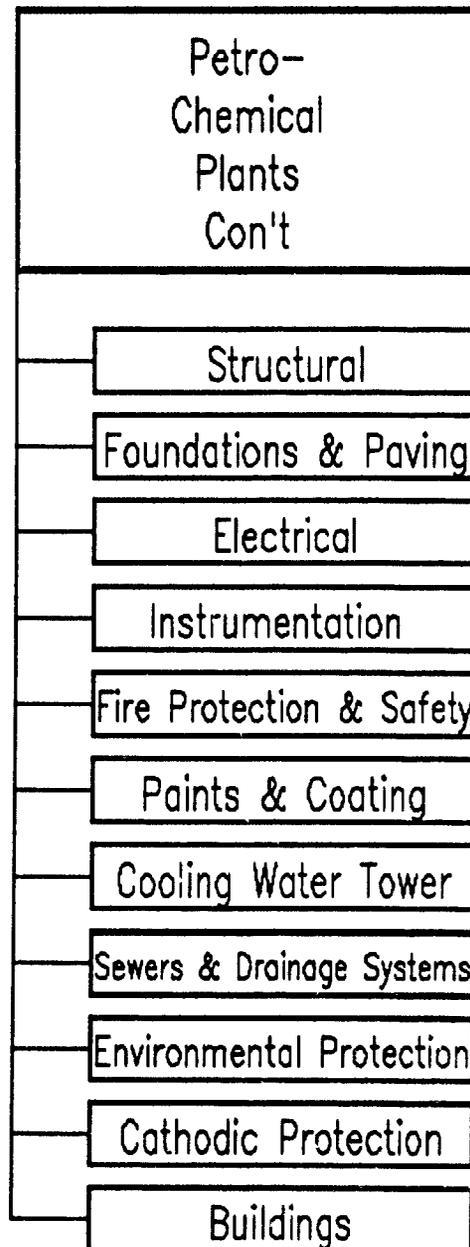


Figure 3.7:Functional Breakdowns-Petrochem. Plants (Cont'd.)

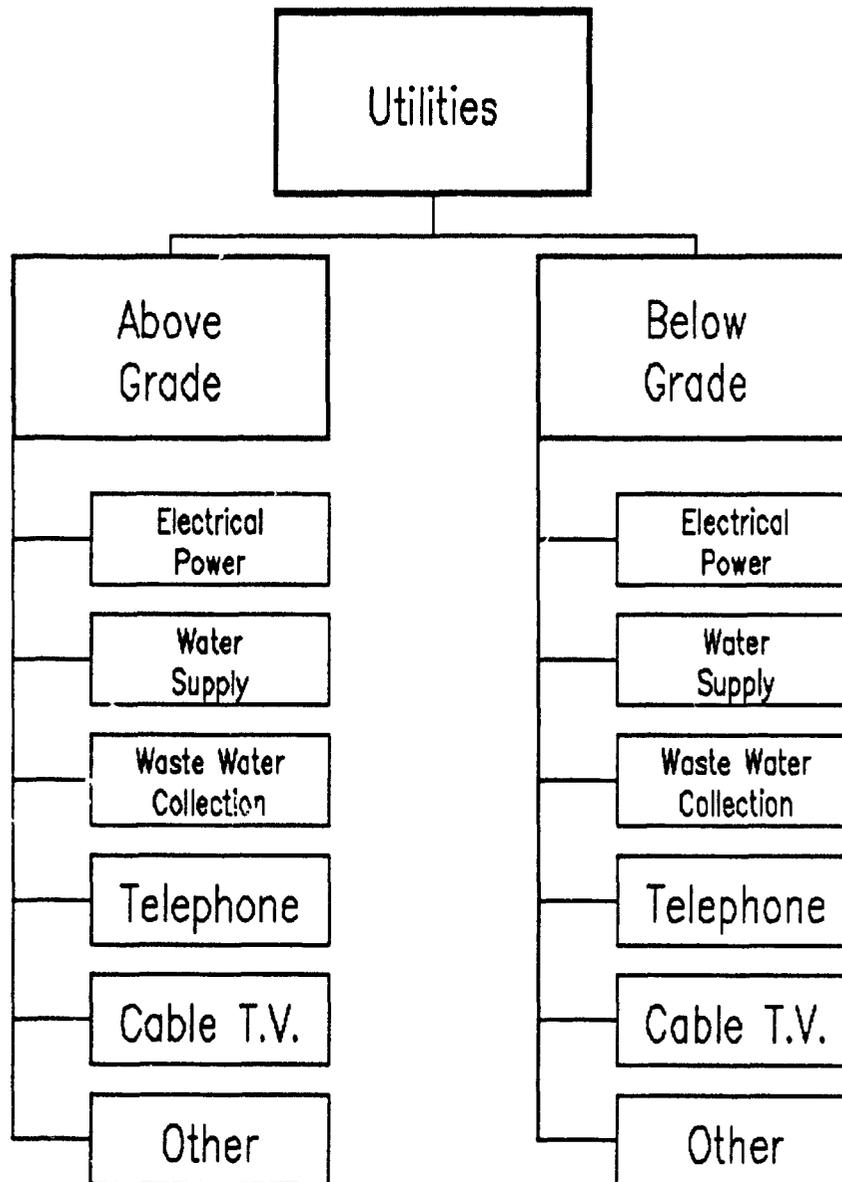


Figure 3.8: Functional Breakdowns - Utilities

types. An attempt to depict this project type has been made as shown in Figure 3.8.

### **3.4 Quantifying Divisional Utility**

After developing the elements of the various projects considered in the previous section, the next step is to consider how these essential elements are aligned with the divisions used in a specification. The 16 divisions used in the CSI format are used for this comparison. Considering how this relationship should ideally exist provides some insight into evaluating the utility of division level organization. As discussed in Chapter 2, the divisions should be organized to make each self-contained, and to eliminate overlap. The ability of the divisions to attain these goals when compared to functional areas is tremendously constrained by the nature or structure adopted for the functional areas. If the functional areas are clearly defined and distinct, then the divisions are more likely to be comprehensive internally and avoid overlap. As each organization, and indeed each project has functional areas which are unique, this work does not attempt to prescribe the ground rules for their establishment, but once the functional areas are adopted, a uniform way of evaluating the divisions used in the specifications can be established.

Ideally, the matrix of functional areas compared with the divisions used in the specifications would look like the generic model shown in Table 3.1. This would be the case if the functional areas and divisions were properly aligned to eliminate overlap as well as to ensure that each

Functional Area	CSI DIVISIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Functional Area 1	✓																
Functional Area 2		✓															
Functional Area 3			✓														
Functional Area 4				✓													
Functional Area 5					✓												
Functional Area 6						✓											
Functional Area 7							✓										
Functional Area 8								✓									
Functional Area 9									✓								
Functional Area 10										✓							
Functional Area 11											✓						
Functional Area 12												✓					
Functional Area 13													✓				
Functional Area 14														✓			
Functional Area 15															✓		
Functional Area 16																	✓

Table 3.1: Divisions vs. Functional Areas, Ideal Case

functional area fit cleanly into only one division. Although this will seldom be the case, it is used here as the goal which the specification structure should allow. This would be ideal in the case of multiple prime contracts. If the functional areas are established in such a manner that each of them has elements in a number of divisions, it would appear as in Table 3.2. This is not desirable in that the divisions lose their individuality through repeated use in several functional areas. The worst case, as shown in Table 3.3, is one in which an entire project falls into a single division. This is often the case in some highway projects, and creates unnecessary complications. It is extremely difficult for any particular subcontractor to quickly identify the portions of the specification which are germane to his operation. He cannot simply select his portion of the specification by locating the items under his title of interest, as the entire specification is a single, massive division.

Assuming then that the ideal would be to have each functional represented in only one division, and the divisions distinct enough so that one does not encompass an entire project, some measure of attaining this goal is necessary. One possible solution would be to establish a Division Utility Index which gives a score to a combination of divisions and functional areas. The Division Utility Index (DUI) uses a matrix layout to depict which divisions are associated with the functional areas for a project with the addition of rows to total the numbers. The DUI consists of an index value which indicates if the degree to which functional areas corresponds to the divisional structure, and the degree to which specification divisions become confused due to overlapping functions.

Functional Area	CSI DIVISIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Functional Area 1	✓															
Functional Area 2	✓															
Functional Area 3	✓															
Functional Area 4	✓															
Functional Area 5	✓															
Functional Area 6	✓															
Functional Area 7	✓															
Functional Area 8	✓															
Functional Area 9	✓															
Functional Area 10	✓															
Functional Area 11	✓															
Functional Area 12	✓															
Functional Area 13	✓															
Functional Area 14	✓															
Functional Area 15	✓															
Functional Area 16	✓															

Table 3.2: Divisions vs. Functional Areas, Worst Case

Functional Area	CSI DIVISIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Functional Area 1		✓	✓	✓	✓											
Functional Area 2		✓	✓	✓	✓											
Functional Area 3			✓	✓	✓	✓	✓	✓	✓							
Functional Area 4		✓	✓	✓												
Functional Area 5		✓	✓	✓	✓	✓	✓	✓	✓	✓						
Functional Area 6					✓	✓	✓	✓	✓	✓	✓					
Functional Area 7				✓	✓	✓	✓	✓	✓	✓						
Functional Area 8								✓	✓	✓	✓	✓	✓	✓		
Functional Area 9					✓	✓	✓	✓	✓	✓						
Functional Area 10		✓	✓	✓	✓											
Functional Area 11		✓	✓	✓	✓			✓	✓	✓	✓					
Functional Area 12												✓	✓	✓	✓	✓
Functional Area 13		✓	✓	✓	✓				✓	✓	✓					
Functional Area 14		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Functional Area 15							✓	✓	✓	✓	✓	✓				
Functional Area 16							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3.3: Div.vs. Funct. Areas, Example - Poor Organization

It is reported as: ##.##. Examples of the Division Utility Index are provided in Figures 3.9 - 3.11.

The calculations associated with the DUI are quite simple:

Step 1. A n "Interface" value for each division is calculated by:

- summing the number of functional areas involving each division.
- This value is entered under each division number in the row titled N.

Step 2. A "Modified Interface" value for each division is calculated by:

- squaring the interface value for each division.
- This value is entered under each division number in the row titled  $N^2$ .

Step 3. The "Division Utility Index" for the project can be calculated by:

- summing the values of the "Modified Interface value and
- dividing by the number of divisions actually used.

The DUI developed and calculated by the above process provides a correlation between the divisions used in the project specification and the functional areas used to describe and organize the project. Squaring the division column totals prior to dividing by the number of divisions allows this approach to be valid for a very large number of functional areas while not losing scale in relation to the number of divisions. A value of 1.0 indicates that the divisions and functional areas are completely complimentary. Values greater than 1.0 indicate that the func-

Functional Area	CSI DIMSIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Functional Area 1	✓															
Functional Area 2		✓														
Functional Area 3			✓													
Functional Area 4				✓												
Functional Area 5					✓											
Functional Area 6						✓										
Functional Area 7							✓									
Functional Area 8								✓								
Functional Area 9									✓							
Functional Area 10										✓						
Functional Area 11											✓					
Functional Area 12												✓				
Functional Area 13													✓			
Functional Area 14														✓		
Functional Area 15															✓	
Functional Area 16																✓
Interface Value: N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mod. Interface Value: N <sup>2</sup>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

$$\text{Division Utility Index} = \frac{\text{Sum of Modified Interface Values}}{\text{Number of Divisions Used}} = \frac{16}{16} = 1.0$$

Figure 3.9: Division Utility Index, Ideal Case

Functional Area	CSI DIVISIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Functional Area 1		✓	✓												✓	✓
Functional Area 2		✓	✓		✓										✓	
Functional Area 3		✓													✓	✓
Functional Area 4		✓	✓		✓											✓
Functional Area 5		✓	✓		✓										✓	✓
Functional Area 6		✓	✓												✓	✓
Functional Area 7		✓	✓		✓										✓	✓
Functional Area 8		✓	✓		✓											
Functional Area 9		✓													✓	✓
Functional Area 10		✓	✓												✓	
Functional Area 11			✓		✓											
Functional Area 12		✓	✓													
Functional Area 13		✓														✓
Functional Area 14		✓													✓	✓
Functional Area 15		✓													✓	✓
Functional Area 16		✓	✓													
Interface Value: N	0	15	11	0	6	0	0	0	0	0	0	0	0	0	10	10
Mod. Interface Value: N	0	225	121	0	36	0	0	0	0	0	0	0	0	0	100	100

$$\text{Division Utility Index} = \frac{\text{Sum of Modified Interface Values}}{\text{Number of Divisions Used}} = \frac{482}{5} = 96.4$$

Figure 3.10: Division Utility Index, Worst Case

Functional Area	CSI DIVISIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Functional Area 1		✓	✓												✓	✓
Functional Area 2		✓	✓	✓	✓	✓						✓	✓	✓	✓	✓
Functional Area 3	✓	✓	✓		✓	✓	✓			✓	✓				✓	✓
Functional Area 4		✓	✓	✓	✓				✓	✓	✓	✓				✓
Functional Area 5		✓	✓		✓		✓	✓	✓	✓					✓	✓
Functional Area 6		✓	✓		✓	✓	✓	✓							✓	✓
Functional Area 7		✓	✓		✓						✓	✓	✓	✓	✓	✓
Functional Area 8		✓	✓		✓		✓	✓	✓	✓	✓					
Functional Area 9		✓										✓	✓	✓	✓	✓
Functional Area 10		✓	✓			✓		✓	✓	✓				✓	✓	
Functional Area 11			✓		✓					✓	✓	✓				
Functional Area 12		✓	✓									✓	✓		✓	✓
Functional Area 13		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
Functional Area 14		✓	✓	✓											✓	✓
Functional Area 15		✓	✓	✓	✓										✓	✓
Functional Area 16		✓	✓						✓		✓	✓				
Interface Value: N	1	15	15	5	10	5	5	5	6	7	7	6	5	5	11	12
Mod. Interface Value: N <sup>2</sup>	1	225	225	25	100	25	25	25	36	49	49	36	25	25	121	144

$$\text{Division Utility Index} = \frac{\text{Sum of Modified Interface Values}}{\text{Number of Divisions Used}} = \frac{1135}{16} = 70.9$$

Figure 3.11: Division Utility Index, Typical Case

tional areas cross many divisional boundaries, with the score increasing as the number of overlaps increases. Assuming that the divisions are fixed in the project, the organization of the functional areas should be reconsidered.

The intent of this Division Utility Index is simply to allow a specification user to be able to evaluate the relationship of the divisions used within the specification with the functions described by the work breakdown structures for the project. It may indicate that if the divisions to be used are fixed, then there may be some utility in redefining the functions to better operate within the division structure of the specification and make the specification easier to use.

The following chapter provides a preliminary analysis of the CSI specification format, using the DUI as a method of evaluating functional areas and divisions for the project types selected for study.

## CHAPTER 4

### PRELIMINARY ANALYSIS

#### 4.1 Functional Breakdowns vs. CSI Divisions

The functional breakdowns introduced in the previous chapter were used to determine the critical elements of engineered projects, and serve as a basis for evaluation of the structure or format in question. As previously stated, the CSI format, being the most widely accepted and used format in the United States today, was chosen as the structure against which the work breakdown structures would be compared. Tables 4.1 - 4.6 display the comparison of the essential elements of work as shown on the work breakdown structures with the 16 Divisions as currently used in the CSI format. These tables show two interesting results. The first is that the CSI format is quite comprehensive, and that there is opportunity to accommodate every element from each of the project types within one of the divisions. This seemingly remarkable result can partly be attributed to the CSI formats built in flexibility; by having room for miscellaneous items, the CSI format allows for each element to be accommodated somewhere. The second observation springs directly from the first finding. Although each element is accommodated, many of the elements are only accommodated with difficulty, and the fit is less than comfortable. This can be attributed to the fact that many of the sub-

Functional Area	CSI DIVISIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Demolition		✓															
Earthwork		✓															
Ducts & Undergrounds		✓	✓		✓												
Pavements		✓															
Buildings		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Utilities		✓			✓					✓					✓	✓	
Equipment										✓	✓			✓			
Fencing		✓			✓					✓							
Landscaping		✓															
Lighting					✓					✓							✓
Drainage		✓															
Miscellaneous	✓								✓				✓				

Table 4.1: Functions vs. CSI - Airports

Functional Area	CSI DIMSIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Comminutor			✓							✓						
Mix Chambers										✓			✓			
Flocculation													✓			
Coagulation Basins													✓			
Chem. Feed Rooms			✓		✓	✓	✓				✓		✓			
Chlorinators											✓		✓			
Nitrification Reactors													✓			
Nitrification Sed Basins		✓	✓								✓					
Aeration													✓			
Wash Water Pumps																✓
Filtration													✓			
Toxics & Odor Control											✓					
Softening											✓					
Brine & Salt Tanks													✓			
Chem. Delivery Fac.											✓		✓			
Instr. & Control													✓			✓
Maint. & Storage		✓	✓		✓		✓		✓		✓				✓	✓
Fencing		✓			✓											
Lighting																✓
Stairs & Railings					✓											
Power Plant																✓
Painting										✓						
Buildings		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
Roads & Paths		✓														
Infrastructure		✓													✓	✓
Landscaping		✓														

Table 4.2: Functions vs. CSI - Treatment Plants

Functional Area	CSI DIMENSIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
General	✓															
Earthwork		✓														
Base Courses		✓														
Bituminous Pavements		✓														
Portland Cement Pvs.		✓														
Bridge Construction		✓	✓		✓	✓										
Incidental Const.	✓	✓	✓	✓			✓		✓			✓				✓
Material Details		✓	✓	✓	✓	✓										

Table 4.3: Functions vs. CSI -Roads &amp; Bridges

Functional Area	CSI DIMSIONS																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Site Prep. & Excavation		✓															
Support		✓	✓	✓	✓												
Linings		✓	✓	✓	✓												
Opns. & Maint. Roads		✓															
Dewatering & Drainage		✓															
Grouting & Caulking		✓	✓														
Piping																✓	
Electrical																	✓
Miscellaneous	✓	✓					✓	✓						✓	✓		

Table 4.4: Functions vs. CSI -Tunnels &amp; Waterways

Functional Area	CSI DIMENSIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Site Improvement	✓															
Earthwork & Piling	✓															
Circ. Water Sys.											✓				✓	
Concrete			✓													
Buildings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Turbine Gen													✓			✓
Steam Gen. & Accys.															✓	✓
Nuc. Steam Supply													✓		✓	
Other Mechanical															✓	
Coal/Ash Handling														✓		
Piping															✓	
Insulation							✓									
Instrumentation													✓			✓
Electrical Equip.																✓
Paint & Finishes									✓							
Off Sites	✓															
Substation	✓	✓			✓	✓	✓	✓	✓		✓	✓			✓	✓

Table 4.5: Functions vs. CSI - Power Plants

Functional Area	CSI DIMSIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Quality Assurance	✓															
Materials	✓		✓	✓	✓	✓	✓	✓								
Piping																✓
Storage Tanks & Facs.													✓			
Insulation							✓									✓
Winterization							✓									✓
Heat Exchangers											✓					✓
Pres. Vessels & Columns											✓					✓
Process Machinery											✓					
Pres. Protection											✓					
Structural	✓	✓			✓						✓					✓
Foundations & Paving		✓	✓													
Electrical											✓					✓
Instrumentation													✓			✓
Fire Protection/Safety										✓			✓			✓
Paints & Coatings									✓							
Cooling Water Tower													✓			
Sewers & Drainage		✓														
Environmental Prot.		✓												✓		
Cathodic Protection											✓		✓			
Buildings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 4.6: Functions vs. CSI - Petrochemical Plants

Functional Area	CSI DIMSIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Storage & Transportation	✓						✓				✓		✓			
Distillation	✓	✓			✓		✓		✓				✓			✓
Flooding	✓	✓			✓		✓				✓		✓			✓
Cat. Cracking	✓	✓			✓		✓					✓			✓	
Saturates Gas Plant	✓	✓			✓		✓				✓		✓			✓
Cracked Gas Plant	✓	✓			✓		✓				✓		✓			✓
Alkylation & Poly.	✓	✓			✓								✓			✓
Catalytic Reforming	✓	✓			✓		✓		✓				✓			✓
Dehydrogenation	✓	✓			✓		✓						✓			✓
Thermal Cracking	✓	✓			✓		✓		✓				✓			✓
Gasoline Blending	✓	✓			✓				✓				✓			✓
Asphalt Plant	✓	✓			✓		✓						✓			✓
Hydrotreating	✓	✓			✓		✓		✓				✓			✓
Vadbreaking & Coking	✓	✓			✓								✓			✓
Separation Process	✓	✓			✓								✓			✓
Sulphur Plant	✓	✓			✓		✓		✓				✓			✓
Isomerization	✓	✓			✓		✓		✓				✓			✓
Solvent Recovery	✓	✓			✓		✓		✓		✓		✓			✓
Ethylene Plant	✓	✓			✓		✓		✓		✓		✓			✓
Utilities Function	✓				✓						✓		✓			✓

Table 4.6: Functions vs. CSI- Petrochemical Plants (Cont'd.)

elements, for example buildings in airport projects, have so many subordinate components that they must be split up and are covered in multiple divisions. It is also apparent that some of the divisions are overloaded with elements, as is Division 2 : Sitework , again for airport projects. Almost every subordinate element in the airport project has some portion of it involved in Division 2. This makes that division overly crowded with information, unwieldy and often having to be too general to accommodate this great number of different elements. This need to generalize does not fit into the pattern of a well developed and comprehensive structure or format. The DUI, introduced in Chapter 3, was computed for these project types, with the results provided in Table 4.7. The values indicate that these projects fall far from the ideal case of divisional utility. Although the flexibility of the CSI format is validated by this review of project elements versus the divisional format, it also shows that there is room for refinement.

#### **4.2 Analysis of Actual Specifications**

The next step was to canvas the construction industry for samples of specification formats. A total of 25 firms representing the project types that were selected for this study were surveyed. A mixture of public and private projects was achieved by including Corps of Engineers projects with the private sector projects provided. The project cross section also represented a mixture of large and small projects in an effort to make the data representative of the construction industry.

Project Type	Division Utility Index	Suitability
Airports	10.44	Good
Treatment Plants	26.43	Average
Roads and Bridges	7.8	Very Good
Waterways and Tunnels	6.64	Very Good
Power Plants	10.56	Good
Petrochemical Plants	149.68	Worst
Buildings	1.0	Ideal

Table 4.7: Division Utility Index by Project Type

While a few sources reported back that they use their own format for specifications (DOW, James River Corporation), most others surveyed use either the CSI format as published or slight variations of it. ( Corps of Engineers, Gilbert/Commonwealth Inc. ) This further confirms or validates the approach of using the CSI format as the jumping off point or base line for recommending an improved format for industry-wide use.

A total of 95 different specifications were gathered and reviewed in an effort to compare what is being used in the field today against the CSI format, and thereby find ways to improve the format. The specifications came from a wide variety of sources and can be viewed in abbreviated form in Table 4.8, with a complete listing of specifications studied is provided in Appendix 2. Those specifications indicating the Associated General Contractors (A.G.C.) as the source were viewed and studied on the A.G.C. premises, and were not acquired and maintained by the author. The same is true of those specifications (and "GUIDESPECS") annotated as (Returned) from the U.S. Army Corps of Engineer Districts, which were viewed and studied at the District Offices in Galveston and Fort Worth.) The preponderance of the other specifications were provided by various sources in the construction industry and government directly for this study.

Specifications for other than engineered projects were not actively sought, neither were they excluded when provided. They provide some "leavening" which makes the study more universal in application. For the purpose of record keeping, these projects primarily have been

PROJECT TYPE	# PRIVATE	# PUBLIC	TOTAL
Airports	0	2	2
Treatment Plants	2	4	6
Roads & Bridges	0	11	11
Waterways & Tunnels	0	25	25
Power Plants	9	4	13
Petrochemical Plants	2	0	2
Utilities	2	5	7
Manufacturing Plants	3	0	3
Buildings & Facilities	0	11	11
Other Misc.	12	3	15
<b>TOTAL</b>	<b>30</b>	<b>65</b>	<b>95</b>

Table 4.8: Summary of Specifications Studied

classified as Manufacturing Plants or Buildings and Facilities. The specifications then were organized and categorized by these 9 project types for further analysis.

These specifications were individually analyzed and their structures cataloged for comparison. The method involved using the CSI 16 division structure as detailed in the Manual of Practice as a guide. The actual specifications were reviewed and organized to two levels of detail below the division title level, (a total of three levels) and captured in that format. To accommodate comparison, titles and nomenclatures in the individual specifications were converted to the title or nomenclature used by CSI to allow for categorization and to establish a common base line. Although some minor errors may be introduced as a result of this translation, this is felt to be a minimal concern. The detailed analysis and compilation of the full breakdown of elements of the project specifications studied by CSI Broad Scope and Medium Scope titles is provided in Appendix 3 : Comprehensive Outlines.

#### **4.3 CSI Divisional Applicability by Project Type**

By screening information from the Comprehensive Outlines (Appendix 3) to only considering whether a division title was used or required in a specific project specification, and then viewing all the similar project types separately, it is possible to gain an appreciation of which CSI divisions are really necessary for a particular project type and engineered projects in general and which might be considered unnecessary.

This information is depicted in Tables 4.9 - 4.17. Again, this comparison is only valid for the project types being considered.

A summary of the divisions used for these projects is provided in Table 4.18. This table provides a valuable visual image of the degree to which the 16 CSI divisions accommodated the projects studied. It clearly shows that for many of the project types, over half of the divisions serve no purpose. This inefficiency dilutes the power of the divisional structure to organize and structure specifications efficiently. This is not the case for the building projects, which the CSI format was designed for, where none of the 16 divisions can be classified as serving no purpose. The ideal format would accommodate engineered projects as well as this format does for building projects.

Based on the wide divergence of the sub-elements of the different project types, every division is used in one of the project types or another. This seems to rule out the possibility of deleting any of the current divisions as being redundant or unnecessary. It is true that several of the divisions are infrequently used, (i.e. Division 10: Specialties for airport projects and Division 11: Equipment for petrochemical plants). However, little used or not, they are necessary to allow for all of the essential elements of the projects studied. Any important change then, must be based on more detailed examination of the components rather than simply looking at the division title level.

DIVISION	SPECIFICATION #	
	43	45
0 Bidding Rqt's	✓	✓
1 General Rqt's	✓	✓
2 Sitework	✓	✓
3 Concrete		✓
4 Masonry		
5 Metals		
6 Woods & Plastics		
7 Thermal & Moist. Prot.		
8 Doors & Windows		
9 Finishes		
10 Specialties		✓
11 Equipment		
12 Furnishings		
13 Special Const.		
14 Conveying Systems		
15 Mechanical		
16 Electrical		✓

✓ indicates that this item was in the specification

Table 4.9: Divisions Used - Airport Specifications

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓
1 General Rq't's	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓
3 Concrete	✓	✓		✓	✓	✓
4 Masonry	✓			✓		
5 Metals	✓	✓		✓	✓	✓
6 Woods & Plastics	✓					✓
7 Thermal & Moist. Prot.	✓	✓		✓		✓
8 Doors & Windows	✓	✓		✓		✓
9 Finishes	✓			✓		✓
10 Specialties	✓			✓		✓
11 Equipment	✓		✓	✓	✓	✓
12 Furnishings	✓					
13 Special Const.	✓		✓	✓	✓	✓
14 Conveying Systems	✓					✓
15 Mechanical	✓	✓	✓	✓		✓
16 Electrical	✓	✓	✓	✓	✓	✓

✓ Indicates that this item was in the specification

Table 4.10: Divisions Used - Treatment Plant Specifications

DIVISION	SPECIFICATION #										
	38	41	46	48	51	76	80	84	85	86	95
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
1 General Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Concrete		✓	✓	✓				✓	✓	✓	✓
4 Masonry											
5 Metals								✓			
6 Woods & Plastics											
7 Thermal & Moist. Prot.											
8 Doors & Windows											
9 Finishes											
10 Specialties											
11 Equipment											
12 Furnishings											
13 Special Const.											
14 Conveying Systems											
15 Mechanical											
16 Electrical				✓				✓			

✓ indicates that this item was in the specification

Table 4.11: Divisions Used - Road & Bridge Specifications

DIVISION	SPECIFICATION #								
	40	42	47	52	53	54	55	56	57
0 Bidding Req'ts		✓	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Concrete		✓		✓	✓		✓	✓	✓
4 Masonry									
5 Metals									
6 Woods & Plastics									
7 Thermal & Moist. Prot.									
8 Doors & Windows									
9 Finishes									
10 Specialties									
11 Equipment									
12 Furnishings									
13 Special Const.									
14 Conveying Systems									
15 Mechanical				✓					
16 Electrical									

✓ indicates that this item was in the specification

Table 4.12: Divisions Used - Waterway & Tunnel Specs.

DIVISION	SPECIFICATION #									
	58	59	60	61	62	63	64	65	66	67
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts	✓	✓		✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Concrete	✓			✓	✓		✓			
4 Masonry										
5 Metals										✓
6 Woods & Plastics				✓						
7 Thermal & Moist. Prot.										
8 Doors & Windows										
9 Finishes										✓
10 Specialties										
11 Equipment										
12 Furnishings										
13 Special Const.										
14 Conveying Systems										
15 Mechanical										
16 Electrical										✓

✓ indicates that this item was in the specification

Table 4.12: Divisions Used-Waterway & Tunnel Specs.(Cont'd.)

DIVISION	SPECIFICATION #						
	68	69	70	71	72	73	74
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts	✓	✓	✓		✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓
3 Concrete		✓			✓	✓	
4 Masonry							
5 Metals	✓					✓	
6 Woods & Plastics							
7 Thermal & Moist. Prot.							
8 Doors & Windows							
9 Finishes						✓	
10 Specialties							
11 Equipment							
12 Furnishings							
13 Special Const.							
14 Conveying Systems							
15 Mechanical							
16 Electrical						✓	

✓ indicates that this item was in the specification

Table 4.12: Divisions Used-Waterway & Tunnel Specs.(Cont'd.)

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓				✓		✓		✓	✓
3 Concrete	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4 Masonry											✓
5 Metals	✓				✓			✓	✓		✓
6 Woods & Plastics	✓										
7 Thermal & Moist. Prot.	✓								✓		✓
8 Doors & Windows	✓										✓
9 Finishes	✓										✓
10 Specialties											
11 Equipment											
12 Furnishings											
13 Special Const.											
14 Conveying Systems											
15 Mechanical	✓	✓		✓							✓
16 Electrical	✓		✓				✓				✓

✓ indicates that this item was in the specification

Table 4.13: Divisions Used - Power Plant Specifications

DIVISION	SPECIFICATION #	
	7	27
0 Bidding Rqt's	✓	✓
1 General Rqt's	✓	✓
2 Sitework	✓	✓
3 Concrete	✓	✓
4 Masonry		
5 Metals	✓	✓
6 Woods & Plastics		✓
7 Thermal & Moist. Prot.		✓
8 Doors & Windows		
9 Finishes		✓
10 Specialties		
11 Equipment	✓	✓
12 Furnishings		
13 Special Const.		✓
14 Conveying Systems		
15 Mechanical	✓	✓
16 Electrical	✓	✓

✓ indicates that this item was in the specification

Table 4.14: Divisions Used - Petrochemical Plant Specs.

DIVISION	SPECIFICATION #						
	11	32	77	89	91	91	93
0 Bidding Req'ts	✓	✓		✓	✓	✓	✓
1 General Rqt's	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓		✓	✓	✓	✓	✓
3 Concrete	✓		✓		✓	✓	✓
4 Masonry			✓				
5 Metals			✓				
6 Woods & Plastics							
7 Thermal & Moist. Prot.			✓				
8 Doors & Windows			✓				
9 Finishes			✓			✓	
10 Specialties			✓				
11 Equipment			✓				
12 Furnishings							
13 Special Const.			✓				
14 Conveying Systems							
15 Mechanical		✓	✓			✓	
16 Electrical			✓	✓	✓	✓	✓

✓ indicates that this item was in the specification

Table 4.15: Divisions Used - Utility Specifications

DIVISION	SPECIFICATION #
	1,2,3
0 Bidding Rqt's	✓
1 General Rqt's	✓
2 Sitework	✓
3 Concrete	✓
4 Masonry	✓
5 Metals	✓
6 Woods & Plastics	✓
7 Thermal & Moist. Prot.	
8 Doors & Windows	✓
9 Finishes	
10 Specialties	
11 Equipment	
12 Furnishings	
13 Special Const.	
14 Conveying Systems	
15 Mechanical	✓
16 Electrical	✓

✓ Indicates that this item was in the specification

Table 4.16: Divisions Used - Manufacturing Plant Specs.

DIVISION	SPECIFICATION #										
	25	26	39	75	78	79	81	81	83	88	94
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
1 General Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
3 Concrete	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
4 Masonry	✓	✓	✓	✓	✓	✓	✓	✓			✓
5 Metals	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
6 Woods & Plastics	✓	✓	✓	✓	✓	✓	✓	✓			✓
7 Thermal & Moist. Prot.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8 Doors & Windows	✓	✓	✓	✓	✓	✓	✓	✓			✓
9 Finishes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10 Specialties	✓	✓	✓	✓	✓	✓	✓	✓			✓
11 Equipment		✓	✓	✓	✓	✓					✓
12 Furnishings			✓	✓	✓	✓		✓			✓
13 Special Const.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14 Conveying Systems	✓	✓		✓		✓					✓
15 Mechanical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16 Electrical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ indicates that this item was in the specification

Table 4.17: Divisions Used - Bldg. & Facility Specs.

PROJECT TYPE	CSI DIVISIONS FOUND:	
	NEEDING RESTRUCTURING	MINIMAL UTILITY
Airports	2,10	4,5,6,7,8,9,11,12,13,14,15
Treatment Plants	11,13	None
Roads & Bridges	2	4,6,7,8,9,10,11,12,13,14,15
Waterways & Tunnels	2	4,7,8,10,11,12,13,14
Power Plants	15,16	10,11,12,13,14
Petrochemical Plants	2,3,5,11,13,15	4,8,10,12,14
Utilities	2	6,12,14
Manufacturing Plants	2,16	7,9,10,11,12,13,14
Buildings	None	None

## Summary

Needing Restructuring	Unnecessary
2,3,5,10,11,13,15,16	None

Table 4.18: CSI Division Efficiency By Project Type

#### **4.4 Problems With The CSI Format For Engineered Projects**

After determining the occurrence of essential elements for the various project types, some conclusions can be reached. These conclusions, coupled with a number of comments and suggestions from several Architectural/Engineering (A/E) firms, can point the way to improved practices.

The following are the major problems found by the author while reviewing the project types against the CSI format.

- Division 2: Sitework is overloaded for airport projects.
- Division 2: Sitework is overloaded for treatment plant projects.
- Division 15: Mechanical lacks adequate structure for treatment plant projects.
- Division 2: Sitework contains too great a portion of road and bridge projects, which reduces utility.
- Division 2: Sitework is overloaded for waterways and tunnels projects, again reducing utility of the division.
- Division 15: Mechanical lacks internal structure for power plant and petrochemical plant projects.
- Division 2: Sitework lacks structure for utility projects.
- Division 7: Thermal and Moisture Protection and Division 9: Finishes are overloaded for some project types.
- Division 11: Equipment lacks specificity for equipment intensive projects like petrochemical and treatment plants.

- Several division titles (i.e. Division 8: Doors and Windows, and Division 10: Specialties) need some modification to better describe their contents.

#### **4.5 Problem Analysis**

Each project type was analyzed for specific problem areas associated with projects ability to utilize the CSI 16 division format. The results are summarized below.

The airport projects which were studied focused on modernization and improvements. These are reasonable for use in this study, as the majority of most work being done within the airport area annually is in fact modification rather than new construction. For this project type, Division 1: General Requirements, was fully utilized indicating the absolute necessity of covering the ground rules or general requirements in this type work. (This is true in any project, as will be seen in the following paragraphs). Division 2: Sitework is overloaded with key elements and therefore inefficient because such a great portion of the total project falls into this division. The utility of the division level of organization is severely reduced when the preponderance of the entire work is contained in a single division. Many contractors and perhaps separate contracts may be involved in this part of the work, and the compressed nature of the division makes extracting their specific requirements difficult. Some means which would perhaps separate earthwork, paving and utilities might be a first step in making the division more "user friend-

ly". Division 10: Specialties, although not an often used division, is quite important to the completion of the airport projects.

Treatment plant projects again display a highly ordered and vital Division 1. Division 2 for treatment plants is too multi-functional, with the varied areas of utilities, demolition, paving and surfacing as well as items such as site improvements and landscaping vying for attention. Just as with airports, Division 10: Specialties and in this case Division 11: Equipment are essential to the project, but are often not considered vital by some critics of the CSI format. They prove their importance in projects like treatment plants which involve complex process equipment. Division 15: Mechanical displays a distinct lack of structure. It would be much easier for contractors conducting estimates and bidding if their particular specialty (HVAC, Plumbing, etc.) were easier to distinguish.

The road and bridge projects provide an example of a complete project type which falls almost entirely into a single division, in this case Division 2: Sitework. As displayed earlier, the utility of the division structure is squandered when this is the case. Again, the grouping together of earthwork and paving may be justified, however there seems to be a need to separate utilities and perhaps landscaping. Placing everything into this single division, without clear internal subdivisions simply makes the division less useful.

Waterways and tunnel projects suffer from the same conditions as stated above for roads and bridges. This project type, with its tremendous amount of earthwork, and separate marine work, as well as exten-

sive piles and caissons, would be better served by a more detailed structure within the division.

Power plants again are seen to place a premium on information in Division 1, where conditions are specified in great detail. Division 15 for power plant projects, just as with treatment plants, is a poor approach for breaking the work down efficiently into component elements for the various distinct potential contractors. These comments are equally true for petrochemical plants. These projects also have extensive General Requirements, covering proprietary information, safety, quality control, and many other items addressed in Division 1 and validate the necessity for this introductory division.

Utility projects are fairly well served by Division 2: Sitework, where the preponderance of their components fall. Many of the same points about over use made concerning roads and bridges can be made here. Providing some subordinate elements or headings within the division would improve the usefulness of the structure and modifying or expanding the divisional level structure would be even better.

Manufacturing plants are well accommodated by the CSI format. Aside from a recurrence of several of the crowding and organizational problems described above, particularly in Divisions 2 and 16, the CSI format is well suited for these project types.

Chapter 5 deals with the results of studying the more comprehensive outlines as depicted in Appendix 3, integrating these findings with comments from industry, and presents a proposal based on that information.

## CHAPTER 5

### FORMING THE HYPOTHESIS: A BETTER WAY

#### 5.1 Introduction

It is obvious that the CSI format is not readily adaptable for engineered projects. The utility of the divisional level in the CSI format is severely limited for engineered projects. The problems are not so tremendous that they make the format unusable, but are significant enough to make the format less than optimal for most engineered project applications. It also is reason enough to create one's own system for engineered projects, producing a disincentive for overall system standardization.

#### 5.2 Comments From Industry and CSI

Comments from industry have been collected concerning some of the difficulties encountered with the CSI format as currently utilized. These comments amplify and also add to the difficulties of using the CSI format for engineered projects as detailed in Chapter 4.

The Supervisor of Design Services for James River Corporation commented on a number of problems that organization has encountered with the CSI format. The most important concerned the nature of the CSI format which causes specifications to be very comprehensive. This

should be an advantage, but taken to extremes can cause specifications to become too lengthy. Some contractors will not take adequate time to read them, and problems for the project naturally follow. (Doug Hight, letter to the author, March 1991).

Others, like Gilbert/Commonwealth Inc. find the format very useful, with only minor alterations required. Many noted a dissatisfaction with the current hierarchy within several divisions, as was addressed earlier. Interestingly, the respondents were almost evenly split concerning the 16 division format, with about half firmly resolved to maintain the number at 16, mostly because their accounting and cost tracking systems and filing mechanisms are established to accommodate that system now. The others, called for expansion of the format from 17 to perhaps 25 divisions, depending upon the particular needs of their organization.

A survey conducted by the School of Building Construction at the University of Florida and ENR found that contractors are not satisfied with current specifications.<sup>1</sup> Contractors reported that specifications are often biased, have significant omissions, conflict with other contract documents and require too many modifications. Of the 120 contractors who responded, only 10% rated specifications as excellent for overall quality and comprehensiveness. Good ratings were delivered by 37%, while 35% rated them fair and 17% rated specifications as being poor.

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<sup>1</sup> Janice L. Tucheran, "Contractor Survey Finds That Specs Don't Measure Up", *ENR* 226 (17 June 1991): 24-28

Clearly contractors are dissatisfied with specifications as currently organized and prepared.

The CSI Ad Hoc MASTERFORMAT Committee, in their *Final Report* in January 1991, uncovered a few other problems and ideas which deserve mention.<sup>2</sup> The comments from the report which relate to this study are provided below.

- There is a desire for a more hierarchical organization within MASTERFORMAT. There are some weaknesses in the arrangement of MASTERFORMAT, as well as inconsistencies and illogical arrangement. Examples include:

- It is not always obvious which numbers within the MASTERFORMAT are broadscope and mediumscope. (For example the Broadscope title 00300 Bid Forms has no subordinate Mediumscope titles associated with it at all. Title 01025 Measurement and Payment has three subordinate titles, Schedule of Values, Applications for Payment and Unit Prices, but none of them have and Mediumscope title numbers.)
- Groupings are not necessarily all-inclusive. For example, not all metal products are included within Division 5 : Metals, where it would reasonably be expected to be. (For example

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<sup>2</sup> James M. Robertson, comp., Ad Hoc MASTERFORMAT Committee, Final Report. (Alexandria, VA: Construction Specifications Institute, 1991), 7

reinforcing steel is listed in Division 3: Concrete rather than Division 5: Metals.)

–Attributes, such as types of materials, are presented in different sequences in different parts of the MASTERFORMAT.

–In some instances the inconsistency of arrangement limits the specifiers ability to expand specific technical subjects.

- The existing organization of Division 1 is perceived by some users to be illogical and cumbersome. There does not seem to be a meaningful distinction between "administrative" and "procedural" requirements. During their 1988 update of the MASTERFORMAT, the committee considered establishing five subordinate headings, including:

- Contract Conditions,
- Administrative Procedures,
- Temporary Requirements,
- Closeout Requirements, and
- References.

(The committee recommended that CSI initiate a study to improve the organization of Division 1, and to expand educational materials and programs covering Division 1.)

- There is a need for an elemental format. It is difficult to use MASTERFORMAT for the development of project outline specifications, some types of performance specifications, and preliminary cost estimates. Specifically addressed items include:

- MASTERFORMAT's numbers and titles are based on products and systems. In the early stages of a conventional design, elements of the project must be described before specific products or systems have been chosen.
- The need for an alternative format extends beyond the early stages of design. There are a growing number of projects where specifications are based on the performance of an assembly (exterior walls) or performance of a system (lighting). MASTERFORMAT is difficult to use and can lead to confusion in these applications.
- MASTERFORMAT does not work well for those who establish building performance criteria or who administer the maintenance of a completed facility. These activities lend themselves to descriptions of a facility by its elements or components rather than by individual products.
- Because of the high cost of building operations there is a need for life cycle analyses for building elements and systems. These studies must be organized around assemblies and components. MASTERFORMAT does not function as well as a format built around building elements in this case.

The challenge for the Committee is to identify and evaluate alternative approaches to specification organization to accommodate elemental specifications within their format.

### 5.3 A Proposed Solution

What is now required is to select an approach for making changes to the CSI format. The approach selected here is to:

- meld the key points detected during the analysis of project types versus the CSI Divisions,
- incorporate suggestions from industry, and
- incorporate suggestions debated but not yet instituted by the CSI MASTERFORMAT Committee.

The changes proposed by this study are based on modification of the CSI format, and do not incorporate how to integrate an elemental format into the CSI format as that is beyond the scope of this study. Additionally, some of the ideas or suggestions which are justified from the analysis of the specifications studied are discounted by comments from industry.

The foremost decision needed here is how to shape the structure. Initially, the proposed changes might have included increasing the number of divisions from the 16 currently in use (17 including the unnumbered Bidding Requirements, Contract Forms, and Conditions of the Contract), to a new total of 25. Based on input from industry, this might be better accomplished by restructuring and subdividing some divisions rather than create new ones. This is a reasonable approach, and is suggested here.

The proposed changes then, which leave the CSI divisions numerically intact, are small in number, yet critical to the full integration of engineered projects into the format.

- First, Division 0: Bidding Requirements, Contract Forms, and Conditions of the Contract should be readmitted to the formal structure. The MASTERFORMAT maintains the information, but deleted the Division 0 title in the 1983 update of the MASTERFORMAT. This information in fact is still quite necessary, and is still included in every specification. For continuity, these documents should be addressed in the same manner as the technical specification items, that is, as a division.
- Division 2: Sitework would be much better if the number of competing, important elements was reduced, which would increase its utility. This could easily be accommodated by creating a number of divisions from the current one. Alternately, rather than add a complication by increasing the number of divisions, Division 2 could be expanded and reorganized by adding subordinate titles or subdivisions. These should include 2A: Earthwork, 2B: Utilities, 2C: Foundations, 2D: Paving and Surfacing and 2E: Miscellaneous Sitework and Landscaping. This provides the benefit of separating and identifying the major subordinate components of the division while keeping these items within the familiar Division 2 location. This allows the organizational improvement to be instituted without a complete reorganization of the CSI divisions.
- Division 8: Doors and Windows, Division 10: Specialties, and Division 11: Equipment should see minor changes. The most obvious change should be minor changes in the titles to better represent the contents of the division. The revised titles should be Division 8: Doors,

Windows and Glazing, Division 10: Speciality Items, and Division 11: Non-Mechanical Equipment. These changes would better reflect the contents of the divisions, and clear up some of the confusion about what constitutes "equipment" for example. This change would make it more evident that Division 11 would accommodate non-mechanical equipment, and mechanical items would then be found in Division 15: Mechanical.

The same reasoning for not expanding the total number of divisions as addressed for Division 2 is applied to revisions of Divisions 15: Mechanical and Division 16: Electrical.

- Division 15 should be expanded as follows: 15A: Piping and Plumbing, 15B: HVAC, 15C: Engineered Vessels and Equipment, 15D: Mechanical Controls, and 15E: Other Mechanical.
- Division 16: Electrical should be expanded to allow for two subordinate titles, 16A: Electrical Specialties and 16 B: Controls and Instrumentation. The Division 16 title should be changed to Electrical, Controls and Instrumentation.

The current CSI divisions, with the proposed changes is displayed in Table 5.1. The process undertaken to test and refine this proposal is discussed in Chapter 6.

**Current CSI Division Format vs. Proposed Divisional Format**

CURRENT FORMAT	PROPOSED FORMAT
Bidding Req'ts, Contract Forms & Conditions of the Contract	Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract
Div 1 General Requirements	Div 1 General Requirements
Div 2 Sitework	Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping
Div 3 Concrete	Div 3 Concrete
Div 4 Masonry	Div 4 Masonry
Div 5 Metals	Div 5 Metals
Div 6 Wood & Plastic	Div 6 Wood & Plastic
Div 7 Thermal & Moist. Prot.	Div 7 Thermal & Moist. Prot.
Div 8 Doors & Windows	Div 8 Doors, Windows & Glazing
Div 9 Finishes	Div 9 Finishes & Treatments
Div 10 Specialties	Div 10 Specialty Items
Div 11 Equipment	Div 11 Non-Mechanical Equipment
Div 12 Furnishings	Div 12 Furnishings
Div 13 Special Construction	Div 13 Special Construction
Div 14 Conveying Systems	Div 14 Conveying Systems
Div 15 Mechanical	Div 15 Mechanical 15A Piping 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical
Div 16 Electrical	Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation

Table 5.1: CSI Division Format vs. Proposed Division Format

## CHAPTER 6

### TESTING THE HYPOTHESIS

Having arrived at the proposed revisions to the CSI MASTERFORMAT's divisional structure in the previous chapter, the natural next step is to verify that the hypothesis is in fact viable.

As this work is primarily qualitative, so must be the initial criteria applied to assessing the validity of the proposed revision of the format. The criteria applied to the validation include:

- does the proposed format agree with the majority of mainstream comments provided by industry and professional groups,
- does the proposed format require only minor revisions to the CSI format as opposed to a complete restructuring, and
- does it improve the format by providing a better distribution of total project cost; by making the divisional level more intuitive or descriptive; and by reducing the dominance of total project cost by a small portion of the total divisional structure.

#### 6.1 Arguments Supporting the Hypothesis

The first approach selected to validate the value of the proposed revision is to consider the primary arguments which support it. The foremost argument springs from the source of the research itself. Many

organizations and individuals have expressed a desire to revise the 16 division CSI format.

The American Society of Civil Engineers Specification Committee is addressing this need, and their query served as the spark which initiated this research. Their search for modifications was spurred by comments and requests from within the construction community, particularly from the traditionally civil components. The current format used for structuring specifications into 16 divisions provides inadequate visibility for many of the civil functions, as discussed previously. The proposed changes provide for added flexibility by providing the minimal internal organization needed. This also provides a somewhat emotional satisfaction for those elements involved in the civil activities particularly, giving them greater visibility. The proposed revision accommodates these concerns in an efficient manner.

A second very important argument for the viability of this format revision is that it has the potential to be accepted. Rather than beginning with a totally blank sheet, this revision takes into account the very real inertia of the industry toward change. The charter given to the chairman of the CSI MASTERFORMAT Committee included the instruction that the 16 divisions as currently used would be essentially inviolate.<sup>1</sup> This led to the rapid realization that any suggested revision, if it would be seriously considered by the publishers of the format used by almost

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<sup>1</sup> Mr. Michael King, telephone interview by author, Washington, D.C., 9 July 1991

everyone in the industry, would have to use the 16 divisions as a base line. The proposed revisions keep the 16 division titles essentially intact, and work within the existing divisions to create the organization necessary to provide the proper flexibility. The motivation of this compromise is significant, beyond meeting the requirements of the MASTERFORMAT Committee. A tremendous segment of the industry already has heavily invested time and effort in establishing accounting systems, and filing systems based on the 16 division format. Completely reorganizing the in-place system might be the most effective way to begin the reorganization, but is hardly practical. The uproar from industry would be tremendous, and would require unnecessary time and effort for people to bring their systems into line with the new format. This would be inefficient and likely unacceptable. This was clearly stated in the CSI MASTERFORMAT Committee report, which stated: "CSI/CSC should pursue formal recognition of MASTERFORMAT as an American Standards Institute (ANSI) Standard."<sup>2</sup> (CSC is Construction Specifications Canada, the Canadian equivalent to and now partner of CSI for publishing MASTERFORMAT.) They clearly have listened to their constituents and they have stated that the 16 division organization should remain intact for future editions and updates. By working within the existing divisions, the recommended changes provide flexibility without damaging the in-place infrastructure.

The first test of the hypothesis was accomplished by having the Chairman of the American Society of Civil Engineers Specification Committee, Mr. Edgar Neely, review the proposed revision and to comment on it. As this ASCE Committee initially suggested this work, it was the natural first step. With only one minor phraseology change, which has already been incorporated into the proposed format as presented in the previous chapter, the proposal survived this first test. The acceptance of the basic approach and outcome by the chairman of the initiating body provided the necessary confidence to continue the attempt to validate the concept.

The second criteria, that of the revision being as compatible as possible with the CSI format is also met by the proposed format. By keeping the 16 divisions in nearly the same configuration, the worst fears of the CSI Committee members concerning a reorganization of the format are alleviated.

## **6.2 Validation by Project Element Costs**

The next phase of the validation was to check the rationale of focusing on reorganization through subdivisions. The key question was could the proposed reorganization be validated by using cost of construction figures from the industry. The ability to gain feedback during this phase has proven frustrating. Although several firms were contacted, cost data was provided only by one. Thus, while the validation is weakened, it is adequate to give an initial view of the reasonableness of the subdivision organization presented. The figures displayed for air-

port projects (Table 6.1), waterway and tunnel projects (Table 6.2), and roads and bridges (Table 6.3) were provided by Parsons, Brinkerhoff, Quade and Douglas, Inc.. They should be taken as approximate, but valid for the purpose of this evaluation.<sup>3</sup> The figures for treatment plants (Table 6.4) and Buildings and Facilities (Table 6.5) were provided by the Fort Worth District of the Corps of Engineers. The data used for power plant projects (Table 6.6) was provided by Mr. Arthur E. White of Gilbert/Commonwealth Inc. The data for the final project type reviewed in this section, petrochemical plants (Table 6.7) was provided by Dow Chemical, thanks to the efforts of Mr. Paul Cooper, a Senior Lecturer at the University of Texas at Austin. Perhaps the primary concern is that the percentages of construction for several of the project types, do not sum up to 100 percent. This obviously creates some problem in using the data, but as all conclusions which were drawn are relational to a percentage of the whole and not anchored to a top limit of 100 percent, the data still provides some useful insights.

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<sup>3</sup> Eli. T. Abdullah, Parsons, Brinkerhoff, Quade & Douglas, Inc., letter to the author, 16 July 1991

COST (% of Total) by Division

PROPOSED FORMAT	% Cost (Range) of Project			
	CSI Divisions	Proposed Divisions		
Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract				
Div 1 General Requirements	9.6%	9.6%		
Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping	14.6%	ZA: 1.0% 2B: 5.1% 2C: 1.0% 2D: 1.9% 2E: 5.6%		
Div 3 Concrete	21.8%	21.8%		
Div 4 Masonry	24.0%	24.0%		
Div 5 Metals				
Div 6 Wood & Plastics				
Div 7 Thermal & Moist. Protection				
Div 8 Doors, Windows & Glazing				
Div 9 Finishes & Treatments				
Div 10 Speciality Items				
Div 11 Non-Mechanical Equipment				
Div 12 Furnishings				
Div 13 Special Construction	5.9%	15A: 0.9% 15B: 5.0% 15C: 15D: 15E:		
Div 14 Conveying Systems				
Div 15 Mechanical 15A Piping & Plumbing 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical				
Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation			17.0%	17.0% 16A: 16B:

Table 6.1: Airport Project Cost Breakdown

COST (% of Total) by Division

PROPOSED FORMAT	% Cost (Range) of Project	
	CSI Divisions	Proposed Divisions
Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract		
Div 1 General Requirements	5-10%	5-10%
Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping	55-92%	2A: 40-60% 2B: 10-12% 2C: 5-10% 2D: 0-5% 2E: 0-5%
Div 3 Concrete	20.0%	20.0%
Div 4 Masonry	0-5%	0-5%
Div 5 Metals	10%	10%
Div 6 Wood & Plastics		
Div 7 Thermal & Moist. Protection	5-10%	5-10%
Div 8 Doors, Windows & Glazing		
Div 9 Finishes & Treatments		
Div 10 Speciality Items		
Div 11 Non-Mechanical Equipment		
Div 12 Furnishings		
Div 13 Special Construction		
Div 14 Conveying Systems		
Div 15 Mechanical 15A Piping & Plumbing 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical	20-25%	15A: 0-5% 15B: 20% 15C: 15D: 15E:
Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation	10.0%	16A: 16B:

Table 6.2: Waterway & Tunnel Project Cost Breakdown

## COST (% of Total) by Division

PROPOSED FORMAT		% Cost (Range) of Project	
		CSI Divisions	Proposed Divisions
Div 0	Bidding Req'ts, Contract Forms & Conditions of the Contract	5-10%	5-10%
Div 1	General Requirements	5-10%	5-10%
Div 2	Sitework	25-35%	25-35%
2A	Earthwork		2A: _____
2B	Utilities		2B: _____
2C	Foundations		2C: _____
2D	Paving & Surfacing		2D: _____
2E	Misc. Sitework & Landscaping		2E: _____
Div 3	Concrete	25-35%	25-35%
Div 4	Masonry	10%	10%
Div 5	Metals	10-25%	10-25%
Div 6	Wood & Plastics		
Div 7	Thermal & Moist. Protection	5%	5%
Div 8	Doors, Windows & Glazing		
Div 9	Finishes & Treatments		
Div 10	Speciality Items		
Div 11	Non-Mechanical Equipment		
Div 12	Furnishings		
Div 13	Special Construction		
Div 14	Conveying Systems		
Div 15	Mechanical	20%	15A: --- 10% ---
15A	Piping & Plumbing		15B: _____
15B	HVAC		15C: _____
15C	Engr. Vessels & Equip.		15D: 10%
15D	Mech. Controls		15E: _____
15E	Other Mechanical		
Div 16	Electrical, Controls & Instrumentation	20.0%	20.0%
16A	Electrical Specialties		16A: _____
16B	Controls & Instrumentation		16B: _____

Table 6.3: Road and Bridge Project Cost Breakdown

## COST (% of Total) by Division

PROPOSED FORMAT	% Cost (Range) of Project	
	CSI Divisions	Proposed Divisions
Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract		
Div 1 General Requirements	1-2%	1-2%
Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping	11-19%	2A: 3-5% 2B: 4-6% 2C: <1% 2D: 2-3% 2E: 2-4%
Div 3 Concrete	16.0%	16.0%
Div 4 Masonry	<1%	<1%
Div 5 Metals	2-4%	2-4%
Div 6 Wood & Plastics	<1%	<1%
Div 7 Thermal & Moist. Protection	1%	1%
Div 8 Doors, Windows & Glazing	<1%	<1%
Div 9 Finishes & Treatments	1-3%	1-3%
Div 10 Speciality Items	<1%	<1%
Div 11 Non-Mechanical Equipment	1-4%	1-4%
Div 12 Furnishings	<1%	<1%
Div 13 Special Construction	1-2%	1-2%
Div 14 Conveying Systems	<1%	<1%
Div 15 Mechanical 15A Piping & Plumbing 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical	46-68%	15A: 6-12% 15B: <1% 15C: 30-40% 15D: 8-10% 15E: 2-5%
Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation	10-24%	16A: 10-12% 16B: 0-2%

Table 6.4: Treatment Plant Project Cost Breakdown

## COST (% of Total) by Division

PROPOSED FORMAT	% Cost (Range) of Project	
	CSI Divisions	Proposed Divisions
Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract		
Div 1 General Requirements	<1%	<1%
Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping	12-28%	ZA: 7-10% 2B: 5.0% 2C: 0-5% 2D: 0-5% 2E: 0-3%
Div 3 Concrete	18.0%	18.0%
Div 4 Masonry	6%	6%
Div 5 Metals	4%	4%
Div 6 Wood & Plastics	2%	2%
Div 7 Thermal & Moist. Protection	5%	5%
Div 8 Doors, Windows & Glazing	6%	6%
Div 9 Finishes & Treatments	9%	9%
Div 10 Speciality Items	2%	2%
Div 11 Non-Mechanical Equipment	<1%	<1%
Div 12 Furnishings	1%	1%
Div 13 Special Construction	3%	3%
Div 14 Conveying Systems	<1%	<1%
Div 15 Mechanical 15A Piping & Plumbing 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical	12-30%	15A: 5-10% 15B: 5-10% 15C: 15D: 2-5% 15E: 0-5%
Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation	9-18%	16A: 5-10% 16B: 4-8%

Table 6.5: Building &amp; Facility Project Cost Breakdown

COST (% of Total) by Division

PROPOSED FORMAT	% Cost (Range) of Project	
	CSI Divisions	Proposed Divisions
Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract		
Div 1 General Requirements		
Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping	2-17%	2A: 0-5% 2B: 2-5% 2C: 0-1% 2D: <1% 2E: 0-5%
Div 3 Concrete	6%	6%
Div 4 Masonry		
Div 5 Metals	10%	10%
Div 6 Wood & Plastics	8-12%	8-12%
Div 7 Thermal & Moist. Protection	6-8%	6-8%
Div 8 Doors, Windows & Glazing	5%	5%
Div 9 Finishes & Treatments	1-2%	1-2%
Div 10 Speciality Items		
Div 11 Non-Mechanical Equipment		
Div 12 Furnishings		
Div 13 Special Construction		
Div 14 Conveying Systems		
Div 15 Mechanical 15A Piping & Plumbing 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical	14-52%	15A: 5-20% 15B: 1-2% 15C: 2-5% 15D: 1-5% 15E: 5-20%
Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation	20-45%	16A: 10-25% 16B: 10-20%

Table 6.6: Power Plant Project Cost Breakdown

COST (% of Total) by Division

PROPOSED FORMAT	% Cost (Range) of Project	
	CSI Divisions	Proposed Divisions
Div 0 Bidding Req'ts, Contract Forms & Conditions of the Contract	2-3%	2-3%
Div 1 General Requirements		
Div 2 Sitework 2A Earthwork 2B Utilities 2C Foundations 2D Paving & Surfacing 2E Misc. Sitework & Landscaping	5%	5% ZA: _____ 2B: _____ 2C: _____ 2D: _____ 2E: _____
Div 3 Concrete	3-4%	3-4%
Div 4 Masonry		
Div 5 Metals	4-7%	4-7%
Div 6 Wood & Plastics		
Div 7 Thermal & Moist. Protection		
Div 8 Doors, Windows & Glazing		
Div 9 Finishes & Treatments	8%	8%
Div 10 Speciality Items	1%	1%
Div 11 Non-Mechanical Equipment	1%	1%
Div 12 Furnishings	1%	1%
Div 13 Special Construction		
Div 14 Conveying Systems		
Div 15 Mechanical 15A Piping & Plumbing 15B HVAC 15C Engr. Vessels & Equip. 15D Mech. Controls 15E Other Mechanical	25-60%	15A: 15-30% 15B: _____ 15C: 10-20% 15D: 5% 15E: 5%
Div 16 Electrical, Controls & Instrumentation 16A Electrical Specialties 16B Controls & Instrumentation	15-20%	16A: 5-8% 16B: 10-12%

Table 6.7: Petrochemical Plant Project Cost Breakdown

### 6.3 Standard Deviation of Divisional Costs

The first method used to evaluate the performance of the proposed reorganization based on cost data was to compare the standard deviation of the portion of the total project costs by division for each project type. Standard deviation was selected as the statistic to be considered as it provides a measure of the dispersion in the distribution of project cost by division. It would be impractical to attempt to achieve a divisional structure which perfectly equalizes the contributions made by each division, and these "balanced divisions" would likely not fit the work breakdown structures for engineered projects. The test then is to measure cost breakdown by division. A small standard deviation, providing a smooth, normal distribution of costs which moderates the influence of any single division by keeping their values reasonably consistent from division to division is desirable. This makes the standard deviation, rather than the mean for example, a better measure of divisional utility.

It must be remembered that since these values are based on proportions of the project total, the fact that the sums of the percentages for each do not equal 100 percent does not make them unusable. The comparison of the standard deviations for the two organizational structures is depicted in Table 6.8.

For every project type considered, the standard deviation of the projects divisional cost breakdown was reduced under the proposed organization. Substantial improvement is recorded for the waterways and tunnels, treatment plant, buildings and facilities, power plants and

PROJECT TYPE	STANDARD DEVIATION ( $\sigma$ ) OF DIVISIONAL/SUBDIVISIONAL COSTS		CHANGE (%)	EFFECTED DIVISIONS	IMPROVEMENT FROM NEW FORMAT
	CURRENT CSI FORMAT	PROPOSED FORMAT			
Airports	6.41	5.41	17%	2, 15	Good
Waterways & Tunnels	22.93	12.92	44%	2, 15	Major
Roads & Bridges (Steel)	9.9	9.76	2%	15	Minor
Roads & Bridges (Conc.)	9.75	9.29	5%	15	Minor
Treatment Plants	14.29	7.37	48%	2, 15, 16	Major
Buildings & Facilities	7.10	3.83	46%	2, 15, 16	Major
Power Plants	12.76	5.25	59%	2, 15, 16	Major
Petrochemical Plants	14.33	6.04	58%	15, 16	Major

Table 6.8: Standard Deviation of Project Cost By Division

improved so dramatically for buildings, as the CSI format is most closely associated with that project type already. Some improvement was recorded for airports and roads and bridges.

This analysis indicates that the proposed organization indeed is validated based on cost data. By reducing the standard deviations of the division cost figures, each division is weighted more appropriately when considered against the entire project. The two project types which showed the least improvement were roads/bridges and airports, each of which have a very large percentage of the total cost associated with Division 3: Concrete. Although not proposed in this study, if a manner could be devised to subdivide this division, like that proposed for Division 2, the standard deviations for these two project types could be improved also.

#### **6.4 Consistency of Division Costs**

Another way to view the data is to determine if some consistency in the percentage of total project cost is achieved. If all divisions are to be considered equal then the portions of the total project cost that each comprises should be distributed in a manner which avoids peaks where some divisions overshadow the others.

The figures for the first project type, airports, are as shown in Table 6.1. These figures, particularly those for the subdivisions of Division 2: Sitework, are large enough to indicate that there is value in compartmentalizing or subdividing those elements of work. The values

reported which exceed five (5) percent indicate there is enough fiscal significance to deserve subdivision of the Sitework division.

Similar results are seen in the figures provided for waterway and tunnel projects as shown in Table 6.2. Again it can be seen that the subordinate components of the divisions selected for internal reorganization command a substantial portion of the overall project cost. As this project type leans heavily on the traditional civil specialties, as was expected, it none the less validates the concept. With the subordinate element Earthwork commanding fully 40 to 60 percent of the total project cost, and with Utilities and Foundations each accounting for well over 5 percent of the total, it is clear that these critical elements require more visibility than is provided under the current organization. This is seen again for the subdivisions of Division 15: Mechanical. Each of the sub-elements in this division accounts for at least 5 percent of the total project cost, a claim that many of the traditional 16 divisions cannot make for this project type.

The data for roads and bridges was presented in Table 6.3. Unfortunately, the data provided lacked the detailed breakdown for subdivisions 2A-2E, but the tremendous percentage of the total project cost (25-35%) included in Division 2 clearly indicates that the subordinate elements would command large portions of the total project cost. Information provided by the Fort Worth District of the Corps of Engineers verifies this conclusion. Based upon bid abstracts available there, typical values for the subordinate elements of Division 2 for road and bridge work were: 2A: Sitework - 20% and 2D: Paving and Surfacing - 50 to

70%. These values are greater than those reported in Table 6.3 due to the Corps of Engineer projects considered dealt with roadwork primarily, with little of the more costly bridge work included. Although these two sets of figures cannot be directly compared, they each indicate that the proposed elements subordinate to the major divisions are very important sub-classes of work in the overall project, and deserve higher visibility and more attention.

The Fort Worth District Office's data for treatment plants, is depicted in Table 6.4. For this project type, at least two of the subdivisions of Division 2 warrant individual attention, but the critical items are within Divisions 15 and 16. It is clear that Division 15: Mechanical commands up to half of the total project cost, and several of its subordinate elements (Piping and Plumbing, Engineered Vessels and Equipment, and Mechanical Controls) are responsible for large segments of the total. Each of these easily exceeds 5 percent of the total project cost, and should be recognized as semi-separate items. Although less dramatic, the same holds true for the components of Division 16: Electrical, where Electrical Specialties accounts for about 10 percent of the total project cost.

The other project type which the Corps of Engineers provided data for is Buildings and Facilities, as was shown in Table 6.5. This data is based upon the four projects which they had active at the time of the information request, which ranged in total project cost from \$927,500 to \$10,500,000. Again, the data validates the concept of having sub-elements with their own titles, as all but one of the Division 2 subdivisions

could be expected to reach 5 percent of the project total, and the same holds true for some of the Division 15 and all of the Division 16 subordinate elements.

The data used for power plant projects is depicted in Table 6.6. Although the data seems to indicate that subordinate titles within Division 2 may not be necessary for this project type, it clearly indicates that the subordinate titles are needed within Divisions 15 and 16. With values ranging up to 20 percent of the total project cost, which are not surprising for this type of project, many of the subordinate elements are clearly critical and deserve and require better handling and visibility.

The data for petrochemical plants is in Table 6.7. The data is primarily for refining operations within the petrochemical industry, and not for plastics production or similar work. Once again, not every one of the proposed subordinate element titles command enough of the total project cost for this type project to rate subdivision, but some are in fact quite critical to the project, as the numbers portray. The tremendous proportion of the total cost captured in Divisions 15 and 16 are certainly overwhelming enough to deserve subdivision.

Presently, no data has been made available to view the two remaining project types discussed within this work. The first, manufacturing plants, vary so much depending on the actual plant, and other conditions that its exclusion is not detrimental to the conclusions which are reached here. The second, utilities would provided additional confirmation of the validity of the subdivisions under Division 2, as earthwork and

utilities can be expected to be major players in that work, but the data has not been as of yet made available to present here.

## **6.5 Summary of Analysis**

Comments from industry as well as comparisons of the distribution of total project cost under the proposed organization clearly support revision of the 16 division format. Although the data used here for validation falls short of providing overwhelming proof that the proposed revisions are completely valid, it does provide a strong indicator. Other approaches to reorganization may be equally valid, but this analysis has shown that the proposed revisions studied in this work would improve the organization and utility of the division level for specifications.

This analysis has been conducted not to provide proof positive that the suggested modification is the absolutely best approach, but to provide a litmus test of the validity of this particular approach. The data provides at least that. In any instance where over 10 percent of the total project cost can be attributed to a subordinate component of a division, there is clearly the opportunity to create a stand alone portion of the specification, and 5 percent is more likely to be the correct threshold. Not every one of the proposed subdivisions will meet this criteria for each project type, but the mix of project types studied has validated them for at least one project type, and typically in several.

Subdivision of many of the specification's 16 divisions is warranted. The approach advocated here minimizes the impacts of change while providing improved flexibility and organizational efficiency. This

provides better visibility and attention to these important subordinate elements within the division structure for engineered projects without disrupting the 16 divisions which are considered by many to be too well established and accepted to be changed at any cost. The hypothesis has survived the two critical tests; it is viable and reasonable based upon cost data, and does not create major disruption of the current 16 division format.

## CHAPTER 7

### CONCLUSIONS AND RECOMMENDATIONS

#### 7.1 Conclusions

The need to have a true industry-wide standard has been clear throughout this research. Although the CSI format is considered by many to be the standard, there unfortunately is no formally recognized standard format accepted by the entire construction industry.

This work has centered around the premise that the CSI format for organizing specifications might benefit from some modifications. This has been shown to be true for many project types. The CSI format is not well suited to engineered projects. These engineered projects then are justifiably hindered from supporting the adoption of the CSI format as a national standard; although a national standard is necessary. Much is to be gained by modifying the CSI format to better accommodate engineered projects.

It has been demonstrated that the current utility of the CSI format can be increased for many project types by providing some reorganization and additional subdivisions of a few of the larger, more critical divisions. Although this suggestion falls short of creating a completely hierarchical organization which some espouse, and was addressed in the CSI Ad Hoc MASTERFORMAT Committee report, it is a step in the right direction. As that committee pointed out, the attempt to make the

organization completely hierarchical is perhaps the utopian ideal, and would be used if this were the first publication of the document, but the years of service which the format has seen have built up extensive infrastructure and inertia which are impractical to attempt to overcome.

The modifications espoused in Chapter 5 are the least difficult way to implement change within the existing divisional format in order to serve engineered projects. Although perhaps not ideal, they provide the necessary flexibility and structural framework needed for these project types, without massive changes to the accepted format. These changes could easily be incorporated into the next (1993) update of the MASTERFORMAT, and would be beneficial to heavy civil projects, process-dependent projects, and many other types of engineered projects.

## **7.2 Recommendations**

The recommendations which follow are presented as the initial steps in creating a truly comprehensive format for specifications which applies to any project type.

- The first recommendation naturally is that the modifications to the format addressed in Chapter 5, should be accepted by CSI and included in the next update of the CSI MASTERFORMAT publication scheduled for 1993. Additionally, more research into a method of subdividing Chapter 3: Concrete would provide a significant additional means of bringing that

division's contributions to total project cost in line with the others.

- The industry needs to adopt a standard format. This could and should be easily remedied. The wide acceptance of the CSI format makes it a natural front runner to assume the role of a standard format, although the CSI format in its present form does not satisfy the requirements to be an industry-wide standard. The CSI MASTERFORMAT writers should incorporate those features of the other formats which compliment their format and improve the structure and organization. They should include these improvements into their next revision, and then seek to have their format recognized as a true standard by the American Standards Institute (ANSI). This has already been discussed within CSI, and should be pursued.
- From an industry-wide prospective, perhaps the most vital of the recommendations which should be incorporated in the updated CSI MASTERFORMAT is a linkage or melding of the CSI format with an elemental format, as discussed in Chapter 2. The advantages of the elemental format, especially in the early stages of project life, or when using performance specifications which are not easily accommodated by the CSI MASTERFORMAT style are substantial and worth capitalizing upon. This will be no simple task, as the two format are not similar enough to make their combination easy or natural, but

would provide substantial benefits for the construction industry as a whole.

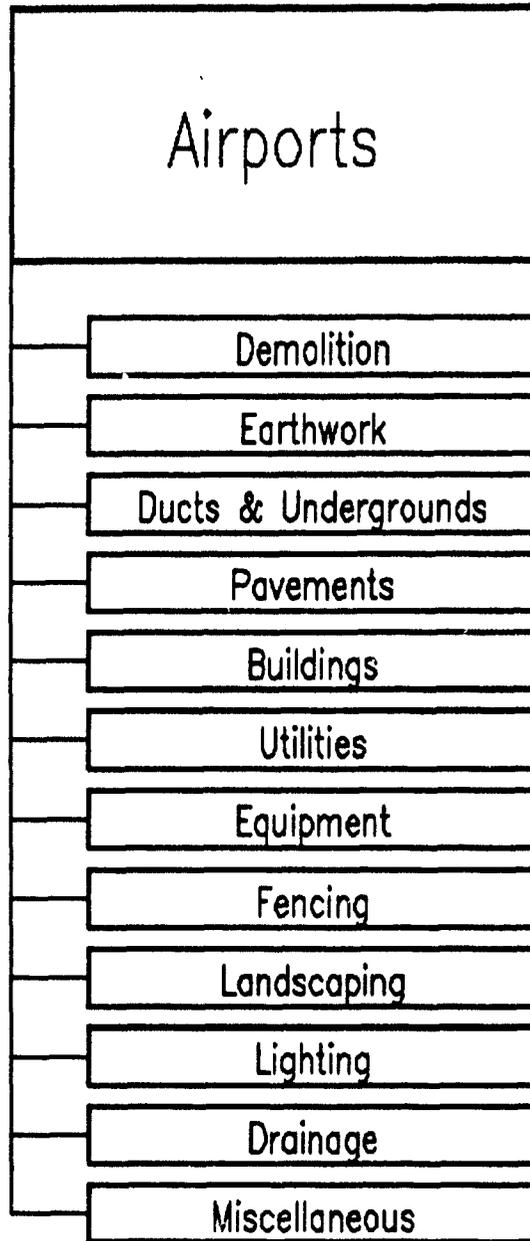
- During the next update, the CSI publishers should put more effort into improving the ease of use of the MASTERFORMAT. During this research, many misconceptions about the format, numbering, hierarchy, and the like were discovered in both the actual industry and academic world. Many of the current complaints about the MASTERFORMAT could be alleviated by providing better "How to" information in the introduction portion of the document.
- A feedback system, to gather input from the industry and allow for its inclusion in future format updates is necessary. This last recommendation, that the ultimate publisher of what ever document becomes the industry standard should establish a feedback loop which gathers comments and suggestions from industry, circulate them for appropriate study, comment and modification, and then include them in future updates is critical. This is the most obvious, and possibly most valuable of the recommendations made within this work. The industry must make better use of the collective knowledge, experience and wisdom available if it is to expand and continue to be a world leader.

These recommendations, although not radical and in some cases not new, should provide a better document and a better served industry. Many of these ideas were provided by the many individuals and com-

panies which provided data and assistance, and reflect then the ideas from industry as well as those developed in this work. It applies beyond the halls of academia. As better specifications will result in better projects, the search for a better specification format is important to the entire industry, and should be pursued with vigor.

APPENDIX 1

**PROJECT TYPE FUNCTIONAL BREAKDOWNS**



**AIRPORTS FUNCTIONAL BREAKDOWN  
SUBORDINATE LEVELS**

• **DEMOLITION**

- Blasting

• **EARTHWORK**

- Clearing
- Grubbing
- Excavation
- Embankments
- Subbase Course
- Borrow Operations
- Backfilling
- Grading
- Disposal of Cut Material
- Compaction and Watering
- Compaction Test
- Soil Stabilization Test

• **DUCTS AND UNDERGROUNDS**

- Conduits
- Concrete Ducts
- Steel Ducts

• **PAVEMENTS (RUNWAYS, TAXIWAYS, AND ROADS)**

- Pavement (Runways, Taxiways, Service and Security Roads, Parking Lots, Helipads)
- \* Flexible Pavements
  - Base Course
  - Surface Course
  - Bituminous Prime Coat
  - Bituminous Tack Coat
  - Bituminous Seal Coat
  - Bituminous Surface Treatment
  - Joint Sealing Filler
  - Asphalt
  - Asphalt Concrete Surface Coat
  - Bituminous Plant Operations
- \* Rigid Pavements
  - Pavement
  - Joint Sealing Filler
  - Structural Portland Cement Concrete

- Concrete Mixing
- Reinforcing Steel
- Curing
- Mixing Plant Operations
- Finishing

- **BUILDINGS**

- Terminal Facility
- Control Tower
- Cargo Building and Terminal
- Hangers
- Maintenance Facilities
- General Aviation Services Building
- Power Plant
- Rescue and Fire Fighting Facilities
- Fuel Servicing Facilities
- Parking Facilities/Garage
- Footings and Foundations
- Brick Masonry
- Structural Concrete
- Structural Steel
- Mechanical Work
- Electrical Work

- **UTILITIES AND INFRASTRUCTURE**

- Water Supply and Distribution
- Power Distribution
- Telephone Specialties

- **EQUIPMENT**

- Rescue and Fire Fighting Equipment
- Communications Equipment
- Radio Navigation Aids
- Visual Aids
- Customs Equipment
- Security Equipment
- People Movers, Elevators and Escalators
- Weather Data Gathering and Evaluation Equipment
- Cables
- Ground Markers
- Testing Equipment

**• FENCING**

- Security Fencing
- Noise Control Fencing
- Barricades
- Warning Signs and Markings

**• LANDSCAPING**

- Seeding
- Sprigging
- Sodding
- Topsoiling
- Tilling
- Mulching
- Planting Trees
- Shrubs and Vines
- Tree Wells and Root Protection

**• LIGHTING**

- Airfield Lights
- Rotating Beacon
- Hazard Beacon
- Beacon Towers
- Wind Cones
- Underground Lighting Cables
- Transformer Vault and Equipment
- Wind Tee
- Medium Intensity Lights
- Obstruction Lights
- Internally-Lighted Taxi-Guidance Signs
- High Intensity Runway Lights
- Approach Lights

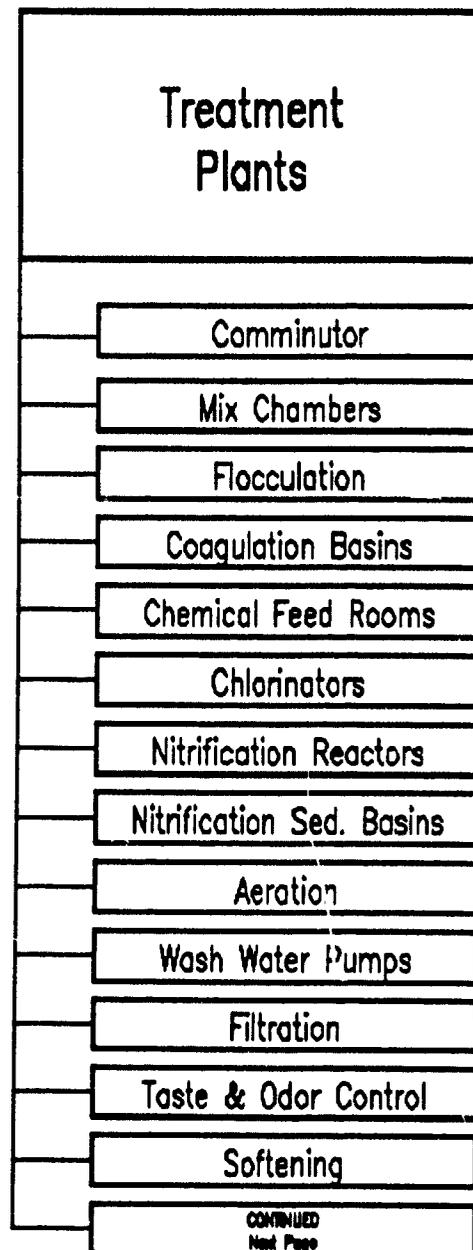
**• DRAINAGE**

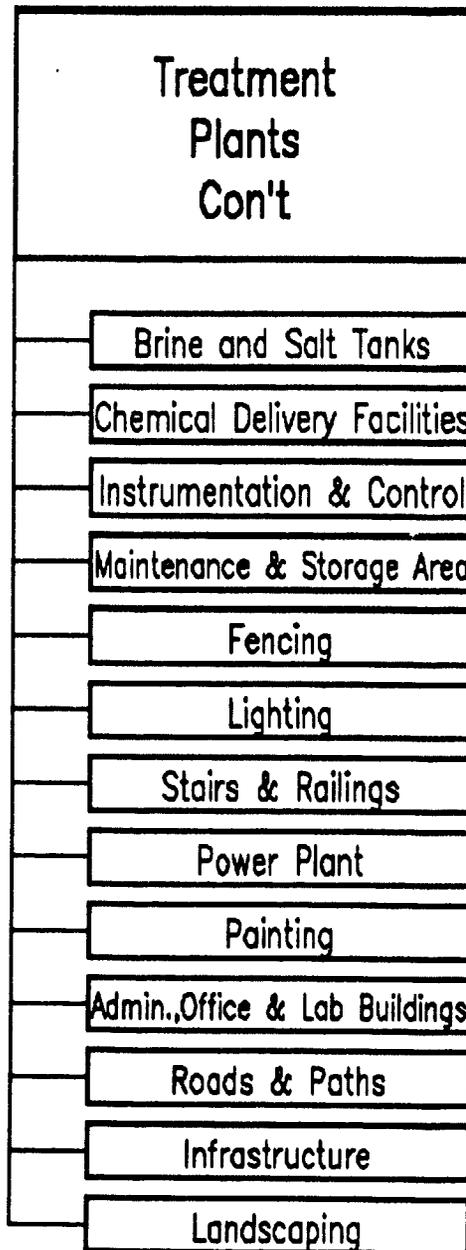
- Storm Sewers
- Culverts
- Underdrains
- Pipe Arches
- Manholes
- Catch Basins
- Inlets and Inspection Holes
- Head Walls
- Paved Gutters

- Ditches and Flumes

- MISCELLANEOUS

- Painting
- Clean-up (Post Construction and F.O.D. Avoidance)
- Licenses and Permits





**WATER TREATMENT PLANT FUNCTIONAL BREAKDOWN  
SUBORDINATE LEVELS**

• **COMMINUTOR**

- Raw Sewage Inflow Structure
- Bar Screen or Comminutor

• **MIX CHAMBERS**

- Mixing Tanks
- Mixing Process Equipment

• **FLOCCULATION**

- Flocculation Mixing Equipment
- Flocculation Chemical Injection

• **COAGULATION BASINS**

- Coagulation Basin/Tanks
- Gravity Basin

• **CHEMICAL FEED ROOMS**

- Feed Room Structure
- Chemical Feeding Equipment
- Control Instrumentation

• **CHLORINATORS**

- Chlorination Direct Feeders
- Chlorine Solution Feeders
- Liquid Chlorine Evaporators
- Hypochlorite Feeders

• **NITRIFICATION REACTORS**

- Nitrification Equipment

• **NITRIFICATION SEDIMENTATION BASINS**

- Site Preparation
- Nitrification Sedimentation Basins

• **AERIATION**

- Waterfall Aerators
- Diffusion Aerators
- Mechanical Aerators

• **WASH WATER PUMPS**

- Wash Water Injection Equipment
- Wash Water Supply

- FILTRATION

- Slow Sand Filters
- Rapid Sand Filters
- Mixed Media Filters

- TASTE AND ODOR CONTROL

- Mechanical (Aeriation)
- Chemical Injection and Treatment
- Absorptive Filters

- SOFTENING

- Pre-treatment Chemical Injection

- BRINE AND SALT TANKS

- Brine and Salt Tank Facilities

- CHEMICAL DELIVERY FACILITY

- Train Car Off Load Facilities
- Barge Off Load Facility
- Truck Receiving Point

- INSTRUMENTATION AND CONTROLS

- Plant Control System
- Plant Instrumentation Systems

- MAINTENANCE AND STORAGE AREAS

- Equipment Maintenance Facility
- Tool and Test Equipment Storage Area

- FENCING

- Security and Access Control Fencing

- LIGHTING

- Facility Internal Lighting
- Plant Area and Security Lighting
- Maintenance Lighting

- STAIRS AND RAILINGS

- Guard Railings
- Plant Access Stairs and Ladders
- Maintenance Ladders

- POWER PLANT

- Auxiliary Power Unit

- PAINING

- Painting and Finishing
- Waterproofing

- BUILDINGS

- Plant Administration Building
- Laboratory Facility
- Maintenance and Laboratory Lavatories and Safety Showers
- Conference Facilities

- ROADS AND PATHS

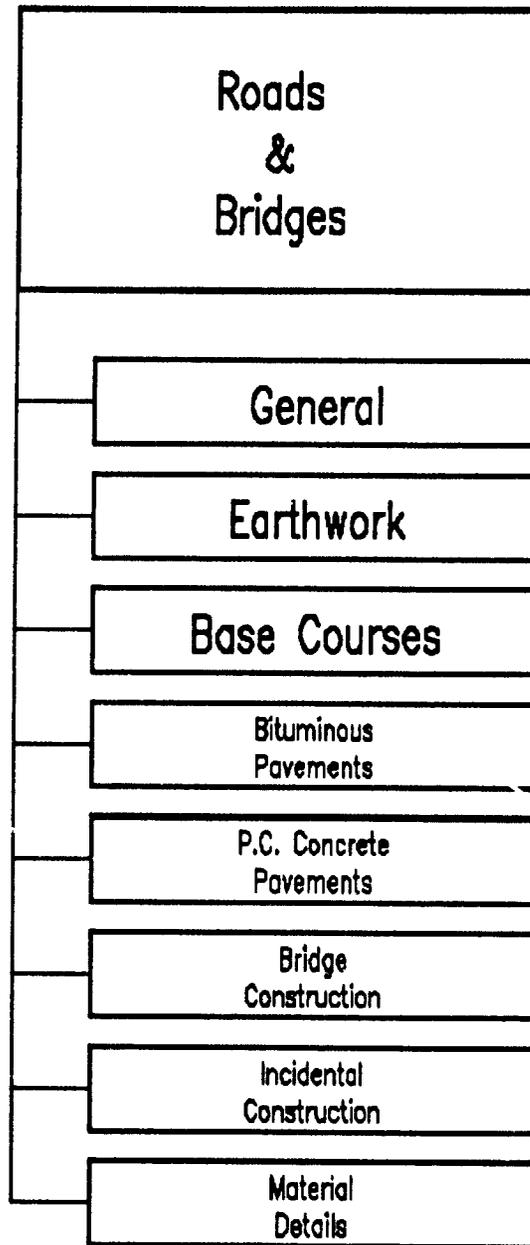
- Access Roads
- Delivery Facility Roads
- Maintenance Paths
- Parking Facilities

- INFRASTRUCTURE

- Power Lines
- Water and Sewage Lines
- Telephone Service

- LANDSCAPING

- Landscaping and Area Maintenance



**ROAD AND BRIDGE FUNCTIONAL BREAKDOWN  
SUBORDINATE LEVELS**

**• GENERAL**

- Definitions and Terms
- Bidding Requirements and Conditions
- Award and Execution of Contract
- Scope of Work
- Control of Work
- Control of Material
- Legal Relations and Responsibility to the Public
- Prosecution and Progress
- Measurement and Payment

**• EARTHWORK**

- Clearing and Grubbing
- Removal of Structures and Obstructions
- Excavation and Embankment
- Soil Erosion Control
- Subgrade Preparation
- Prewatering of Excavation Areas
- Overhaul
- Structure Excavation for Conduits and Minor Structures
- Water Pollution Control
- Obliteration of Old Roadways
- Roadside Clean-up

**• BASE COURSES**

- Plant Mixed Bituminous Base Courses
- Road Mixed Bituminous Base Courses
- Aggregate Base Course
- Subgrade Modification
- Reconditioning Roadbed
- Lime Treated Courses
- Cement Treated Courses
- Portland or Blended Hydraulic Cement Concrete Base Course
- Econocrete Base Courses
- Lime-Fly Ash Treated Courses

**• BITUMINOUS PAVEMENTS**

- Sheet Asphalt Pavement
- Open Graded Friction Course
- Cold Bituminous Pavement

- Road Mix Bituminous Pavement
- Tack Coat
- Prime Coat
- Seal Coat
- Bituminous Surface Treatment
- Recycling Bituminous Pavement Material

- **PORTLAND CEMENT CONCRETE PAVEMENT**

- Description
- Materials
- Proportioning
- Equipment
- Preparation of Grade
- Setting Forms
- Conditioning of Subgrade or Base Courses
- Handling, Measuring, and Batching Materials
- Mixing Concrete
- Limitations of Mixing
- Placing and Consolidating Concrete
- Test Specimens
- Strike-off of Concrete and Placement of Reinforcement
- Joints
- Final Strike-off
- Surface Test
- Curing
- Removing Forms
- Repair of Defective Pavement Slabs
- Sealing Joints
- Protection of Pavement
- Opening to Traffic
- Tolerance in Pavement Thickness
- Methods of Measurement
- Basis of Payment

- **BRIDGE CONSTRUCTION**

- Excavation and Fill
- Sheet Piling
- Bearing Piles
- Concrete Structures
- Reinforcing Steel
- Ashlar Masonry
- Mortar Rubble Masonry
- Dry Rubble Masonry

- Brick Masonry
- Steel Structures
- Bronze or Copper-Alloy Bearing and Expansion Plates
- Steel Grid Flooring
- Railings
- Painting Metal Structures
- Protection of Embankments and Slopes
- Concrete Cribbing
- Waterproofing
- Dampproofing
- Name Plates
- Timber Structures
- Preservative Treatments For Timber
- Timber Cribbing
- Const. and Installation of Soil Metal Plate Structure Interaction Systems
- Wearing Surfaces
- Elastomeric Bearings
- Const. of Tunnels Using Steel Tunnel Liner Plates
- TFE Bearing Surfaces
- Const. and Installation of Soil-Reinforced Concrete Structure Interaction Systems

• MISCELLANEOUS CONSTRUCTION

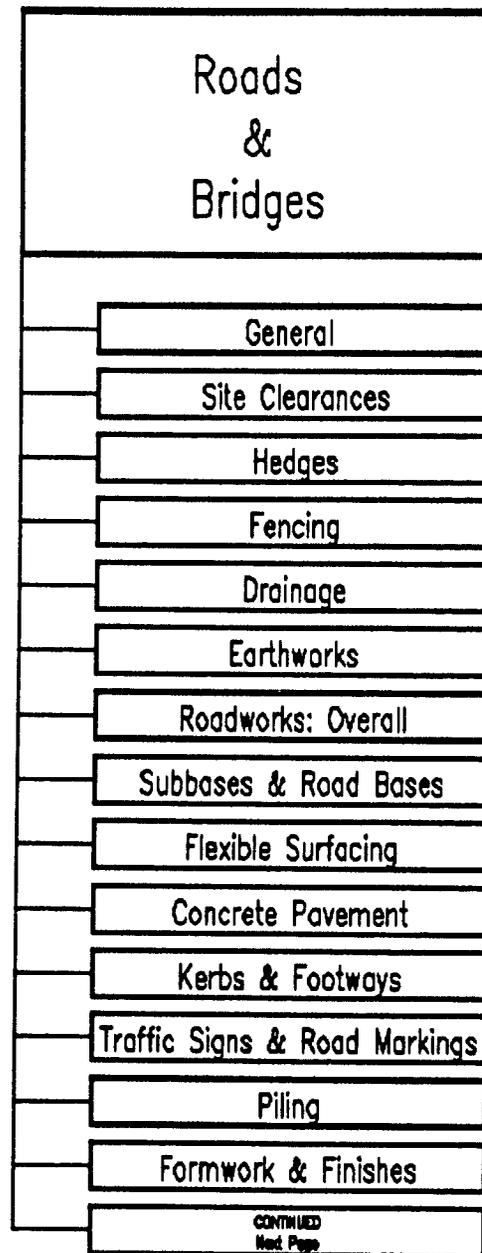
- Concrete for Minor Structures and Incidental Construction
- Reinforcing Steel
- Culverts and Storm Drains
- Manholes, Inlets, and Catch Basins
- Underdrains
- Guardrail
- Fences
- Sidewalks
- Curb, Curb and Gutter, Paved Ditches and Paved Flumes
- Turf Establishment
- Furnish and Plant Trees, Shrubs, Vines and Groundcovers
- Mobilization
- Slope Protection
- Concrete Barrier
- Erosion Checks
- Riprap
- Reference Markers
- Traffic Control
- Erosion Mats and Bales

**• MATERIAL DETAILS**

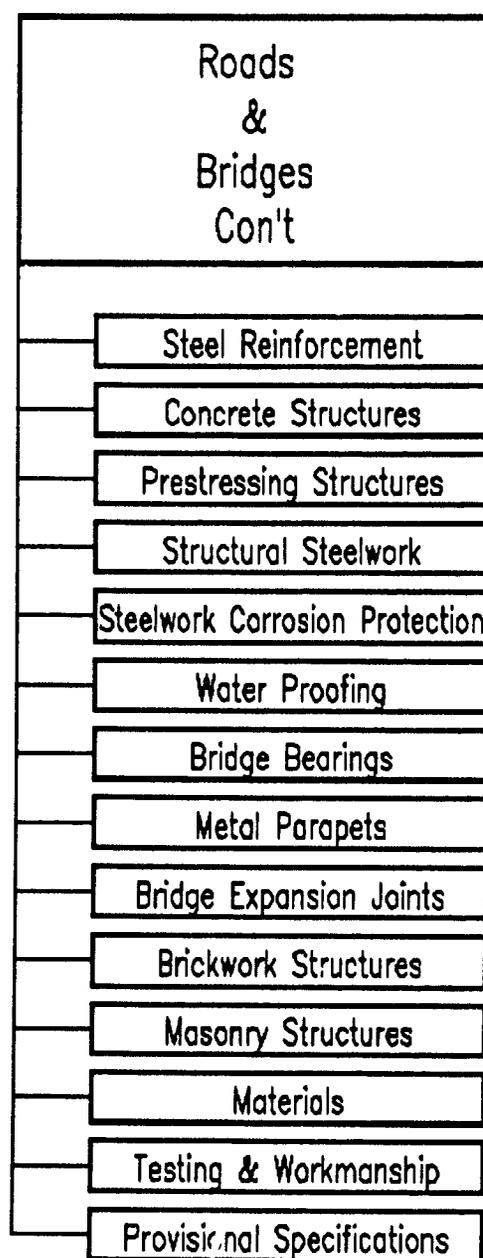
- Hydraulic Cement
- Bituminous Materials
- Aggregates
- Aggregate for Drainage
- Stone Blanket Protection and Filter Blanket
- Masonry Units
- Joint Materials
- Concrete, Clay and Fiber Pipe
- Metal Pipe
- Paints
- Reinforcing Steel and Wire Rope
- Fence and Guardrail
- Concrete Curing Materials and Admixtures
- Miscellaneous
- Roadside Improvement Materials

# U.K. ROADS AND BRIDGES

## Functional Breakdown



## U.K. ROADS AND BRIDGES Functional Breakdown



UNITED KINGDOM ROAD AND BRIDGE FUNCTIONAL BREAKDOWN  
SUBORDINATE LEVELS

• GENERAL

- Offices for the Engineer
- Operatives for the Engineer's Staff
- Traffic Safety & Control (Traffic Safety Measures)
- Temporary Diversion of Traffic
- Privately and Publicly Owned Services
- Existing Ground Levels
- Vehicles for the Engineer
- Progress Photographs
- Alternative Materials
- Accommodation Works
- Noise Control

• SITE CLEARANCE

- Clearing
- Existing Trees, Stumps, and Roots

• HEDGES

- Hedges

• FENCING

- Requirements for Temporary, Stated Temporary and Permanent Fences
- Temporary Fencing
- Motorway Fencing
- Accommodation Works Fencing
- Gates and Gate Posts
- Removing and Re-Erecting Existing Fences and Gates
- Marker Posts
- Safety Fences - Overall Requirements
- Tensioned Corrugated Beam Safety Fence
- Open Box Beam Safety Fence
- Untensioned Corrugated Beam Safety Fence
- Pre-Treatment and Painting of Fences, Gates and Posts

• DRAINAGE

- Types of Pipeline
- Excavation for Pipelines and Drainage Structures
- Bedding, Laying and Surrounding of Pipes
- Jointing of Pipes
- Backfilling of Trenches and French Drains

- Connecting to Existing Sewers, Drains and Manholes
- Manholes, Catchpits, Inspection Chambers and Draw Pits
- Gullies and Pipe Junctions
- Testing and Cleaning
- Intercepting Ditches
- Land Drains
- Filling to Pipe Bays on Bridges
- Permeable Backing to Earth Retaining Structures
- Ducts

#### • EARTHWORKS

- Definition, Classification and General Use of Earthworks Materials
- Explosives and Blasting
- Excavation of Cuttings
- Excavation Below Embankments and Below Formation Level in Cutting
- Excavation of Foundation Pits and Trenches
- Refilling of Foundation Pits and Trenches and Removal of Supports
- Forming of Embankments and Other Areas of Fill
- Compaction of Embankments and Other Areas of Fill
- Preparation and Surface Treatment of Formation
- Earthworks to be Kept Free of Water
- Soiling, Grassing and Turfing
- Watercourses
- Filling Existing Watercourses
- Clearing Existing Ditches
- Granular Fill to Structures

#### • ROADWORKS: OVERALL REQUIREMENTS

- Horizontal Alignments, Surface Levels and Surface Regularity of Pavement Courses
- Cold Weather Working
- Use of Surfaces by Constructional Plant
- Number of Layers for Bituminous Courses
- Transporting, Laying and Compacting of Pavement Materials Containing Tar or Bitumen Binders
- Use of Rubber in Bituminous Materials

#### • SUB-BASES AND ROAD BASES

- Materials for Sub-Bases and Roadbases
- Construction Requirements for Materials
- Granular Sub-base Material Type 1
- Granular Sub-base Material Type 2
- Soil Cement

- Cement-Bound Granular Material
- Lean Concrete
- Wet-mix Macadam
- Dry-Bound Macadam
- Dense Tarmacadam Roadbase
- Dense Bitumen Macadam Roadbase
- Rolled Asphalt Roadbase
- Maintenance of Surface of Roadbase
- Paved Hardshoulders and Hardstrips
- Wet Lean Concrete for Sub-Bases

• **FLEXIBLE SURFACING**

- Flexible Surfacing Materials
- Rolled Asphalt Basecourse
- Dense Bitumen Macadam Basecourse
- Dense Tarmacadam Basecourse
- Bitumen Macadam Basecourse
- Tarmacadam Basecourse
- Rolled Asphalt Wearing Course
- Dense Bitumen Macadam Wearing Courses
- DTS Wearing Course
- Cold Asphalt Wearing Course
- Coating of Chippings for Application to Pre-mixed Surfacing
- Open-textured Bitumen Macadam Wearing Course
- Open-textured Tarmacadam Wearing Course
- Slurry Sealing
- Surface Dressing
- Bituminous Sprays

• **CONCRETE PAVEMENT**

- Constituents of the Mix
- Water-Cement ratio and Air Content
- Proportioning the Mix
- Concrete Strength
- Trial Mixes
- Limit of Workability
- Waterproof Membrane
- Steel Reinforcement
- Transverse Joints
- Longitudinal Joints
- Grooves at Joints
- Sealing of Grooves
- Treatment at Manholes and Gullies

- Use of Side Forms, Rails and Guide Lines for Machine Laid Concrete
- Delivery, Storage and Batching of Materials
- Mixing Concrete
- Transport and Placing
- Spreading by Machine
- Compaction and Finishing by Machine
- Compaction and Finishing with a Hand Guided Vibrating Beam
- Surface Finish During Initial Construction of Concrete Pavements
- Curing
- Trial Lengths
- Inspection of Joints in Concrete Pavements by Removal of Wet Concrete

• **KERBS AND FOOTWAYS**

- Precast Concrete Kerbs, Channels, Edgings and Quadrants
- In Situ Asphalt Kerbs
- In Situ Concrete Kerbs
- Footways (Concrete Paved)

• **TRAFFIC SIGNS AND ROAD MARKINGS**

- Permanent Traffic Signs
- Road Markings

• **PILING FOR STRUCTURES**

- General
- Precast Concrete Piles
- Cast-in-Place Piles
- Steel Bearing Piles and Permanent Steel Sheet Piles
- Pile Records

• **FORMWORK AND SURFACE FINISH FOR STRUCTURES**

- Construction
- Formed Surfaces - Classes of Finishes
- Preparation of Formwork Before Concreting
- Removal of Formwork
- Uniform Surfaces - Classes of Finishes
- Remedial Treatment of Surfaces

• **STEEL REINFORCEMENT FOR STRUCTURES**

- General
- Bending of Reinforcement
- Placing of Reinforcement
- Cover Blocks
- Welding of Reinforcement

## • CONCRETE FOR STRUCTURES

- Concrete Mix Design
- Concrete for Ancillary Purposes (Class E)
- Trial Mixes
- Admixtures
- Delivery and Storage of Materials
- Mixing Concrete
- Ready-Mixed Concrete
- Sampling Concrete
- Transport and Placing
- Compaction of Concrete
- Construction Joints
- Curing of Concrete
- Early Loading
- Storage of Precast Reinforced Members
- Handling and Placing of Precast Reinforced Members
- Manufacture of Precast Reinforced Members Off the Site
- Porous No-Fines Concrete

## • PRESTRESSING FOR STRUCTURES

- General
- Prestressing Components
- Prestressing Tendons
- Sheaths and Extractable Cores
- Anchorages
- Jacks for Prestressing
- Post-tensioning Procedure
- Grouting for Ducts
- Pl. . for Grouting of Ducts
- Grout for Ducts
- Storage of Prestressed Members
- Handling and Placing of Prestressed Members
- Composite Slab Bridges
- Pretensioned Members
- Manufacture of Prestressed Members Off the Site

## • STRUCTURAL STEELWORK

- General Requirements - Workmanship, Fabrication and Erection
- Working Drawings
- Welding and Flame Cutting Procedure Trails
- Qualification and testing of Welders
- Supervision of Welding

- Welding Plant
- Welding
- High Strength Friction Grip Bolts
- **PROTECTION OF STEELWORK AGAINST CORROSION**
- Preparation of Surfaces to Receive Paint
- Metal Coatings
- Protection of Joints
- Storage of Paint
- Application of Paint
- Storage of Steel and Fabricated Steelwork
- Repairs to Damaged Surfaces
- Etch Primers and Blast Primers
- Uncoated Surfaces
- Protective Systems
- **WATERPROOFING FOR STRUCTURES**
- General
- Waterproofing with Mastic Asphalt
- Waterproofing with Prefabricated Sheeting
- Waterproofing with Rubberized Filled Bitumen
- Protective Layers to Waterproofing
- Painting with Tar or Bitumen
- **BRIDGE BEARINGS**
- General
- Metal Bearings
- Elastomeric Bearings
- **METAL PARAPETS**
- General
- Welding
- Inspection and Testing of Welding
- Erection of Parapets
- Alignment
- **BRIDGE EXPANSION JOINTS**
- General
- Prevention of Damage
- Epoxy Mortar Nosings
- Sealing

### • BRICKWORK FOR STRUCTURES

- General
- Cold Weather Working
- Protection of New Work
- Reinforced Brickwork
- Treatment of Exposed Joints
- Brick Facework Fixed to Concrete

### • MASONRY FOR STRUCTURES

- General
- Joints
- Cold Weather Working
- Protection of New Work
- Ashlar
- Block-in-Course
- Squared Rubble-Coursed or Broken Coursed
- Random Rubble-Coursed or Uncoursed
- Backing to Masonry Facework
- Masonry Facework Fixed to Concrete
- Dry Rubble Walling
- Special Stonework Including Quoins, Copings, Plinths, Voussoirs, etc.
- Cast Stonework

### • MATERIALS

- Submission of Samples and Test Certificates
- Aggregates for Concrete
- Aluminized Curing Compound
- Bolts, Nuts and Washers
- Bond Breaking Coatings for Dowel Bars
- Bricks
- Cast Iron
- Cast Stone
- Cement
- Cement Grout for General Use
- Clay Puddle
- Dowel Bars and Tie Bars for Concrete Pavements
- Electrodes for Welding
- Fencing Wire
- Fertilizer
- Grass Seed
- Gullies, Gully Covers and frames

- Hydrated Lime
- Joint Sealants and Seals
- Lime Mortar
- Manholes and Inspection Chambers
- Manholes and Catchpit Covers and Frames
- Mortar
- Natural Stone
- Cancelled Clause
- Paint and Other Protecting Coatings for Steelwork
- Pipes for Drainage and Ducts
- Precast Concrete Flags
- Precast Concrete Kerbs, Edgings and Quadrants
- Preformed Joint Filler
- Elastomeric Bridge Bearings
- Sheaths for Prestressed Concrete
- Stainless Steel
- Steel Castings
- Steel Forgings
- Steel Reinforcement
- Steel Tendons for Prestressed Concrete
- Steel Wire Mesh and Expanded Metal
- Structural Steel
- Timber for General Purposes
- Timber for Permanent Fencing
- Water for Use with Cement
- Waterproofing Materials for Structures
- Waterproof Underlay
- Structural Aluminum

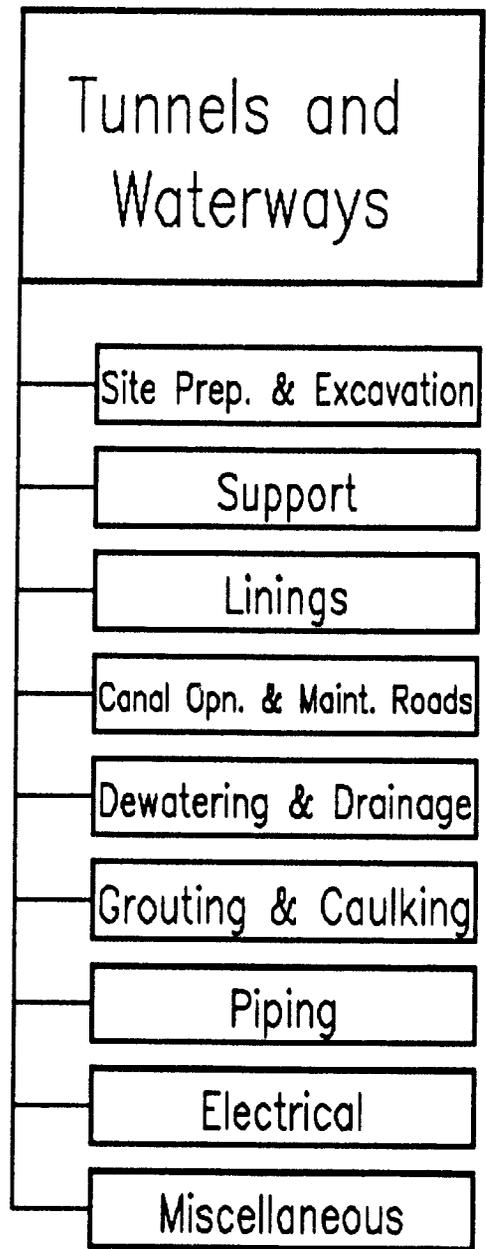
#### • TESTING OF MATERIALS AND WORKMANSHIP

- Provision of Testing Equipment
- Assistance in Sampling and Testing
- Testing of Moisture Content of Timber
- Testing of Pipe Bedding Material
- Testing of Lean Concrete
- Testing of Cement Bound Granular Material and Soil Cement
- Testing of Bituminous Mixtures and their Component Materials
- Testing of Slurry Sealing Material
- Testing of Concrete, Surface Texture and Curing Membranes for Concrete Pavements
- Testing of Concrete for Structures
- Testing of Pretensioned Beams

- Inspection and Testing of Precast Concrete Units
- Testing of Steel for Structures
- Testing of Welding
- Testing of Elastomeric Bridge Bearings
- Testing of Paints
- Testing of Metal Coatings
- Testing of Portland-Blastfurnace cement
- Accelerated Wear Test
- Pile Tests
- Testing of Prestressing Anchorages
- Determination of the Chloride Content of Aggregates

**• PROVISIONAL SPECIFICATIONS**

- Provisional Specification for Rolled Asphalt Wearing Course with Crushed Rock Fine Aggregates
- Provisional Specification for Rolled Asphalt Wearing Course with Slag Fine Aggregate for Low Speed Roads
- Provisional Specification for Bituminous Materials Manufactured by the Wibau SL Plant
- Provisional Specification for Bituminous Materials Manufactured by the Coalmaster DFE Plant
- Provisional Specification for Tar-Bitumen Blends for Use in Surface Dressing
- Provisional Specification for Texturing Hardened Concrete by Grooving
- Provisional Specification for Bituminous Material Manufactured by Continuous Drum Mixing Plants



TUNNELS AND WATERWAYS FUNCTIONAL BREAKDOWN  
SUBORDINATE LEVELS

• SITE PREPARATION AND EXCAVATION

- Subsurface Exploration
- Clearing
- Diversion of Creeks and Potential Flood Streams
- Blasting
- Drilling
- Excavation
- Temporary Decking (Cut and Cover Tunneling)
- Dredging
- Ground Stabilization
- Production and Transportation of Stone
- Backfill
- Mucking
- Temporary or Construction Roads and Paths
- Dewatering
- Compaction
- Riprap
- Gravel Protection
- Soil Disposal

• SUPPORT

- Steel Ribs
- Bolts and Tie Backs
- Timber Sets
- Liner Plates
- Shotcrete
- Concrete Segment Linings
- Underpinning
- Piles and Lagging
- Caissons
- Sheet Piles
- Diaphragm Walls
- Riprap

• LININGS

- Masonry
- Concrete
- Steel Plate
- Cast Iron
- Joint Materials

- Steel Reinforcing Bar
- Acoustical Treatment

- CANAL OPERATION AND MAINTENANCE ROADS

- Compaction
- Aggregate Surfacing
- Asphalt Surfacing
- Asphaltic Concrete Surfacing
- Concrete Surfacing

- DEWATERING AND DRAINAGE

- Trench Excavation
- Sand Filters
- Predraining of Soils Ahead of Tunnels
- Coarse Aggregate
- Pipes
- Valves

- GROUTING AND CAULKING

- Tunnel Grouting

- PIPING

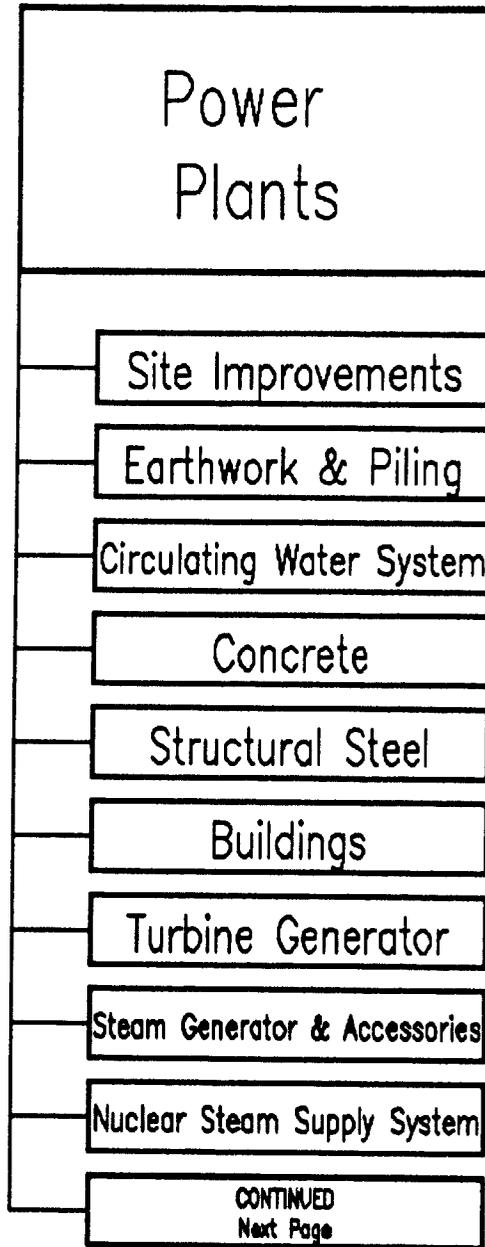
- Metal Piping
- Concrete Piping
- Other Piping

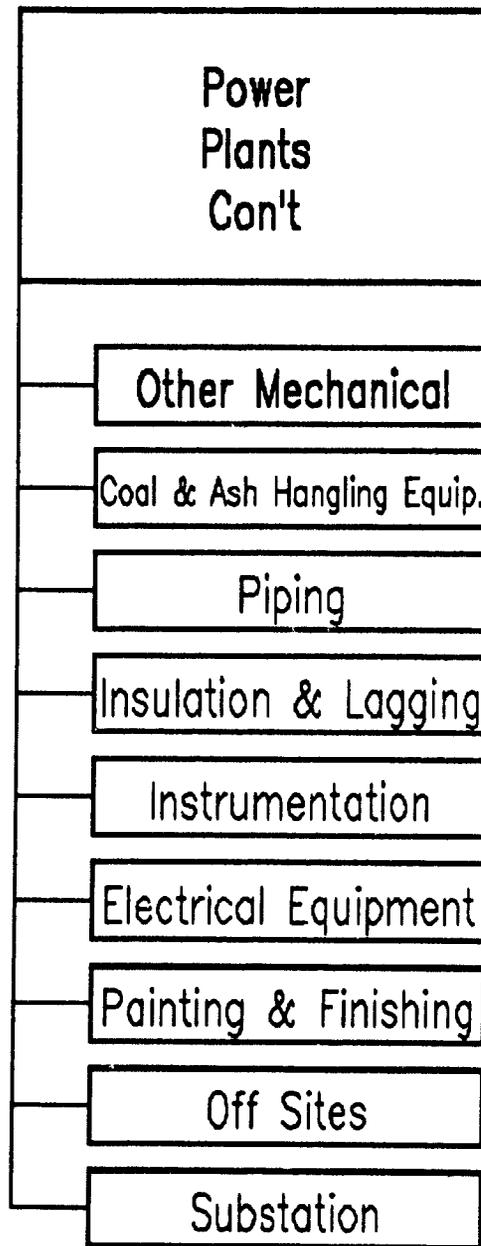
- ELECTRICAL

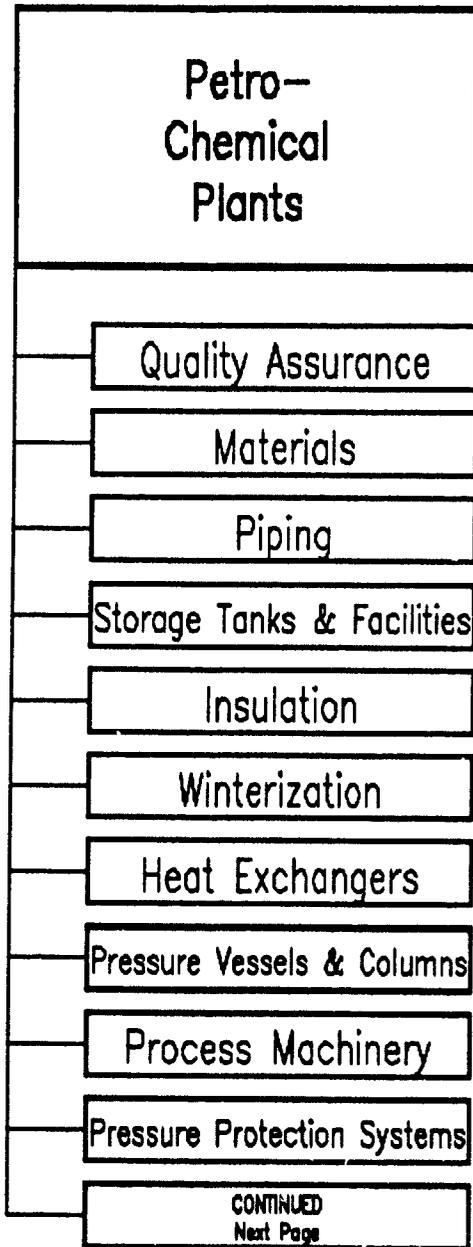
- Instrumentation
- Controls
- Lighting

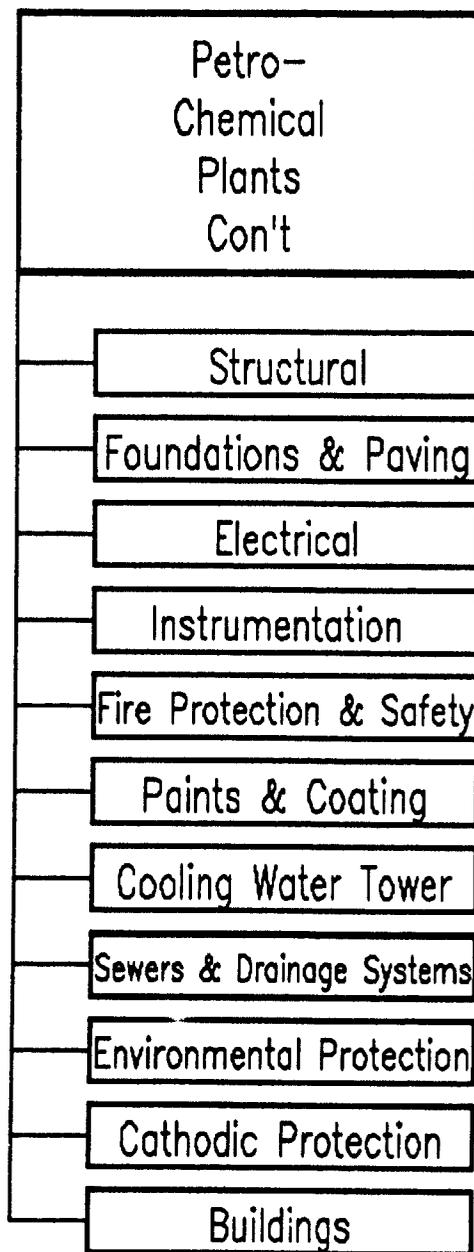
- MISCELLANEOUS

- Fencing
- Cattle Guards
- Guard Rails
- Gates and Trash Racks
- Ventilation
- Markings and Signs
- Material Handling Equipment
- Trackage Within Tunnel
- Pumping Plant









PETRO CHEMICAL PLANT FUNCTIONAL BREAKDOWN  
SUBORDINATE LEVELS

• QUALITY ASSURANCE

• MATERIALS

- Steel Selection
- Material Requirements for Caustic Service
- Material Requirements for Amine Service
- Material Requirements for Hydrogen Service
- Material Requirements for Chlorine, Hydrogen Chloride and HCL Acid
- Material Requirements for Sulfuric Acid Service
- Welding
- Pressure Retaining Castings and Forgings

• PIPING

- Metallic Piping
- Cold Bending of Pipe
- Induction Bending of Pipe
- Expansion Joints
- Basic Valve Requirements
- Utility Piping
- Steam and Condensate Piping
- Process Piping

• STORAGE TANKS AND FACILITIES

- External Floating Room Storage Tanks
- Shop Fabricated Fixed Roof Storage Tanks
- Field Erected Open Top Storage Tanks

• INSULATION

- Hot Service Insulation

• WINTERIZATION

• HEAT EXCHANGERS

- Shell and Tube Heat Exchangers
- Hairpin Heat Exchangers
- Air-Cooled Heat Exchangers
- Steam Service Condensers and Auxiliaries

• PRESSURE VESSELS AND COLUMNS

- Off the Shelf Pressure Vessels
- Minimum Service Pressure Vessels
- General Service Pressure Vessels

- Column Trays and Internal Components
- Requirements for Unfired Steam Drums
- Carbon Steel Pressure Equipment

- PROCESS MACHINERY

- Distillation
- Flashing
- Catalytic Cracking
- Saturates Gas Plant
- Cracked Gas Plant
- Alkylation and Polymerization
- Catalytic Reforming
- Dehydrogenation
- Thermal Cracking
- Gasoline Blending
- Asphalt Plant
- Hydrotreating
- Visbreaking and Coking
- Sulphur Plant
- Isomerization
- Solvent Recovery
- Ethylene Plant
- Centrifugal Pumps
- Steam Turbines
- Gear Units
- Lubrication Systems

- PRESSURE PROTECTION SYSTEMS

- Relief Valves
- Rupture Disks

- STRUCTURAL

- Structural Steel
- Fireproofing
- Battery Limit Fencing
- Railroads Spur

- FOUNDATIONS AND PAVING

- Excavation
- Piling
- Foundations
- Concrete Pavements

**• ELECTRICAL**

- Plant Power
- Lighting
- Grounding Systems
- Plant Communication System
- Electrical Installation
- Electrical Inspection and Testing
- Electrical Motors
- Switchracks
- Transformers
- Interrupter Switches
- Wire and Cable
- Backup Power System
- Electrical Heat Tracing

**• INSTRUMENTATION**

- Analyzer Systems
- Distributed Control Systems
- Programmable Logic Controllers
- Alarm Systems
- Emergency Control and Shutdown Systems
- Differential Pressure Flow Meters
- Pressure Measurement
- Instrument Calibration and Precommissioning

**• FIRE PROTECTION AND PERSONNEL SAFETY**

- Firewater Distribution Systems
- Fixed Water Spray and Deluge Systems
- Swanh Station
- Eyewash
- Safety Showers
- Breathing Stations
- Fireproofing

**• PAINTING AND COATINGS**

- Field Painting
- Shop Priming - Inorganic Zinc
- Shop Priming - Epoxy Primer
- Thin Film Lining
- Hot Dip Galvanizing
- Galvanizing for Sheet Metal
- Galvanized and Coil Coated Sheet Steel

- Mechanical Galvanizing
- Pipeline Coatings
  - COOLING WATER TOWERS
  - SEWERS AND DRAINAGE SYSTEMS
  - ENVIRONMENTAL PROTECTION
- Environmental Protection - Noise
  - CATHODIC PROTECTION
- Cathodic Protection Installation
- Cathodic Protection Rectifiers
  - BUILDINGS
- Control/Maintenance/Switchgear Building
- Standby Generator Building
- Lubrication Building

APPENDIX 2

**LISTING OF SPECIFICATIONS STUDIED**

**SPEC #: 1****SPEC TYPE: Manufacturing Plant Enlargement - Auburn PA.****DESCRIPTION: 1986 Calander Project, Demolition and Structural****SOURCE: Mr. White - Gilbert/Commonwealth Inc.****SPEC #: 2****SPEC TYPE: Manufacturing Plant Enlargement - Auburn PA.****DESCRIPTION: 1986 Calander Project, Mechanical****SOURCE: Mr. White - Gilbert/Commonwealth Inc.****SPEC #: 3****SPEC TYPE: Manufacturing Plant Enlargement - Auburn PA.****DESCRIPTION: 1986 Calander Project, Electrical****SOURCE: Mr. White - Gilbert/Commonwealth Inc.****SPEC #: 4****SPEC TYPE: Power Plant Modification - Muskingum River Power Plant****DESCRIPTION: D.O.E. Duct Injection Test Facility, Civil, Structural****SOURCE: Mr. White - Gilbert/Commonwealth Inc.****SPEC #: 5****SPEC TYPE: Power Plant Modification - Muskingum River Power Plant****DESCRIPTION: D.O.E. Duct Injection Test Facility, Mechanical****SOURCE: Mr. White - Gilbert/Commonwealth Inc.****SPEC #: 6****SPEC TYPE: Power Plant Modification - Muskingum River Power Plant****DESCRIPTION: D.O.E. Duct Injection Test Facility, Electrical****SOURCE: Mr. White - Gilbert/Commonwealth Inc.****SPEC #: 7****SPEC TYPE: Petro. Chemical Plant Modification****DESCRIPTION: Polyethylene Plant Hoppers****SOURCE: Mr. Cooper (DOW Chemical) - Univ. of Texas**

**SPEC #: 8**

**SPEC TYPE: Treatment Plant - City of Austin**

**DESCRIPTION: Onion Creek Wastewater Treatment Facility**

**SOURCE: Dr. O'Connor - Univ. of Texas**

**SPEC #: 9 (Not Used)**

**SPEC TYPE: Utility - City of Austin**

**DESCRIPTION: U.S. Hwy 183, 48 in. Water Transmission Phase II**

**SOURCE: Dr. O'Connor - Univ. of Texas**

**SPEC #: 10 (Not Used)**

**SPEC TYPE: Utility - City of Austin**

**DESCRIPTION: U.S. Hwy 183 Water and Wastewater Relocation**

**SOURCE: Dr. O'Connor - Univ. of Texas**

**SPEC #: 11**

**SPEC TYPE: Utility - Downtown Seattle Transit Project**

**DESCRIPTION: Advanced Utilities Relocation**

**SOURCE: Mr. Abdallah - Parsons Brinkerhoff Quade & Douglas Inc.**

**SPEC #: 12**

**SPEC TYPE: Transit Facility - Bay Area**

**DESCRIPTION: Daly City Turnback (BART/U.M.T.A.), Civil & Structures**

**SOURCE: Mr. Abdallah - Parsons Brinkerhoff Quade & Douglas Inc.**

**SPEC #: 13**

**SPEC TYPE: Power Plant Modification - Tonawanda, N.Y.**

**DESCRIPTION: Precipitator Mods. @ Inlet Duct Plenums**

**SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.**

**SPEC #: 14**

**SPEC TYPE: Power Plant Addition - Huntley Steam Station, Tonawanda**

**DESCRIPTION: Bottom Ash Handling Pumps**

**SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.**

**SPEC #: 15****SPEC TYPE: Power Plant Modification - Dunkirk Steam Station****DESCRIPTION: Bottom Ash System Modification, Pump/Piping Replacement****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 16****SPEC TYPE: Treatment Plant Modification - Dunkirk Steam Station****DESCRIPTION: Waste Water Mods., Metal Containing Waste Collection  
and Treatment****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 17****SPEC TYPE: Power Plant Modification - Albany Steam Station****DESCRIPTION: High Press. Heater Replacement and Installation****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 18****SPEC TYPE: Power Plant Addition - Albany Steam Station****DESCRIPTION: Secondary Containment System for Kerosene Storage****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 19****SPEC TYPE: Treatment Plant - Dunkirk Steam Station****DESCRIPTION: Metal Containing Waste Water Treatment System****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 20****SPEC TYPE: Power Plant - 4 Steam Stations****DESCRIPTION: Electrical Installation for Equipment Installations****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 21****SPEC TYPE: Power Plant Modification****DESCRIPTION: Std. Specification for 600 VAC Switchgear****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.**

**SPEC #: 22****SPEC TYPE: Power Plant Maintenance - South Glens Falls Hydro Station****DESCRIPTION: Reinforcing Intake Structure & Stabilization of Intake Structure****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 23****SPEC TYPE: Power Plant: Repair - Dunkirk Steam Station****DESCRIPTION: Thaw Shed Roof Repair****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 24****SPEC TYPE: Power Plant Addition - Huntley Steam Station, Tonawanda****DESCRIPTION: Fly Ash Landfill, River Road****SOURCE: Mr. Treadwell - Niagara Mohawk Power Corp.****SPEC #: 25****SPEC TYPE: Maintenance Facility - Naval Station, Charleston S.C.****DESCRIPTION: Shore Intermediate Maintenance Facility****SOURCE: Tim Pugh (U.S. Navy) - Univ. of Texas****SPEC #: 26****SPEC TYPE: Maintenance Facility - Naval Station, Long Beach, CA.****DESCRIPTION: Shore Intermediate Maintenance Facility****SOURCE: Tim Pugh (U.S. Navy) - Univ. of Texas****SPEC #: 27****SPEC TYPE: Petro Chemical Plant - Freeport, TX****DESCRIPTION: Unit No. III, Onion Creek Division****SOURCE: (DOW Chemical) - Univ. of Texas****SPEC #: 28****SPEC TYPE: Miscellaneous Standard Specification****DESCRIPTION: Spec. For Control Panels, James River Corp.****SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 29**  
**SPEC TYPE: Miscellaneous Standard Specification**  
**DESCRIPTION: Spec. for Load Center Unit Substation, 1000 KVA,**  
**Indoor Fluid Insulated, James River Corp.**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 30**  
**SPEC TYPE: Miscellaneous Master Specification**  
**DESCRIPTION: Master Spec. for Piping Insulation, James River Corp.**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 31**  
**SPEC TYPE: Miscellaneous Piping Spec.**  
**DESCRIPTION: Process Piping**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 32**  
**SPEC TYPE: Miscellaneous Piping Spec.**  
**DESCRIPTION: Class 1 Cleaning of Piping Systems**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 33**  
**SPEC TYPE: Miscellaneous Piping Spec.**  
**DESCRIPTION: Class 2 Cleaning of Piping System**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 34**  
**SPEC TYPE: Miscellaneous Piping Spec.**  
**DESCRIPTION: Class 3 Cleaning of Piping Systems**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 35**  
**SPEC TYPE: Miscellaneous Piping Spec.**  
**DESCRIPTION: Class 4 Cleaning of Piping Systems**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 36**  
**SPEC TYPE: Pump Station**  
**DESCRIPTION: Pumping Station Spec.**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 37**  
**SPEC TYPE: Miscellaneous Piping Spec.**  
**DESCRIPTION: SPECTEXT - Piping Insulation**  
**SOURCE: Mr. Hight - James River Corp.**

**SPEC #: 38**  
**SPEC TYPE: Road and Bridge - Norfolk and Bull Shoals Lakes**  
**DESCRIPTION: Minor Road Repair at Various Park Areas at Norfolk and  
Bull Shoals Lakes**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 39**  
**SPEC TYPE: Avionics Facility - Tinker A.F.B., OK.**  
**DESCRIPTION: B2 Avionics Facility**  
**SOURCE: A.G.C. Austin - U.S.A.F./U.S. Army Corps of Engineers**

**SPEC #: 40**  
**SPEC TYPE: Waterway - Chambers & Galveston Counties, TX.**  
**DESCRIPTION: Dredging, Houston Ship Channel**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 41**  
**SPEC TYPE: Road and Bridge - Marshall, TX.**  
**DESCRIPTION: Road and Parking Lot Rehab., Longhorn Army Ammunition  
Plant**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 42**  
**SPEC TYPE: Waterway - Pulaski County, Ark.**  
**DESCRIPTION: Woodson Levee Emergency Closure Rehab.**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 43**

**SPEC TYPE: Airport - Carswell, A.F.B., TX.**

**DESCRIPTION: Airfield Pavement Repair, Airfield Pavement Joint Seal  
and Tie Down Construction**

**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 44**

**SPEC TYPE: Treatment Plant - City of Livingston, TX.**

**DESCRIPTION: Waste Water Treatment Plant Improvements**

**SOURCE: A.G.C. Austin - Brannon Corp., Tyler TX**

**SPEC #: 45**

**SPEC TYPE: Airport - Waxahachie, TX**

**DESCRIPTION: New Midlothian/Waxahachie Municipal Airport**

**SOURCE: A.G.C. Austin - Charles Willis & Assoc., Arlington, TX.**

**SPEC #: 46**

**SPEC TYPE: Road and Bridges - Texas Dept. of Criminal Justice**

**DESCRIPTION: Road Improvements Project at 4 Units**

**SOURCE: A.G.C. Austin - Texas Dept. of Criminal Justice**

**SPEC #: 47**

**SPEC TYPE: Waterway - Cameron and Willaly Counties, TX.**

**DESCRIPTION: Dredging, Port of Isable - Port Mansfield & Tributaries**

**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 48**

**SPEC TYPE: Road Construction - Ft. Polk, LA**

**DESCRIPTION: Riverton Drive, Ft. Polk, LA**

**SOURCE: Ft. Worth Dist., Corps of Engineers**

**SPEC #: 49**

**SPEC TYPE: Water Treatment Plant Modification, Longhorn AAP**

**DESCRIPTION: Sewage Treatment Plant Restoration & Septic Tank Sys**

**SOURCE: Ft. Worth Dist., Corps of Engineers,**

**SPEC #: 50**

**SPEC TYPE: Water Treatment Plant - LA Army Ammunition Plant**

**DESCRIPTION: Spec. for Water Treatment Plant**

**SOURCE: Ft. Worth Dist., Corps of Engineers**

**SPEC #: 51**

**SPEC TYPE: Flood Control - Maintenance, Roads & Realignment**

**DESCRIPTION: Grenada Lake, MS Road Repair, Resurface, etc.**

**SOURCE: Vicksburg Dist., Corps of Engineers**

**SPEC #: 52**

**SPEC TYPE: Waterway**

**DESCRIPTION: Sicily Isl. Area Levee Project**

**SOURCE: Vicksburg Dist., Corps of Engineers**

**SPEC #: 53**

**SPEC TYPE: Waterway**

**DESCRIPTION: Canal 43 Channel Improvements, Ark.**

**SOURCE: Vicksburg Dist., Corps of Engineers**

**SPEC #: 54**

**SPEC TYPE: Waterway**

**DESCRIPTION: Peggy Lake Disposal Area (Spillways)**

**SOURCE: Galveston District., Corps of Engineers**

**SPEC #: 55**

**SPEC TYPE: Waterway**

**DESCRIPTION: Little Vince Bayou Floodway Channel Rectification**

**SOURCE: Galveston District, Corps of Engineers**

**SPEC #: 56**

**SPEC TYPE: Waterway**

**DESCRIPTION: Little Vince Bayou Floodway Channel Rect. Con't.**

**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 57**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Little Vince Bayou Floodway Channel Rect. Con't.**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 58**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Highland Bayou Channel Diversion**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 59**  
**SPEC TYPE: Waterway (Dredging)**  
**DESCRIPTION: Corpus Christi Ship Channel Dredging**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 60**  
**SPEC TYPE: Waterway (Dredging)**  
**DESCRIPTION: Corpus Christi Ship Channel Dredging Con't.**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 61**  
**SPEC TYPE: Waterway (Jetty Rehabilitation)**  
**DESCRIPTION: Freeport Harbor Jetty Rehab. & Extension**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 62**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Hildebrandt Bayou Channel Rectification**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 63**  
**SPEC TYPE: Waterway (Dike Rehabilitation)**  
**DESCRIPTION: Rehab. of Port O'Connor South Dike**  
**SOURCE: Galveston District, Corps of Engineers**

**SPEC #: 64**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Turning Basin & Docking Area, Ingleside**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 65**  
**SPEC TYPE: Waterway (Dredging & Stake Removal)**  
**DESCRIPTION: Dredging & Stake Removal, Beaumont**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 66**  
**SPEC TYPE: Special**  
**DESCRIPTION: Debris Removal & Containerized T.H.W., Matagorda Isl.**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 67**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Guidewalls & Lock Gate, Colorado River Locks**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 68**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Replace Mooring Anchors, Brazos River Floodgates**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 69**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Hildebrandt & Willow Marsh Bayous Channel Rect.**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 70**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Dredging & Staking Mooring Area, Beaumont**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 71**  
**SPEC TYPE: Waterway (Dredging)**  
**DESCRIPTION: Entrance Channel Dredging, Freeport Harbor**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 72**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Diversion Dam & Navigation Channel, Colorado R.**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 73**  
**SPEC TYPE: Waterway**  
**DESCRIPTION: Guidewalls, Gate & Mooring Anchors, Brazos R. Floodgate**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 74**  
**SPEC TYPE: Waterway (Erosion Control)**  
**DESCRIPTION: Spilmans Isl. Disposal Area Erosion Protection**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 75**  
**SPEC TYPE: Office Building**  
**DESCRIPTION: Galveston District HQ Building**  
**SOURCE: Galveston Dist., Corps of Engineers**

**SPEC #: 76**  
**SPEC TYPE: Road and Bridge**  
**DESCRIPTION: Road and Turnout Surfacing, Greens Ferry Lake**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 77**  
**SPEC TYPE: Utilities**  
**DESCRIPTION: Sanitary Sewer Improvements - Rio Vista, TX**  
**SOURCE: A.G.C. Austin - Brannon Corp., Tyler TX**

**SPEC #: 78**  
**SPEC TYPE: Buildings & Facilities**  
**DESCRIPTION: Addition to Dining Hall, Tinker A.F.B., OK**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 79**  
**SPEC TYPE: Building & Facilities**  
**DESCRIPTION: Auto Craft Shop, Ft. Sill, OK**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 80**  
**SPEC TYPE: Roads and Bridges**  
**DESCRIPTION: Roadway & Slope Repair, Lock 2 Brdg Approach**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 81**  
**SPEC TYPE: Buildings & Facilities**  
**DESCRIPTION: M9 Detection Paper Facility, Pine Bluff Arsenal**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 82**  
**SPEC TYPE: Buildings & Facilities**  
**DESCRIPTION: Addition to Child Care Center, Tinker A.F.B.**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 83**  
**SPEC TYPE: Buildings & Facilities**  
**DESCRIPTION: Deployment Storage Buildings, Ft. Polk, LA**  
**SOURCE: A.G.C. Austin - U.S. Army Corps of Engineers**

**SPEC #: 84**  
**SPEC TYPE: Roads & Bridges**  
**DESCRIPTION: New International Bridge, Los Indios, TX**  
**SOURCE: A.G.C. Austin**

**SPEC #: 85**

**SPEC TYPE: Roads & Bridges**

**DESCRIPTION: Road Improvements, TDC Darrington, Retrieve, Clemmens**

**SOURCE: A.G.C. Austin - Goodwin-Lassiter Inc., Lufkin, TX**

**SPEC #: 86**

**SPEC TYPE: Roads & Bridges**

**DESCRIPTION: Road Improvements, TDC Gatesville & Hilltop Units**

**SOURCE: A.G.C. Austin - Goodwin-Lassiter Inc., Lufkin, TX**

**SPEC #: 87**

**SPEC TYPE: Utilities**

**DESCRIPTION: Replace Hot Water Heating Systems, Ft. Bliss**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 88**

**SPEC TYPE: Buildings & Facilities**

**DESCRIPTION: Clinic/Dental Clinic RMPT, Randolph A.F.B.**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 89**

**SPEC TYPE: Utilities**

**DESCRIPTION: Relocate Elect. Power Lines, Ft. Hood**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 90**

**SPEC TYPE: Power Plants**

**DESCRIPTION: Back-up Power Plant, Lackland A.F.B.**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 91**

**SPEC TYPE: Utilities**

**DESCRIPTION: Elect. Dist. Upgrade, Ft. Sam Houston**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 92**

**SPEC TYPE: Utilities**

**DESCRIPTION: Replace Gas Piping, Ft. Sam Houston**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 93**

**SPEC TYPE: Utilities**

**DESCRIPTION: Addition of Elect. & Water Meters, Ft. Sam Houston**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 94**

**SPEC TYPE: Buildings & Facilities**

**DESCRIPTION: Language Training Lab, Lackland A.F.B.**

**SOURCE: Fort Worth District, Corps of Engineers**

**SPEC #: 95**

**SPEC TYPE: Roads and Bridges**

**DESCRIPTION: Repair Plant Roads, Lone Star Army Ammo Plant**

**SOURCE: Fort Worth District, Corps of Engineers**

APPENDIX 3

**COMPREHENSIVE OUTLINES: BY PROJECT TYPE**

**AIRPORTS IMPROVEMENTS  
SPECIFICATIONS STUDIED  
DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #	
	43	45
0 Bidding Rq't's	✓	✓
1 General Rq't's	✓	✓
2 Sitework	✓	✓
3 Concrete		✓
4 Masonry		
5 Metals		
6 Woods & Plastics		
7 Thermal & Moist. Prot.		
8 Doors & Windows		
9 Finishes		
10 Specialties		✓
11 Equipment		
12 Furnishings		
13 Special Const.		
14 Conveying Systems		
15 Mechanical		
16 Electrical		✓

✓ Indicates that this item was in the specification

**AIRPORTS**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #	
	43	45
0 Bidding Rqt's	✓	✓
1 Gen. Rqt's	✓	✓
Summary of Work	✓	✓
Measurement & Payment		✓
Coordination		
Job Site Admin		✓
Regulatory Requirements		
Legal Relations		✓
References		
FAA Technical Specifications		✓
Submittals	✓	
Progress Reports		✓
As-Built Drawings	✓	
Quality Control		
Contractor Quality Control	✓	
Temporary Facilities & Controls		
Environmental Protection	✓	✓
2 Sitework	✓	✓
Demolition	✓	
Selective Demolition	✓	
Pavement Removal	✓	
Site Preparation		
Clearing & Grubbing		✓
Shoring		✓

✓ indicates that this item was in the specification

AIRPORTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #	
	43	45
2 Sitework Con't		
Earthwork		
Excavation & Backfilling	✓	✓
Base Courses	✓	✓
Soil Stabilization		✓
Slope Prot., Erosion Control		✓
Paving & Surfacing		
Concrete Pavements	✓	✓
Pavement Repair	✓	✓
Bituminous Paving	✓	✓
Pavement Marking	✓	✓
Sewerage & Drainage		
Storm Sewerage		✓
Site Improvements		
Fences & Gates		✓
Landscaping		
Soil Prep. - Topsoiling		✓
Establishment of Turf		✓
3 Concrete		
Cast-in-Place Concrete		✓

✓ Indicates that this item was in the specification

**AIRPORTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #	
	43	45
10 Specialties		
Wind Cones		✓
16 Electrical		✓
Elect. Mat'ls & Methods		
Underground Ducts		✓
Wires & Cables		✓
Voltage Distribution		
Transformer Vault & Equip.		✓
Lighting		✓
Exterior Lighting-Aviation		✓
Controls		
Elect. Systems Control		✓

✓ indicates that this item was in the specification

**TREATMENT PLANTS**  
**SPECIFICATIONS STUDIED**  
**DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓
1 General Rqt's	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓
3 Concrete	✓	✓		✓	✓	✓
4 Masonry	✓			✓		
5 Metals	✓	✓		✓	✓	✓
6 Woods & Plastics	✓					✓
7 Thermal & Moist. Prot.	✓	✓		✓		✓
8 Doors & Windows	✓	✓		✓		✓
9 Finishes	✓			✓		✓
10 Specialties	✓			✓		✓
11 Equipment	✓		✓	✓	✓	✓
12 Furnishings	✓					
13 Special Const.	✓		✓	✓	✓	✓
14 Conveying Systems	✓					✓
15 Mechanical	✓	✓	✓	✓		✓
16 Electrical	✓	✓	✓	✓	✓	✓

✓ indicates that this item was in the specification

**TREATMENT PLANTS  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #					
	8	18	19	44	49	50
0 Bidding Rq'ts	✓	✓	✓	✓	✓	✓
1 Gen. Rq'ts	✓	✓	✓	✓	✓	✓
Summary of Work		✓	✓			
Coordination		✓				
Contractor's Duties			✓			
Job Site Admin.					✓	✓
Field Engineering		✓				
References						
Codes & Standards			✓			✓
Special Procedures						
Fire Prevention		✓				
Invoice Form		✓				
Project Meetings					✓	✓
Submittals		✓		✓	✓	✓
Shop Drawings			✓			
Completion Report		✓				
Material & Equipment		✓	✓	✓		
Trans. & Handling			✓	✓		
Const. Services & Report			✓			
Quality Control			✓		✓	✓
Quality Assurance		✓				
Design Criteria/Features			✓			
Tests			✓			
Guaranteed Characteristics			✓			
Temp. Facilities & Controls		✓		✓	✓	✓
Mobilization				✓		
Trench Excavation Prot.				✓		
Environmental Protection					✓	✓
Temp. Project Sign				✓	✓	✓
Contract Closeout		✓		✓	✓	✓

✓ indicates that this division's content were in the specification

**TREATMENT PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #					
	8	18	19	44	49	50
2 Sitework	✓	✓	✓	✓	✓	✓
Subsurface Exploration				✓		
Demolition		✓		✓	✓	✓
Pavement Removal				✓	✓	
Site Preparation						
Clearing & Grubbing	✓			✓	✓	✓
Underreamed Foundations	✓					
Earthwork				✓		✓
Site Grading	✓	✓				
Excavation & Backfill	✓	✓		✓	✓	✓
Soil Stabilization	✓		✓			
Subbase Course					✓	✓
Base Course					✓	✓
Riprap					✓	
Paving & Surfacing					✓	
Gravel Surface Course					✓	
Concrete Sidewalks						✓
Concrete Pavement	✓					✓
Asphaltic Conc. Pavement				✓		
Bituminous Surface Course					✓	✓
Wheel Stops						✓
Joint Sealing						✓
Pavement Markings						✓
Water Lines					✓	✓

✓ Indicates that this division's content were in the specification

**TREATMENT PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #					
	8	18	19	44	49	50
<b>2 Sitework Con't</b>	✓	✓	✓	✓	✓	✓
Sanitary Sewers					✓	✓
Sludge Drying Bed Rehab.					✓	
Miscellaneous Piping						✓
Site Improvements						
Fences	✓			✓		✓
Traffic Signs						✓
Stone Revetment						✓
Landscaping						
Trees & Plants	✓					
Seeding	✓			✓	✓	✓
Sodding	✓				✓	✓
Job Clean-up				✓		
<b>3 Concrete</b>	✓	✓		✓	✓	✓
Concrete Formwork		✓			✓	✓
Decorative Form Liners				✓		
Concrete Reinforcement		✓		✓	✓	✓
Reinforcing Steel	✓					
Concrete Accessories						
Fasteners & Bolts				✓		
Exp. Joints & Waterstops					✓	✓
Cast-in-Place Concrete		✓			✓	
Structural Concrete	✓			✓		✓
Fiber Reinf. Concrete		✓				
Concrete Curing				✓		
Floor Hardener						✓
Precast Concrete						
Precast Roof/Floor Slabs				✓		

✓ Indicates that this division's content were in the specification

TREATMENT PLANTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
4 Masonry	✓			✓		
Mortar & Grout				✓		
Poured Concrete Grout				✓		
Reinf., Anchors & Ties				✓		
Unit Masonry				✓		
Clay Masonry	✓					
Concrete Masonry	✓			✓		
5 Metals	✓	✓		✓	✓	✓
Metal Materials	✓					
Structural Metal Framing	✓	✓				
Structural Aluminum	✓					
Misc. Metal Fabrications					✓	✓
Metal Stairs				✓		
Handrails & Railing	✓			✓		
Grating	✓			✓		
Sheet Metal	✓					
6 Wood and Plastics	✓					✓
Rough Carpentry						✓
Finish Carp. & Millwork	✓					
Wood Treatment						
Preservative Treatment	✓					

✓ Indicates that this division's content were in the specification

**TREATMENT PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
<b>7 Thermal &amp; Moist. Protection</b>	✓	✓		✓		✓
Waterproofing						
Membrane Waterproofing	✓					
Bituminous Waterproofing						✓
Concrete Wall & Floor Sealer				✓		
Dampproofing	✓					
Insulation						
Building Insulation	✓					
Roof Insulation	✓					
Firestopping						✓
Insul. Roofing & Siding		✓				
Membrane Roofing						
Elastomeric Sheet Roofing				✓		
Flashing & Sheet Metal	✓					
Sealants & Caulking	✓			✓		✓
Poured Concrete Grout				✓		
Caulking				✓		
<b>8 Doors &amp; Windows</b>	✓	✓		✓		✓
Metal Doors & Frames	✓	✓		✓		
Steel Doors & Frames						✓
Aluminum Doors & Frames	✓					
Wood Doors	✓					
Special Doors	✓					
Roll-up Doors & Accys.	✓					
Overhead Coiling Doors				✓		✓
Insul. Coiling Steel Doors		✓				

✓ indicates that this division's content were in the specification

**TREATMENT PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
8 Doors & Windows Con't						
Metal Windows						
Steel Windows						✓
Aluminum Windows	✓					
Hardware						✓
Finish Hardware				✓		
Glass & Glazing				✓		✓
9 Finishes	✓			✓		✓
Lath & Plaster	✓					
Gypsum Drywall	✓					✓
Tile						
Ceramic Tile	✓					✓
Acoustical Ceilings	✓					
Resilient Flooring						
Resilient Tile Flooring	✓					
Sheet Vinyl Flooring	✓					
Carpeting	✓					
Protective Coating	✓					
Painting	✓			✓		✓

✓ Indicates that this division's content were in the specification

TREATMENT PLANTS CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
10 Specialties	✓			✓		✓
Visual Display Boards						
Chalkboard	✓					
Tackboard	✓					
Compartments & Cubicles						
Plastic Toilet Compartments	✓					✓
Prefab. Shower Stalls						✓
Louvers & Vents						
Louvers	✓					
Identifying Devices				✓		
Plaques	✓					
Signs	✓					
Fire Extinguishers & Cabinets				✓		
Partitions						
Folding Partitions	✓					
Toilet Accessories	✓					
11 Equipment	✓		✓	✓	✓	✓
Water Spgy. & Treatment Equip.						
Pumps	✓			✓		✓
Mixers & Flocculators	✓		✓	✓	✓	✓
Clarifiers			✓		✓	✓
Aeration Equip.	✓				✓	✓
Chemical Feed Equip.	✓				✓	✓
Valves	✓					

✓ Indicates that this division's content were in the specification

TREATMENT PLANTS CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
11 Equipment Cont	✓			✓		✓
Waste Treatment & Disposal Equip.						
Sewage & Sludge Pumps	✓		✓	✓	✓	✓
Grit Collecting Equip.	✓					
Screening & Grinding Equip.	✓			✓		
Sedimentation Tank Equip.					✓	
Chemical Equipment	✓		✓		✓	
Sludge Handling & Treating	✓					✓
Filter Equip.			✓	✓		
Package Sewage Equip.	✓					
Kitchen Equipment	✓					
Laboratory Equip.	✓					
12 Furnishings	✓					
Casework						
Laboratory Casework						✓
Kitchen Cabinets	✓					
Furniture & Accys	✓					
Laboratory Furniture	✓					
13 Special Construction	✓		✓	✓	✓	✓
Paint Spray Booth	✓					
Metal Buildings					✓	✓
Storage Tanks			✓			
Elevated Storage Tanks						✓
Filter Underdrains & Media			✓			✓
Sludge Conditioning Systems				✓		
Utility Control Systems	✓					
Wastewater Plant Systems	✓		✓			✓
Building Automation Sys.						
Communication System	✓					

✓ Indicates that this division's content were in the specification

TREATMENT PLANTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
14 Conveying Systems	✓					✓
Freight Elevators	✓					
Material Handling Systems						
Conveyors	✓					
Hoists & Cranes	✓					
Monorail w/ Powered Hoist						✓
15 Mechanical	✓	✓	✓	✓		✓
Mech. Materials & Methods		✓	✓			
Pipe Fab. & Erection		✓	✓	✓		
Concrete Pipe & Fittings	✓					
Ferrous Pipe & Fittings	✓					
Plastic Pipe & Fittings	✓					
Steel Pipe & Fittings	✓					
Valves	✓			✓		
Gates	✓			✓		
Piping Specialties	✓					
Mechanical Insulation		✓				✓
Pipe Insulation	✓					
Fire Protection	✓					
Plumbing	✓	✓				✓
Plumbing Piping	✓					
Gas Piping System	✓					✓
HVAC						
Air Conditioning Sys.	✓					
Heat Generation	✓	✓				✓

✓ indicates that this division's content were in the specification

TREATMENT PLANTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

DIVISION	SPECIFICATION #					
	8	16	19	44	40	50
15 Electrical Cont						
Switching Units	✓				✓	
Overhead Power Distribution					✓	✓
Underground Power Dist.						✓
Service & Distribution						
Motors				✓		
Power Transformers	✓			✓		
Panelboards				✓	✓	
Circuit Disconnectors				✓	✓	
Motor Control	✓				✓	
Control Devices			✓			
Grounding				✓	✓	
Lighting					✓	
Luminaries				✓		
Special Systems						
Battery Charging	✓					
Cathodic Protection						✓
Lighting Protection						✓
Communications						
Plant Communications Sys.	✓					
Elect. Resistance Heating						
Heating Cable						✓
Controls				✓		✓
Elect. Systems Control	✓					✓
Motor Control Centers				✓		
Tank/Pump Controllers				✓		
Instrumentation	✓					✓

✓ Indicates that this division's content were in the specification

**TREATMENT PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #					
	8	16	19	44	49	50
<b>15 Mechanical Cont</b>						
Refrigeration: A.C.	✓					✓
Heat Transfer						
Heat Pumps	✓					
Dehumidifiers	✓					
Air Handling						
Fans	✓					
Ventilation & Exhaust						✓
Air Distribution	✓	✓				
Odor Control Sys.	✓					
Ductwork & Accys.	✓					
Controls			✓			
HVAC Control		✓				
Testing & Adjusting						
HVAC System Testing	✓					
<b>16 Electrical</b>	✓	✓	✓	✓	✓	✓
Elet. Material & Methods		✓		✓	✓	
Conduits				✓	✓	
Wire and Cables	✓			✓	✓	
Wire Connectors & Accys.				✓	✓	
Boxes				✓	✓	
Wiring Devices				✓		
Enclosures			✓			
Electrical Construction	✓					
Power Generation						
Generator: Diesel					✓	
Voltage Distribution						

✓ Indicates that this division's content were in the specification

**ROAD AND BRIDGE CONSTRUCTION  
SPECIFICATIONS STUDIED  
DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #										
	38	41	46	48	51	76	80	84	85	86	95
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
1 General Rq'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Concrete		✓	✓	✓				✓	✓	✓	✓
4 Masonry											
5 Metals								✓			
6 Woods & Plastics											
7 Thermal & Moist. Prot.											
8 Doors & Windows											
9 Finishes											
10 Specialties											
11 Equipment											
12 Furnishings											
13 Special Const.											
14 Conveying Systems											
15 Mechanical											
16 Electrical				✓				✓			

✓ Indicates that this item was in the specification

**ROAD AND BRIDGE CONSTRUCTION  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	38	41	46	48	51	76	80	84	85	86	95
0 Bidding Rqt's	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
1 Gen. Rqt's	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Summary of Work								✓	✓	✓	✓
Measurement & Payment						✓	✓				
Coordination											
Job Site Admin		✓		✓							
References									✓	✓	
Sources of Reference Mat'l.				✓		✓					✓
Ft. Polk. Procedures				✓							
Meetings		✓		✓							✓
Submittals		✓	✓	✓		✓					✓
Quality Control											
Testing & Lab. Services			✓						✓	✓	
Inspection Services			✓								
Contractor Quality Control		✓		✓		✓	✓				✓
Temporary Facilities & Controls		✓	✓	✓		✓	✓		✓	✓	✓
Barriers & Enclosures						✓					
Environmental Protection		✓		✓	✓	✓	✓				✓
Access Roads & Parking						✓					
Temp. Traffic Control			✓			✓			✓	✓	
Bulletin Boards & Signs		✓		✓		✓					✓
Contract Closeout		✓		✓							✓
Project Record Docs.			✓								

✓ indicates that this item was in the specification.

**ROAD AND BRIDGE CONSTRUCTION CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	38	41	46	48	51	76	80	84	85	86	95
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Demolition		✓		✓	✓						
Removal of Existing Const.			✓		✓						✓
Site Preparation			✓					✓			
Clearing & Grubbing		✓		✓	✓		✓				
Earthwork				✓			✓		✓	✓	
Grading	✓		✓		✓						
Excavating & Backfilling	✓	✓			✓	✓		✓			
Excav. & Backfill for Util.				✓							
Base Courses	✓	✓		✓	✓	✓	✓		✓	✓	✓
Soil Stabilization			✓	✓			✓		✓	✓	
Slope Prot. & Erosion Cont.								✓	✓	✓	
Ditch & Shoulder Maint	✓										
Piles & Caissons											
Pile Driving								✓			
Concrete Piles								✓			
Paving & Surfacing											
Granular Paving	✓										
Asphaltic Concrete Paving			✓			✓	✓				
Portland Cement Conc. Paving			✓	✓					✓	✓	✓

✓ indicates that this item was in the specification

**ROAD AND BRIDGE CONSTRUCTION CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	38	41	46	48	51	76	80	84	85	86	95
2 Sitework Con't.											
Prefab. Curbs		✓			✓						
Bituminous Surface Treatment		✓		✓	✓	✓	✓		✓	✓	✓
Pavement Repair	✓	✓	✓		✓						✓
Pavement Markings		✓	✓	✓	✓				✓	✓	✓
Sewerage & Drainage											
Storm Drainage Sys.				✓							
Culverts	✓		✓								
Culvert Removal & Replacement	✓										
Site Improvements											
Parking Barriers					✓						
Railroad Grade Crossings		✓									
Traffic Signs				✓	✓						
Landscaping											
Soil Preparation - Topsoil					✓						
Establishment of Turf		✓		✓	✓		✓				✓
3 Concrete		✓	✓	✓				✓	✓	✓	✓
Concrete Formwork											✓
Concrete Reinforcement											✓
Concrete Accessories								✓			
Expansion Joints								✓			✓

✓ indicates that this item was in the specification

**ROAD AND BRIDGE CONSTRUCTION CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	38	41	46	48	51	76	80	84	85	86	95
<b>3 Concrete Con't.</b>											
Cast-in-Place Concrete		✓	✓	✓				✓	✓	✓	
Structural Concrete								✓			
Concrete Finishes								✓			
Hydraulic Cement								✓			
Concrete Curing								✓			
Pre-Cast Concrete											
Prestressed Conc.								✓			
<b>5 Metals</b>								✓			
Metal Fastenings											
Welding								✓			
Bolting								✓			
Structural Metal Framing								✓			
Structural Steel								✓			
Metal Fabrications											
Handrails & Railings								✓			
<b>16 Electrical</b>				✓				✓			
Voltage Distribution											
Underground Elect. Dist.				✓							
Lighting								✓			

✓ Indicates that this item was in the specification

**WATERWAYS AND TUNNELS**  
**SPECIFICATIONS STUDIED**  
**DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #									
	40	42	47	52	53	54	55	56	57	
0 Bidding Reqs'ts		✓	✓	✓	✓	✓	✓	✓	✓	✓
1 General Rqt's	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Concrete		✓		✓	✓		✓	✓	✓	
4 Masonry										
5 Metals										
6 Woods & Plastics										
7 Thermal & Moist. Prot.										
8 Doors & Windows										
9 Finishes										
10 Specialties										
11 Equipment										
12 Furnishings										
13 Special Const.										
14 Conveying Systems										
15 Mechanical				✓						
16 Electrical										

✓ indicates that this item was in the specification

WATERWAYS AND TUNNELS CONTINUED  
 SPECIFICATIONS STUDIED  
DIVISIONS INCLUDED IN THE SPECIFICATION

DIVISION	SPECIFICATION #									
	58	59	60	61	62	63	64	65	67	
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts	✓	✓		✓	✓	✓	✓	✓	✓	✓
2 Site Work	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 Concrete	✓			✓	✓		✓			
4 Masonry										
5 Metals										✓
6 Woods & Plastics				✓						
7 Thermal & Moist. Prot.										
8 Doors & Windows										
9 Finishes										✓
10 Specialties										
11 Equipment										
12 Furnishings										
13 Special Const.										
14 Conveying Systems										
15 Mechanical										
16 Electrical										✓

✓ indicates that this item was in the specification

WATERWAYS AND TUNNELS CONTINUED  
 SPECIFICATIONS STUDIED  
DIVISIONS INCLUDED IN THE SPECIFICATION

DIVISION	SPECIFICATION #						
	68	69	70	71	72	73	74
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts	✓	✓	✓		✓	✓	✓
2 Sitework	✓	✓	✓	✓	✓	✓	✓
3 Concrete		✓			✓	✓	
4 Masonry							
5 Metals	✓					✓	
6 Woods & Plastics							
7 Thermal & Moist. Prot.							
8 Doors & Windows							
9 Finishes						✓	
10 Specialties							
11 Equipment							
12 Furnishings							
13 Special Const.							
14 Conveying Systems							
15 Mechanical							
16 Electrical						✓	

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	40	42	47	52	53	54	55	56	57	
0 Bidding Rqt's		✓	✓	✓	✓	✓	✓	✓	✓	✓
1 Gen. Rqt's	✓	✓		✓	✓	✓	✓	✓	✓	✓
Summary of Work	✓		✓							
Work Covered by Contract			✓							
Work Sequence	✓		✓							
Measurement & Payment	✓	✓	✓							
Special Project Proc.										
Protection of Pipelines										
Interference w/ Navigation										
Notif. of Utility Owners										
Submittals										
Reporting Requirements	✓		✓							
As-Built Drawings						✓		✓	✓	
Quality Control				✓	✓					
Temporary Facilities & Controls										
Environmental Protection		✓		✓	✓	✓	✓	✓	✓	
Bulletin Boards & Signs										
Construction Office						✓	✓	✓	✓	
Material & Equipment										
Transport of Mat'l's										

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	58	59	60	61	62	63	64	65	67	
0 Bidding Rqt's	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1 Gen. Rqt's	✓	✓		✓	✓	✓	✓	✓	✓	✓
Summary of Work	✓									
Work Covered by Contract										
Work Sequence										
Measurement & Payment										✓
Special Project Proc.										
Protection of Pipelines							✓	✓		
Interference w/ Navigation										✓
Notif. of Utility Owners										
Submittals										✓
Reporting Requirements										
As-Built Drawings				✓		✓	✓	✓	✓	✓
Quality Control										✓
Temporary Facilities & Controls										
Environmental Protection		✓	✓	✓	✓	✓	✓	✓	✓	✓
Bulletin Boards & Signs	✓									✓
Construction Office				✓						
Material & Equipment										
Transport of Mat'ls										

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	68	69	70	71	72	73	74
0 Bidding Rqt's	✓	✓	✓	✓	✓	✓	✓
1 Gen. Rqt's	✓	✓	✓		✓	✓	✓
Summary of Work	✓						
Work Covered by Contract							
Work Sequence							
Measurement & Payment	✓	✓	✓		✓	✓	✓
Special Project Proc.							
Protection of Pipelines		✓					
Interference w/ Navigation							
Notif. of Utility Owners			✓				
Submittals	✓	✓	✓		✓	✓	✓
Reporting Requirements							
As-Built Drawings	✓	✓	✓		✓	✓	✓
Quality Control	✓	✓	✓		✓	✓	✓
Temporary Facilities & Controls							
Environmental Protection	✓	✓	✓		✓	✓	✓
Bulletin Boards & Signs	✓	✓	✓		✓	✓	✓
Construction Office		✓			✓	✓	
Material & Equipment							
Transport of Mat'ls						✓	

✓ Indicates that this item was in the specification

WATERWAYS AND TUNNELS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #									
	40	42	47	52	53	54	55	56	57	
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Demolition										
Selective Demolition	✓									
Clearing & Grubbing		✓		✓	✓	✓	✓	✓	✓	
Stripping		✓				✓	✓	✓	✓	
Site Preparation										
Cofferdams				✓						
Earthwork										
Excavation, Filling & Comp.	✓	✓		✓	✓	✓	✓			
Excav. & Filling - Util.							✓			
Disposal of Excav. Mat'l.		✓	✓							
Base Courses										
Soil Stabilization										
Slope Prot., Erosion Cont.				✓	✓	✓	✓		✓	
Earth Dams			✓	✓		✓				
Piles & Caissons						✓				
Driven Piles						✓			✓	
Marine Work						✓		✓	✓	
Dredging	✓				✓					
Jetties										
Fender System										
Guidewalls										
Mooring Anchors										
Underwater Work	✓									
Buoys										

✓ indicates that this item was in the specification

WATERWAYS AND TUNNELS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #									
	58	59	60	61	62	63	64	65	67	
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Demolition										✓
Selective Demolition										
Cleaning & Grubbing		✓	✓	✓	✓		✓	✓		
Stripping		✓	✓		✓		✓	✓	✓	
Site Preparation										
Cofferdams				✓						
Earthwork										
Excavation, Filling & Comp.	✓	✓	✓	✓	✓		✓	✓	✓	
Excav. & Filling - Util.										
Disposal of Excav. Mat'l.							✓			
Base Courses				✓						
Soil Stabilization				✓						
Slope Prot., Erosion Cont.	✓			✓		✓	✓			
Earth Dams		✓			✓		✓	✓		
Piles & Caissons										
Driven Piles	✓									
Marine Work			✓							✓
Dredging	✓	✓	✓		✓		✓	✓		
Jetties				✓						
Fender System										✓
Guldewalls										✓
Mooring Anchors										
Underwater Work								✓	✓	
Bouys								✓		

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	68	69	70	71	72	73	74
2 Sitework	✓	✓	✓	✓	✓	✓	✓
Demolition						✓	
Selective Demolition							
Clearing & Grubbing		✓	✓		✓	✓	
Stripping		✓	✓		✓	✓	
Site Preparation							
Cofferdams							
Earthwork							
Excavation, Filling & Comp.		✓	✓		✓	✓	
Excav. & Filling - Util.							
Disposal of Excav. Mat'l.							
Base Courses						✓	
Soil Stabilization							
Slope Prot., Erosion Con't.					✓		✓
Earth Dams		✓	✓		✓		
Piles & Caissons							
Driven Piles	✓					✓	
Marine Work							
Dredging		✓	✓		✓	✓	
Jetties							
Fender System						✓	
Guidewalls						✓	
Mooring Anchors						✓	
Underwater Work			✓	✓			
Buoys			✓			✓	

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	40	42	47	52	53	54	55	56	57	
2 Sitework Cont.										
Paving & Surfacing										
Granular Paving				✓						
Concrete Paving										
Asphaltic Concrete										
Bituminous Paving										
Utility Piping Mat'ls.										
Pipe & Fittings				✓		✓				
Sewerage & Drainage										
Subdrainage System		✓		✓				✓	✓	
Storm Sewerage				✓		✓	✓	✓	✓	
Drainage Structures				✓		✓	✓			
Site Improvements										
Fences & Gates				✓		✓		✓	✓	
Traffic Control										
Landscaping										
Establishment of Turf		✓		✓			✓	✓	✓	
3 Concrete		✓		✓	✓		✓	✓	✓	
Concrete Formwork										
Structural Formwork							✓	✓	✓	
Concrete Reinforcement							✓	✓	✓	
Concrete Accys.										
Expansion Joints										✓

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	58	59	60	61	62	63	64	65	67	
2 Sitework Con't.										
Paving & Surfacing										
Granular Paving			✓							
Concrete Paving										
Asphaltic Concrete										
Bituminous Paving										
Utility Piping Mat'ls.										
Pipe & Fittings					✓					
Sewerage & Drainage										
Subdrainage System	✓									
Storm Sewerage							✓	✓		
Drainage Structures								✓		
Site Improvements										
Fences & Gates										
Traffic Control										
Landscaping										
Establishment of Turf										
3 Concrete	✓			✓	✓		✓			
Concrete Formwork										
Structural Formwork										
Concrete Reinforcement										
Concrete Accys.										
Expansion Joints										

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	68	69	70	71	72	73	74
2 Sitework Con't.							
Paving & Surfacing							
Granular Paving							
Concrete Paving						✓	
Asphaltic Concrete						✓	
Bituminous Paving						✓	
Utility Piping Mat'ls.							
Pipe & Fittings		✓	✓		✓		
Sewerage & Drainage							
Subdrainage System							
Storm Sewerage							
Drainage Structures						✓	
Site Improvements							
Fences & Gates							
Traffic Control						✓	
Landscaping							
Establishment of Turf					✓	✓	
3 Concrete		✓			✓	✓	
Concrete Formwork					✓		
Structural Formwork		✓					
Concrete Reinforcement							
Concrete Accys.							
Expansion Joints							

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	40	42	47	52	53	54	55	56	57	
<b>3 Concrete Con't.</b>										
Cast-in-Place Concrete				✓	✓					
Structural Concrete		✓		✓	✓		✓	✓	✓	
Concrete Finishing				✓	✓					
Concrete Curing				✓	✓					
<b>5 Metals</b>										
Metal Materials										
Metal Coatings										
Painting										
Metal Fastening										
Bolting										
Welding										
Metal Fabrications										
Structural Fab.										
<b>6 Wood &amp; Plastics</b>										
Arch. Woodwork										
Stairwork & Handrails										
<b>9 Finishes</b>										
Painting										
Exterior Painting										
Special Paints										

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	58	59	60	61	62	63	64	65	67	
<b>3 Concrete Cont.</b>										
Cast-in-Place Concrete				✓	✓		✓			
Structural Concrete	✓									
Concrete Finishing										
Concrete Curing										
<b>5 Metals</b>										✓
Metal Materials										✓
Metal Coatings										
Painting										✓
Metal Fastening										✓
Bolting										✓
Welding										✓
Metal Fabrications										
Structural Fab.										✓
<b>6 Wood &amp; Plastics</b>				✓						
Arch. Woodwork										
Stairwork & Handrails				✓						
<b>9 Finishes</b>										✓
Painting										✓
Exterior Painting										
Special Paints										✓

✓ indicates that this item was in the specification

WATERWAYS AND TUNNELS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #						
	68	69	70	71	72	73	74
<b>3 Concrete Con't.</b>							
Cast-in-Place Concrete		✓		✓			
Structural Concrete							
Concrete Finishing							
Concrete Curing							
<b>5 Metals</b>	✓					✓	
Metal Materials	✓					✓	
Metal Coatings							
Painting						✓	
Metal Fastening							
Bolting	✓					✓	
Welding	✓					✓	
Metal Fabrications							
Structural Fab.	✓					✓	
<b>6 Wood &amp; Plastics</b>							
Arch. Woodwork							
Stairwork & Handrails							
<b>9 Finishes</b>						✓	
Painting						✓	
Exterior Painting							
Special Paints						✓	

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #								
	40	42	47	52	53	54	55	56	57
15 Mechanical				✓					
Mech. Mat'ls. & Methods									
Slide Gate & Hoist				✓					
Mech. Identification				✓					
16 Electrical									
Elect. Mat'ls. & Methods									
Wires & Cables									
Boxes (Pullboxes)									

✓ Indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #									
	58	59	60	61	62	63	64	65	67	
15 Mechanical										
Mech. Mat'ls. & Methods										
Slide Gate & Hoist										
Mech. Identification										
16 Electrical										✓
Elect. Mat'ls. & Methods										✓
Wires & Cables										✓
Boxes (Pullboxes)										

✓ indicates that this item was in the specification

**WATERWAYS AND TUNNELS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	68	69	70	71	72	73	74
15 Mechanical							
Mech. Mat'ls. & Methods							
Slide Gate & Hoist							
Mech. Identification							
16 Electrical						✓	
Elect. Mat'ls. & Methods						✓	
Wires & Cables						✓	
Boxes (Pullboxes)						✓	

✓ Indicates that this item was in the specification

**POWER PLANTS**  
**SPECIFICATIONS STUDIED**  
**DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1 General Req'ts		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓	✓				✓		✓		✓	✓
3 Concrete	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4 Masonry											✓
5 Metals	✓				✓			✓	✓		✓
6 Woods & Plastics	✓										
7 Thermal & Moist. Prot.	✓								✓		✓
8 Doors & Windows	✓										✓
9 Finishes	✓										✓
10 Specialties											
11 Equipment											
12 Furnishings											
13 Special Const.											
14 Conveying Systems											
15 Mechanical	✓	✓		✓							✓
16 Electrical	✓		✓				✓				✓

✓ indicates that this item was in the specification

**POWER PLANTS  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-8	13	14	15	17	18	20	22	23	24	90
0 Bidding Rqt's	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1 Gen. Rqt's		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Summary of Work		✓	✓	✓		✓	✓	✓	✓	✓	
Work Schedule				✓							
Owner Supplied Mat'l			✓	✓	✓						
Vendor Supplied Mat'l			✓	✓	✓						
Access to Work			✓					✓			
Conditions of Service			✓								
Coordination		✓		✓		✓	✓	✓	✓	✓	
Contractor's Duties				✓							
Field Engineering						✓	✓			✓	
Pump Nameplates			✓								
References				✓							
Abbreviations		✓									
Codes & Standards			✓	✓	✓						
Alternates		✓		✓		✓				✓	
Invoice Form		✓				✓	✓	✓	✓		
Project Meetings											✓
Submittals		✓		✓	✓	✓	✓	✓	✓	✓	✓
Material Certificates			✓								
Technical Data			✓								
Fab. & Erection Sched.				✓							
Shop Drawings				✓							
As-Built Drawings				✓							
Property Record										✓	

✓ Indicates that this division's content were in the specification

**POWER PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
1 Gen. Rqt's Con't											
Const. Services & Report		✓				✓	✓	✓		✓	
Quality Control/Assurance		✓	✓	✓				✓			
Design Criteria/Features			✓								
Vibration & Balance			✓								
Tests			✓								
Guaranteed Characteristics			✓	✓							
Materials & Workmanship			✓	✓							
Contractor Quality Control											✓
Temp. Facilities & Controls		✓		✓		✓	✓		✓		✓
Temp. Utilities				✓							
Barriers				✓							
Environmental Protection											✓
Bulletin Boards & Signs											✓
Temp. Field Offices				✓							
Material & Equipment				✓		✓	✓		✓	✓	
Trans. & Handling				✓							
Disposal of Materials				✓							
Contract Closeout		✓		✓		✓	✓	✓	✓	✓	✓
Parts and Tools			✓								
Completion Report		✓			✓	✓	✓	✓	✓		
2 Sitework	✓	✓				✓		✓		✓	✓
Subsurface Invest.											
Explor. Hole Drilling								✓			
Demolition											
Selective Demolition	✓										

✓ Indicates that this division's content were in the specification

**POWER PLANTS CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
2 Sitework Con't.											
Clearing & Grubbing										✓	✓
Excavation Support Sys.											
Tendon Rock Anchors								✓			
Rock Bolting								✓			
Earthwork	✓										
Stripping, Topsoil Stockpiling										✓	
Site Grading						✓				✓	
Excavation & Fill	✓										
Lines and Grades										✓	
Trench Excav. & Backfill	✓									✓	✓
Subgrade Preparation										✓	✓
Base Courses											✓
Soil Erosion & Sed. Control										✓	
Soil Treatment											
Soil Liner/Embankment Const.										✓	
Paving & Surfacing											
Concrete Paving											✓
Bituminous Surfacing											✓
Utility Piping Materials											
Water Lines											✓
Drainage											
Drainage Control Sys.										✓	✓
Ponds & Reservoirs											
Control of Water										✓	
Site Improvements											
Chain Link Fencing	✓										
Material Disposal								✓			
Top Soil & Seeding										✓	✓

✓ Indicates that this division's content were in the specification

**POWER PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
3 Concrete	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Formwork	✓			✓							
Cast-in-Place: Formwork	✓										✓
Corners	✓										
Req'd. Finish	✓										
Tolerance	✓										
Removal	✓										
Concrete Reinforcement	✓			✓							✓
Reinforcing Steel	✓										
Steel Wire Fabric	✓										
Placement	✓										
Concrete Accessories	✓										
Joints	✓										✓
Embedded Items	✓										
Anchor Bolts & Inserts	✓										
Delivery of Concrete	✓										
Proportioning & Mixing	✓										
Test of Materials	✓										
Placement of Concrete	✓										✓
Subgrade Preparation	✓										
Depositing Under Water	✓										
Cold Weather Concreting	✓										
Pumped Concrete	✓										
Pneumatic Placement	✓										
Free Fall	✓										
Depth of Layers	✓										

✓ indicates that this division's content were in the specification

**POWER PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
<b>3 Concrete Con't</b>											
Consolidation	✓										
Finishes	✓										
Curing & Protection	✓										
Cast-in-Place Concrete				✓				✓			
Grout				✓							
Nonshrink Grout	✓										
Mix Proportioning	✓										
Mixing & Placing	✓										
Finishing & Curing	✓										
Quality Assurance	✓										
Massive Concrete	✓										
<b>4 Masonry</b>											✓
Unit Masonry											
Reinf. Unit Masonry											✓
<b>5 Metals</b>	✓				✓			✓	✓		✓
Fabrication & Delivery	✓				✓						
Structural Steel Erection	✓										
Bolted Connections	✓										
Carbon Steel Welding	✓				✓						
Inspections & Tests	✓										
Storage & Handling	✓										
Structural Metal Framing								✓			
Metal Joists											✓
Steel Joists											✓

✓ Indicates that this division's content were in the specification

POWER PLANTS CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
<b>5 Metals Con't.</b>											
Metal Decking											
Steel Roof Deck	✓										✓
Metal Fabrications											✓
Gratings	✓										
Stair Treads	✓										
Pipe Handrails	✓										
Hangers, Supports & Restraints					✓						
Inspections & Tests	✓										
Receiving & Storing	✓										
<b>6 Wood and Plastics</b>	✓										
Carpentry	✓										
<b>7 Thermal &amp; Moist. Prot.</b>	✓								✓		✓
Dampproofing											
Bituminous Dampproofing											✓
Roofing & Insul.	✓								✓		
Roofing Membrane	✓								✓		
Roof Insul.	✓								✓		✓
Vapor Barrier	✓										
Roofing & Siding											
Siding	✓										
Louvers	✓										
Flashing & Sheet Metal									✓		
Roofing Accessories									✓		
Joint Sealers									✓		✓
Caulking	✓								✓		✓

✓ indicates that this division's content were in the specification

**POWER PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
<b>8 Doors &amp; Windows</b>	✓										✓
Hollow Metal Doors & Frames	✓										
Steel Doors & Frames											✓
Special Doors											
Overhead Coiling Doors											✓
Hardware	✓										
Glass & Glazing	✓										
Wire Glass	✓										
Glazing Cpds. & Putty	✓										
Glazing Accessories	✓										
<b>9 Finishes</b>	✓										✓
Accoustical Treatment											
Accoustical Ceilings											✓
Painting	✓										
<b>15 Mechanical</b>	✓	✓		✓							✓
Materials & Methods				✓							
Piping Specs.	✓			✓							
Piping Fab. & Installation	✓			✓							
Marking & Identification	✓			✓							✓
Piping Supports & Restraints	✓			✓							
Mechanical Insulation											
Piping Insulation	✓										
Fire Protection											
Sprinkler System											✓

✓ Indicates that this division's content were in the specification

**POWER PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
15 Mechanical Cont											
Plumbing											✓
Underground Piping	✓										
Strainers	✓										
Tanks & Vessels	✓										
Special Systems											✓
HVAC											
Air Cond. Systems											✓
Roof Vent. Fans	✓										✓
Hangers, Sppts., & Restraints	✓										
Ductwork		✓									
16 Electrical	✓		✓				✓				✓
Instrumentation	✓										
Materials & Methods	✓						✓				
Codes & Ordinances	✓										
Wire & Cable	✓						✓				
Surface Raceways	✓						✓				
Conduit	✓										
Elect. Ductbanks	✓										
Boxes	✓										
Wiring Devices	✓										
Fittings & Supports	✓										
Circuit & Equip. Ident.	✓										
Power Generation			✓								
Electric Motors			✓								✓

✓ Indicates that this division's content were in the specification

**POWER PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

DIVISION	SPECIFICATION #										
	4-6	13	14	15	17	18	20	22	23	24	90
16 Electrical Cont.											
Voltage Distribution											
Aerial Power Dist.											✓
Underground Power Dist.											✓
Substations	✓										
Enclosed Switches	✓										
Fuses and Holders	✓										
Circuit Breakers	✓										
Grounding	✓						✓				
Service & Distribution											
Panelboards	✓										
Lighting	✓										
Lighting Fixtures	✓										
Communications	✓										
Fire Detection & Alarm											✓
Telephone System											✓
Electric Heating											
Pipe Heating Cable	✓										
Unit Heaters	✓										
Controls											
PLC Control Board	✓										
Testing	✓										

✓ Indicates that this division's content were in the specification

**PETROCHEMICAL PLANTS  
SPECIFICATIONS STUDIED  
DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #	
	7	27
0 Bidding Rqt's	✓	✓
1 General Rqt's	✓	✓
2 Sitework	✓	✓
3 Concrete	✓	✓
4 Masonry		
5 Metals	✓	✓
6 Woods & Plastics		✓
7 Thermal & Moist. Prot.		✓
8 Doors & Windows		
9 Finishes		✓
10 Specialties		
11 Equipment	✓	✓
12 Furnishings		
13 Special Const.		✓
14 Conveying Systems		
15 Mechanical	✓	✓
16 Electrical	✓	✓

✓ indicates that this item was in the specification

**PETROCHEMICAL PLANTS  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #	
	7	27
0 Bidding Rq'ts	✓	✓
1 Gen. Rq'ts	✓	✓
Summary of Work		
Scope of Work	✓	✓
Work Done By Others	✓	✓
Owner Furnished Material	✓	✓
Regulatory Requirements		
Safety	✓	
References	✓	
2 Sitework	✓	✓
Demolition	✓	
Earthwork	✓	✓
Excavation	✓	
Fill & Backfill	✓	
Compaction	✓	
Piles & Caissons		
Piling		✓
Drilled Footings		✓
Railroad Work		✓
Roadwork		✓
Utility Piping Mat'ls		✓
3 Concrete	✓	✓
Imbedded Items	✓	
Cast-in-Place Concrete	✓	
Grouting	✓	

✓ indicates that this item was in the specification

PETROCHEMICAL PLANTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #	
	7	27
5 Metals	✓	✓
Metal Fastening		
Bolting	✓	
Welding	✓	
Structural Steel	✓	✓
6 Wood and Plastics		✓
Carpentry		✓
Timber Construction		✓
7 Thermal & Moist. Protection		✓
Thermal Insulation		✓
9 Finishes		✓
Painting		✓
11 Equipment	✓	✓
13 Special Construction		✓
Gravity Drains		✓
15 Mechanical	✓	✓
Mechanical Materials	✓	
Pipes & Fittings	✓	
Hangers & Supports		✓
Valves	✓	
Plumbing	✓	
Testing		
Piping Sys. Testing	✓	

✓ indicates that this item was in the specification.

**PETROCHEMICAL PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #	
	7	27
16 Electrical	✓	✓
Materials & Methods	✓	
Conduit	✓	
Wire and Cables	✓	
Support Brackets	✓	
Grounding	✓	
Service & Distribution		
Motor Control & Switchgear	✓	
Lighting		
Lighting Fixtures		✓
Controls	✓	✓
Instrumentation	✓	✓
Testing		
Elect. Equip. Testings	✓	
Elect. System Start-up	✓	

✓ indicates that this item was in the specification

**UTILITIES**  
**SPECIFICATIONS STUDIED**  
**DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #						
	11	32	77	89	91	91	93
0 Bidding Req'ts	✓	✓		✓	✓	✓	✓
1 General Req'ts	✓	✓	✓	✓	✓	✓	✓
2 Sitework	✓		✓	✓	✓	✓	✓
3 Concrete	✓		✓		✓	✓	✓
4 Masonry			✓				
5 Metals			✓				
6 Woods & Plastics							
7 Thermal & Moist. Prot.			✓				
8 Doors & Windows			✓				
9 Finishes			✓			✓	
10 Specialties			✓				
11 Equipment			✓				
12 Furnishings							
13 Special Const.			✓				
14 Conveying Systems							
15 Mechanical		✓	✓			✓	
16 Electrical			✓	✓	✓	✓	✓

✓ indicates that this item was in the specification

**UTILITIES**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	11	38	77	89	91	92	93
0 Bidding Rqt's	✓	✓		✓	✓	✓	✓
1 Gen. Rqt's	✓	✓	✓	✓	✓	✓	✓
Summary of Work		✓					
Work Sequence	✓						
Access to Work	✓						
Allowances		✓					
Measurement & Payment	✓						
Coordination			✓				
Job Site Admin.					✓	✓	✓
Field Engineering	✓	✓					
Regulatory Requirements		✓					
Identification Sys.				✓			
References	✓						
Reference Stds.	✓						
Special Proj. Proc.	✓						
Maint. of Utilities	✓						
Submittals	✓		✓		✓	✓	✓
Progress Sched.	✓			✓			
Const. Photos	✓	✓					
As-Built Drawings				✓			
Quality Control	✓			✓	✓	✓	✓
Temporary Facilities & Controls		✓	✓		✓	✓	✓
Mobilization	✓		✓				
Temp. Const. Facilities	✓						

✓ indicates that this item was in the specification

**UTILITIES**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	11	36	77	89	91	92	93
1 Gen Req'ts Cont.							
Environmental Prot	✓			✓		✓	✓
Temp. (Erosion) Cont.		✓					
Temp. Traffic Control	✓						
Bulletin Board & Signs			✓	✓	✓	✓	✓
Field Office		✓					
Mat'ls. & Equip.			✓				
Product Handling			✓				
Facility Startup							
Tests & Insp.		✓					
Contract Closeout	✓		✓		✓	✓	✓
Warranties		✓		✓			
Safety				✓			
2 Sitework	✓		✓	✓	✓	✓	✓
Demolition				✓		✓	
Pavement Removal	✓				✓	✓	✓
Site Prep.							
Clearing & Grubbing			✓				
Earthwork			✓				
Excav. & Backfill for Util.	✓		✓		✓	✓	✓
Embankment			✓				
Subgrade Prep. & Comp.			✓				✓
Base Courses			✓				✓
Erosion Control			✓				
Boring & Tunneling			✓				

✓ indicates that this item was in the specification

**UTILITIES**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	11	36	77	89	91	92	93
<b>2 Sitework Con't.</b>							
Paving & Surfacing					✓	✓	
Concrete Paving	✓						✓
Bitum. Surface Treat.			✓				
Pavement repairs	✓				✓	✓	✓
Pavement Marking	✓						
Water Distribution							
Water Systems	✓						✓
Fuel & Steam Dist.							
Gas Dist. Sys.						✓	
Steam Dist. Sys.	✓						
Site Improvements							
Fences			✓				
Landscaping							
Est. of Turf/Seeding			✓		✓	✓	
Clean-up			✓				
Mowing				✓			
<b>3 Concrete</b>	✓		✓		✓	✓	✓
Concrete Reinf.							
Metal Reinforcement			✓				
Concrete Accys.							
Metal Fast. & Bolts			✓				
Cast-in-Place Conc.						✓	✓
Structural Conc.	✓		✓		✓		
Concrete Curing							
Membrane Curing			✓				

✓ indicates that this item was in the specification

**UTILITIES**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	11	36	77	89	91	92	93
<b>4 Masonry</b>			✓				
Masonry & Grout			✓				
Poured Concrete Grout			✓				
Masonry Accys.							
Reinf. Anchors & Ties			✓				
Unit Masonry							
Conc. Unit Masonry			✓				
<b>5 Metals</b>			✓				
Metal Fabrications							
Handrails & Railings			✓				
Gratings & Covers			✓				
<b>7 Thermal &amp; Moist. Prot.</b>			✓				
Waterproofing			✓				
Wall & Floor Sealers			✓				
Firestopping			✓				
Joint Sealers			✓				
Caulking			✓				
<b>8 Doors &amp; Windows</b>			✓				
Metal Doors & Frames			✓				
Wood Doors			✓				
Hardware			✓				
Glass & Glazing			✓				

✓ Indicates that this item was in the specification

**UTILITIES**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #						
	11	36	77	89	91	92	93
9 Finishes			✓			✓	
Painting			✓			✓	
10 Specialties			✓				
Visual Display Boards			✓				
Fire Prot. Spec.							
Fire Ext. & Cabinets			✓				
11 Equipment			✓				
Water Sppy. & Treat.							
Pumps			✓				
Chlorination Sys.			✓				
13 Special Const.			✓				
Gravity Sludge Dewatering			✓				
15 Mechanical	✓	✓				✓	
Mech. Mat'ls. & Methods							
Pipe & Pipe Fittings	✓	✓					
Piping Specs.	✓						
Valves & Gates	✓	✓					
Sanit. Sewer Manholes			✓				
Plumbing	✓						
Plumbing Piping	✓						
Plumbing Spec.	✓						
Plumb. Fxtures & Trim	✓						
Plumbing Equip.	✓						
Gas Piping Sys						✓	

✓ indicates that this item was in the specification

UTILITIES  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #						
	11	36	77	89	91	92	93
15 Mechanical Con't.							
HVAC		✓					
HVAC Materials		✓					
HVAC Insulation		✓					
Air Distribution		✓					
Ductwork		✓					
Controls							
Temp. Controls		✓					
Testing & Balancing		✓					
16 Electrical			✓	✓	✓	✓	✓
Basic Mat'ls. & Methods			✓				✓
Conduits			✓				
Wire & Cables			✓				
Pull Boxes			✓				
Wiring Devices			✓				
Interior Wiring Sys.					✓	✓	
Motors			✓				

✓ indicates that this item was in the specification

UTILITIES  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #						
	11	36	77	89	91	92	93
16 Electrical Con't.							
Elect. Dist. System							
Aerial Dist. System				✓	✓		
Underground Dist. Sys.				✓	✓		
Service & Dist.							
Panelboards			✓				
Disconnect Switches			✓				
Sppt. Devices			✓				
Grounding			✓				
Transformers			✓				
Lighting							
Luminaries			✓				
Communications							
Telephone Sys.			✓				
Television Sys.						✓	
Controls							
Motors Control Centers			✓				

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS  
SPECIFICATIONS STUDIED  
DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #
	1,2,3
0 Bidding Rq'ts	✓
1 General Rq'ts	✓
2 Sitework	✓
3 Concrete	✓
4 Masonry	✓
5 Metals	✓
6 Woods & Plastics	✓
7 Thermal & Moist. Prot.	
8 Doors & Windows	✓
9 Finishes	
10 Specialties	
11 Equipment	
12 Furnishings	
13 Special Const.	
14 Conveying Systems	
15 Mechanical	✓
16 Electrical	✓

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
0 Bidding Rq'ts	✓
1 Gen. Rq'ts	✓
2 Sitework	
Demolition	✓
Excavation & Backfill	✓
Compacted Fill	✓
3 Concrete	
Reinforced Concrete	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Material Storage	✓
Mfr Design & Testing	✓
Batching	✓
Mixing	✓
Weather Precautions	✓
Reinforcement	✓
Forms	✓
Site Preparation	✓
Conveying	✓
Placing	✓
Construction Joints	✓
Expansion Joints	✓
Surface Finishing	✓
Bolts & Inserts	✓
Tolerances	✓
Curing	✓
Testing	✓

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
3 Concrete (Con't)	
Permanent Formwork	✓
Codes & Standards	✓
Design Criteria	✓
Submittals	✓
Materials & Accys.	✓
Shop Finish	✓
Erection	✓
Concrete Floors	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Installation	✓
Concrete Floor Reinforcement	✓
Construction Joints	✓
Sawed Joints	✓
Floor Finish	✓
Curing & Protection	✓
Drainage Test	✓
Cleaning	✓

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
<b>3 Concrete (Con't)</b>	
Concrete Floor Finishes	✓
Submittals	✓
Materials	✓
Installation	✓
Protection	✓
Curing	✓
Surface Hardened Floors	✓
Codes & Standards	✓
Technical Representative	✓
Submittals	✓
Materials	✓
Floor Finishing	✓
Installation	✓
Grout	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Application	✓
Forms	✓
Area Preparation	✓
Installation	✓
Finishing	✓

✓ Indicates that this item was in the specification

MANUFACTURING PLANTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #
	1,2,3
<b>3 Concrete (Con't)</b>	
Equipment Grouting	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Application	✓
Forms	✓
Area Preparation	✓
Installation	✓
Finishing	✓
<b>4 Masonry</b>	
Concrete Block Masonry	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Mortar Materials	✓
Material Storage	✓
Mortar Mixes	✓
Mortar Mixing (On-Site)	✓

✓ indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
<b>5 Metals</b>	
Structural Steel Fab.	✓
Codes & Standards	✓
Inspections & Tests	✓
Submittals	✓
Materials	✓
Detailing & Workmanship	✓
Shop Painting	✓
Delivery & Storage	✓
Struct. Steel Erection	✓
Submittals	✓
Codes & Standards	✓
Inspections & Tests	✓
Materials	✓
Erection	✓
Touch-up Painting	✓
Misc. Metalwork	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Paint & Prot. Coating	✓
Erection	✓

✓ indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
<b>6 Wood and Plastics</b>	
Rough Carpentry	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Preservative Treatment	✓
Storage & Protection	✓
Temporary Enclosures	✓
Rough Hardware	✓
Finish Hardware	✓
Installation	✓
<b>8 Doors and Windows</b>	
Hollow Metal Doors/Frames	✓
Submittals	✓
Materials	✓
Finishes	✓
Hardware	✓
Storage & Erection	✓
Cleaning	✓
Finish Hardware	✓
Keying Procedures	✓
Locks	✓

✓ indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
15 Mechanical	
Mech. Equip. Installation	✓
Preparation	✓
Field Measurement & Layout	✓
Installation	✓
Leveling & Alignment	✓
Bolting in Place	✓
Doweling	✓
Shop & Field Welding	✓
Scaffolding & Tools	✓
Touch-up Painting	✓
Piping	✓
Codes & Standards	✓
Submittals	✓
Materials	✓
Fab./Assy Requirements	✓
Receiving & Storing	✓
Installation Requirements	✓
Inspection & Testing	✓
Cleaning & Marking	✓
Acceptance Criteria	✓
Pipe Identification Code	✓
Pipe Supports	✓

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
15 Mechanical (Con't)	
Piping Line Specifications	✓
Hot Oil	✓
Med. Pressure Condensate	✓
Stabilizer	✓
Soft Water	✓
Domestic Water (Chlorinated)	✓
Plasticizer	✓
Plant Air	✓
Instrument Air	✓
Medium Pressure System	✓
Atmospheric Vent	✓
Chilled Water	✓
Cooling Tower Water	✓
Piping Sys. Descriptions	✓
Insulation (Piping & Equip.)	✓
Codes & Standards	✓
Approved Manufacturers	✓
Material Requirements	✓
Installation Requirements	✓
Inspections & Tests	✓
Cleaning	✓
Packaging & Storage	✓

✓ indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
<b>15 Mechanical (Cont)</b>	
Ductwork & Insulation	✓
Codes & Standards	✓
Ductwork Requirements	✓
Testing & Balancing	✓
Duct Installation	✓
Air Handling Sys. Descriptions	✓
Control Room Cooling Sys.	✓
Transformer Room Vent.	✓
Web Cooling - Winder	✓
Strainer Motor & Panel Vent.	✓
Mill, Strainer Hood Exhaust	✓
Calender Drives Ventilation	✓
Miscellaneous Items	✓
<b>16 Electrical</b>	
Elec. Equip. Installation	✓
Preparation	✓
Field Measurement & Layout	✓
Installation	✓
Shop & Field Welding	✓
Touch-up Painting	✓
Motor Control Center	✓
Gauge Control System	✓

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
16 Electrical (Con't)	
Precipitator Control Panel	✓
Strainer Oper. Control Sta.	✓
Strainer Drive Panel	✓
Batch Weigh System	✓
Power Panel - Hot Oil	✓
Power Panel - Cooling Train	✓
Control Panel, System Oper.	✓
Winder	✓
Elect. Systems Descriptions	✓
Calender	✓
Winder	✓
Gauge Control System	✓
Strainer	✓
Precipitator	✓
Batch Weigh System	✓
Hot Oil System	✓
Cooling Train Water System	✓
HVAC Systems	✓
Lighting Systems	✓
Wind-up Hoist	✓
Conduit	✓
Conduit Raceways	✓
Conduit Fittings	✓
Conduit Supports	✓

✓ indicates that this item was in the specification

MANUFACTURING PLANTS CONTINUED  
 SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #
	1,2,3
16 Electrical (Cont)	
Wireways	✓
General	✓
Material	✓
Finish	✓
Installation	✓
Cable Trays	✓
General	✓
Materials	✓
Installation	✓
Pull & Junction Boxes	✓
General	✓
Pull Boxes	✓
Terminal Junction Boxes	✓
Installation	✓
Furnishing Cable	✓
Lighting Cable	✓
600 V Armored Power Cable	✓
600 V Single Cond. Power Cable	✓
600 V Multi-Cond. Cable	✓
300 V Instrumentation Cable	✓
300 V Extension Cable	✓
Submittals	✓

✓ Indicates that this item was in the specification

**MANUFACTURING PLANTS CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #
	1,2,3
16 Electrical (Cont)	
Cable Installation	✓
General	✓
Handling of Cable	✓
Cable Instal. - Raceways	✓
Cable Instal. - Equipment	✓
Cable Splices & Terminations	✓
General	✓
Compression Type Connectors	✓
Splices	✓
Terminations	✓
Ident. of Apparatus & Circuits	✓
Identification	✓
Grounding System	✓
Codes & Standards	✓
Grounding	✓
Interior Lighting Systems	✓
General	✓
Interior Lighting	✓
Miscellaneous Inst. Items	✓
Supports	✓
Miscellaneous Items	✓
Testing & Checking	✓
General	✓
Insulation Resistance Tests	✓
Misc. Electrical Tests	✓

✓ indicates that this item was in the specification

MANUFACTURING PLANTS CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE

STRUCTURE	SPECIFICATION #
	1,2,3
16 Electrical (Con't)	
Safety Practices & Procedures	✓
General	✓
Denergizing	✓
Energizing	✓
Responsibility	✓

✓ indicates that this item was in the specification

**BUILDINGS AND FACILITIES**  
**SPECIFICATIONS STUDIED**  
**DIVISIONS INCLUDED IN THE SPECIFICATION**

DIVISION	SPECIFICATION #											
	25	26	39	75	78	79	81	81	83	88	94	
0 Bidding Req'ts	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
1 General Req'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
3 Concrete	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
4 Masonry	✓	✓	✓	✓	✓	✓	✓	✓			✓	
5 Metals	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
6 Woods & Plastics	✓	✓	✓	✓	✓	✓	✓	✓			✓	
7 Thermal & Moist. Prot.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
8 Doors & Windows	✓	✓	✓	✓	✓	✓	✓	✓			✓	
9 Finishes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
10 Specialties	✓	✓	✓	✓	✓	✓	✓	✓			✓	
11 Equipment		✓	✓	✓	✓	✓					✓	
12 Furnishings			✓	✓	✓	✓		✓			✓	
13 Special Const.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
14 Conveying Systems	✓	✓		✓		✓					✓	
15 Mechanical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
16 Electrical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
0 Bidding Rq'ts	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
1 Gen. Rq'ts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Measurement and Payment						✓		✓			
Coordination			✓		✓			✓			
Job Site Admin.									✓	✓	✓
References							✓			✓	✓
Meetings			✓		✓	✓		✓	✓	✓	✓
Submittals			✓		✓		✓	✓	✓	✓	✓
Progress Schedules						✓		✓			
As-Built Drawings				✓			✓				
Quality Control	✓	✓									
Contractor Quality Control			✓	✓	✓	✓	✓	✓	✓	✓	✓
Temporary Facilities & Controls			✓		✓	✓		✓	✓	✓	✓
Environmental Protection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bulletin Boards & Signs			✓		✓	✓	✓	✓	✓	✓	✓
Construction Office				✓							
Material & Equipment			✓		✓	✓		✓			
Contract Closeout			✓		✓	✓		✓	✓	✓	✓
Safety			✓		✓	✓		✓			
2 Sitework	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Demolition	✓	✓	✓	✓	✓	✓		✓			✓
Pavement Removal			✓		✓	✓			✓		✓
Hazardous Mat'l Abatement					✓						
Site Preparation											
Clearing & Grubbing				✓		✓	✓	✓	✓		✓

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
2 Sitework Con't											
Earthwork	✓	✓						✓			
Grading					✓						
Excavating & Backfilling		✓	✓	✓	✓		✓	✓			✓
Excav. & Backfill for Util.		✓	✓	✓	✓	✓	✓	✓	✓		✓
Excav. & Backfill for Pmnt.					✓	✓	✓		✓		✓
Base Courses	✓		✓	✓	✓	✓	✓	✓	✓		✓
Soil Stabilization			✓		✓						✓
Slope Protection				✓							
Soil Treatment	✓										
Piles & Coissons											
Cast-in-Place Piles				✓							
Prestressed Concrete Piles	✓	✓									
Drilled Piers			✓								
Paving & Surfacing									✓		
Granular Paving						✓			✓		
Asphaltic Concrete		✓					✓				
Concrete Pavement			✓	✓	✓	✓	✓	✓	✓		✓
Prefab. Wheelstops						✓					✓
Bituminous Paving	✓		✓	✓	✓	✓	✓	✓			✓
Joint Sealing			✓	✓			✓		✓		✓
Pavement Markings			✓	✓	✓	✓	✓	✓			✓
Water Distribution	✓	✓									
Water Lines			✓	✓		✓	✓	✓			✓

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	30	75	78	79	81	82	83	88	94
<b>2 Sitework Con't</b>											
Fuel & Steam Dist.											
Gas Distribution Sys.			✓		✓	✓	✓	✓	✓		✓
Heat Distribution Sys.					✓						
Sewerage & Drainage											
Subdrainage	✓				✓						✓
Storm Drainage Sys.		✓	✓	✓				✓			
Sanitary Sewer System	✓	✓	✓	✓	✓	✓	✓	✓			✓
Site Improvements											
Sprinkler System		✓				✓					
Fences	✓	✓	✓	✓	✓	✓	✓				✓
Sidewalks & Curbs			✓	✓							
Traffic & Parking Signs			✓	✓		✓					
Guide & Guard Posts											✓
Landscaping		✓									
Est. of Turf	✓		✓	✓	✓	✓	✓	✓			✓
Trees, Shrubs, Etc.			✓	✓	✓	✓					✓
<b>3 Concrete</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Concrete Formwork											
Structural Conc. Formwork			✓	✓	✓	✓		✓			
Concrete Reinforcement			✓	✓				✓	✓		
Concrete Accessories											
Joints & Waterstops			✓	✓	✓	✓					
Cast-in-Place Concrete	✓	✓									
Conc. for Bldg. Construction			✓	✓	✓	✓	✓	✓	✓		✓
Pre-Cast Concrete											
Arch. Precast Concrete	✓			✓							
Tilt-up Precast Concrete		✓									

✓ Indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
<b>4 Masonry</b>	✓	✓	✓	✓	✓	✓	✓	✓			✓
Unit Masonry					✓	✓	✓	✓			✓
Brick Unit Masonry	✓										
Concrete Unit Masonry	✓										
Reinf. Unit Masonry		✓	✓	✓							
Glass Unit Masonry											✓
Stone			✓								
<b>5 Metals</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Metal Fastening											
Welding			✓				✓	✓			✓
Structural Metal Framing											
Structural Steel	✓	✓	✓	✓	✓	✓	✓	✓			✓
Metal Joists											
Steel Joists	✓	✓	✓		✓			✓			
Metal Decking											
Steel Decks	✓	✓	✓		✓	✓		✓			✓
Cold Formed Metal Framing											✓
Load Bearing Metal Sys.					✓						
Metal Fabrications	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
<b>6 Wood &amp; Plastic</b>	✓	✓	✓	✓	✓	✓	✓	✓			✓
Rough Carpentry	✓	✓	✓	✓	✓	✓	✓	✓			✓
Finish Carpentry	✓	✓	✓	✓	✓	✓	✓	✓			✓
Custom Casework							✓	✓			

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
7 Thermal & Moisture Prot.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waterproofing											
Membrane Waterproofing	✓	✓									
Bituminous Waterproofing				✓		✓					✓
Dampproofing											
Bituminous Dampproofing											✓
Insulation							✓				
Masonry Wall Insulation	✓										
Sprayed Insulation	✓			✓							
Ceiling & Wall Insul.	✓	✓									
Roof Insulation	✓	✓		✓							
Exterior Insulation	✓				✓						
Fireproofing	✓										
Firestopping			✓	✓	✓	✓	✓	✓		✓	✓
Manu. Roofing & Siding			✓								
Metal Siding & Roofing	✓	✓		✓	✓						
Membrane Roofing			✓		✓						
Built-up Bituminous Roofing	✓	✓			✓			✓			✓
Contractor Quality Control			✓		✓			✓			
Elastomeric Roofing				✓		✓					
Flashing & Sheet Metal	✓	✓	✓	✓	✓	✓	✓	✓			✓
Roof Spec. & Accys											
Roof Access Hatch	✓										
Prefab. Roof Curbs			✓								✓
Smoke Vents	✓										

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED  
SPECIFICATIONS STUDIED  
COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	28	39	75	78	79	81	82	83	88	94
<b>7 Thermal &amp; Isolat. Prot. Cont'</b>											
Skylights				✓							
Domed Skylights		✓									
Flat Metal Fr. Skylights		✓									
Joint Sealers											
Sealants	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Caulking		✓	✓	✓	✓	✓	✓			✓	✓
<b>8 Doors and Windows</b>	✓	✓	✓	✓	✓	✓	✓	✓			✓
Metal Doors & Frames		✓									
Steel Doors & Frames	✓		✓	✓	✓	✓	✓	✓			✓
Aluminum Doors & Frames	✓			✓	✓	✓	✓				✓
Stainless Steel Doors & Frames				✓							
Wood Doors		✓	✓	✓	✓	✓		✓			✓
Special Doors											
Security Doors			✓								
Colling Doors & Grilles	✓	✓	✓	✓	✓	✓	✓				✓
Folding Doors & Grilles				✓							
Safety Glass Doors				✓							
Sectional Overhead Doors			✓			✓					
Metal Windows											
Aluminum Windows	✓						✓	✓			✓
Hardware	✓	✓	✓	✓	✓	✓	✓	✓			✓
Glass & Glazing	✓	✓	✓	✓	✓	✓	✓	✓			✓
Glazed Curtain Walls											
Glazed Alum. Curtain Wall				✓							
Insul. Translucent Panels	✓										
Exterior Window Walls		✓									

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
9 Finishes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Metal Support Systems	✓	✓									
Lath and Plaster											✓
Lathing		✓									
Stucco		✓		✓							
Gypsum Wallboard	✓	✓	✓	✓	✓	✓	✓	✓			✓
Tile	✓	✓									
Ceramic Tile			✓	✓	✓	✓	✓	✓			✓
Quarry Tile			✓								
Elastomeric Tile			✓								
Acoustical Treatment	✓	✓									✓
Acoustical Ceilings			✓	✓	✓	✓	✓	✓			✓
Special Ceiling Surfaces											
Linear Metal Ceilings			✓								
Resilient Flooring	✓	✓	✓	✓	✓	✓	✓	✓			✓
Carpet	✓	✓	✓	✓	✓			✓			✓
Special Flooring											
Resinous Flooring											✓
Special Coatings	✓										
High Build Glaze Coating	✓										
Coating for Steel	✓										
Protective Coating for Concrete				✓							
Painting	✓		✓	✓	✓	✓	✓	✓		✓	✓
Wall Coverings											
Vinyl Wall Covering			✓	✓	✓			✓			✓

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
10 Specialties	✓	✓	✓	✓	✓	✓	✓	✓			✓
Compartments & Cubicles											
Toilet Partitions	✓	✓	✓	✓	✓	✓	✓				✓
Louvers											
Metal Wall Louvers	✓	✓				✓					✓
Wall & Corner Guards								✓			
Access Flooring		✓									
Raised Floor System				✓							✓
Flagpoles				✓							
Identifying Devices											
Interior Signs		✓	✓	✓			✓	✓			✓
Exterior Signs		✓		✓			✓	✓			✓
Lockers & Benches		✓	✓	✓							
Partitions											
Fire Prot. Specialties											
Fire Ext. Cabinets								✓			
Wire Mesh Partitions		✓	✓								
Demountable Partitions			✓								
Operable Partitions		✓									
Carousel System		✓									
Toilet & Bath Accessories	✓	✓	✓	✓	✓	✓		✓			✓
11 Equipment		✓	✓	✓	✓	✓					✓
Water Supply & Treatment											
Pump, Centrifugal				✓		✓					

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
11 Equipment Con't											
Fluid Waste Treat./Disp.											
Oil Water Separator		✓									
Sewage & Sludge Pumps			✓								✓
Food Service Equipment				✓	✓						
Darkroom Equipment											
Revolving Darkroom Door				✓							
Traffic Equipment				✓							
Loading Dock Equipment											
Loading Dock Leveler				✓							✓
Paint Spray Booth		✓									
Engine Test Equipment		✓									
Abrasive Blast Equip.		✓									
Hold Down Patterns		✓									
Valve Overhaul Stand		✓									
Hydro Test System		✓									
Humidigraph Recorders		✓									
Laboratory Equip.		✓									
12 Furnishings			✓	✓	✓	✓		✓			✓
Manufactured Casework											
Cabinets & Countertops						✓					
ESD Workbench Work Surface			✓								
Window Treatment											
Venetian Blinds			✓		✓			✓			✓
Blackout Draperies				✓							

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	28	39	75	78	79	81	82	83	88	94
12 Furnishings Cont.											
Furniture			✓	✓	✓	✓		✓			
Rugs and Mats											
Floor Mats								✓			✓
Multiple Seating											
Theater Seating											✓
Booths & Tables					✓						
13 Special Construction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sound, Vb. & Seismic Cont.											✓
Seismic Protection						✓	✓	✓			
Radio Freq. Shielded Enclosure	✓	✓									
Pre-Engr. Structures											
Metal Buildings						✓	✓		✓		
Water Conditioning Equip.											✓
Bldg. Automation Systems											
Energy Maint. & Control Sys.			✓	✓	✓	✓		✓			✓
14 Conveying Systems	✓	✓		✓		✓					✓
Elevators											
Hydraulic Elev.	✓		✓								✓
Electric Elev.				✓							
Material Handling Sys.											
Monorail System	✓										
Hoists and Cranes											
Trolley Hoists	✓	✓				✓					
Bridge Cranes	✓	✓									
Jib Cranes & Hoist			✓								
Scissor Lift, Stationary	✓										

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
15 Mechanical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mech. Mat'ls & Methods	✓	✓									
Pipes & Pipe Fittings			✓								
Mechanical Identification			✓		✓			✓			✓
Noise, Vib. & Seismic Cont.		✓	✓		✓						
Mechanical Insulation	✓	✓		✓	✓	✓	✓	✓		✓	
Piping Insulation			✓								
Equipment Insulation			✓								
Fire Protection											
Wet Pipe Sprinkler Sys.	✓	✓	✓	✓	✓	✓	✓	✓			✓
Halon Fire Ext. Sys.			✓	✓							
Fire Standpipe				✓							
Plumbing	✓	✓	✓	✓	✓	✓	✓	✓			✓
Compressed Air Sys.	✓	✓									
Fuel Oil System	✓	✓									
Gas Piping Sys.		✓			✓	✓	✓	✓	✓		✓
Nitrogen Manifolds		✓									
Chem. Tank Drains		✓									
HVAC											
Steam Heating Systems	✓		✓	✓	✓			✓			
Heat Piping System		✓	✓	✓	✓	✓					✓
Water Treatment			✓								

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
15 Mechanical Con't											
Heat Generation											
Heating Boilers		✓									
Gas Fired HEaters					✓	✓	✓		✓		
Refrigeration											
Air Conditioning Sys.	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Cooling Towers		✓									
Fluid Coolers		✓									
Air Handling		✓									
Air Supply System	✓			✓				✓			
Vent. & Exhaust System		✓	✓		✓	✓	✓	✓			✓
Veh. Tailpipe Exhaust Sys.						✓					
Air Distribution		✓	✓	✓	✓			✓			✓
Air Supply Sys.			✓		✓						✓
Ductwork & Accys.		✓									
Controls											
Envir. Control System	✓	✓	✓	✓	✓	✓		✓		✓	
Variable Freq. Drives											✓
Testing, Adjusting, & Balancing											
Air Sys. Testing & Balancing	✓	✓						✓			
Water Sys. Testing & Balancing		✓									
Commissioning HVAC Sys.								✓			

✓ indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
16 Electrical	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Elect. Mat'ls & Methods	✓	✓									
Raceways		✓									
Interior Wiring Sys.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Underfloor Duct Sys.											✓
Underground Elect. Work	✓	✓	✓								
Power Generation											
Generator - Nat. Gas				✓							
Generator - Diesel											✓
Transfer Switches				✓							
Voltage Distribution											
Substations	✓										
Switchgears	✓										
Aerial Dist. System					✓	✓	✓	✓			✓
Underground Dist. Sys.			✓	✓	✓	✓	✓	✓			✓
Service And Distribution											
Transformers		✓									
Interior Switchgear		✓									
Inverters		✓									
Lighting											
Interior Lighting	✓										
Exterior Area Lighting		✓									

✓ Indicates that this item was in the specification

**BUILDINGS & FACILITIES CONTINUED**  
**SPECIFICATIONS STUDIED**  
**COMPREHENSIVE DIVISION OUTLINE**

STRUCTURE	SPECIFICATION #										
	25	26	39	75	78	79	81	82	83	88	94
16 Electrical Cont'											
Special Systems											
Cathodic Protection		✓	✓	✓		✓	✓	✓			✓
Radio Freq. Filters	✓	✓									
Lightning Prot. Sys.			✓	✓			✓				
Static Elect. Prot. Sys.			✓								
Communications											
Alarm & Detection Sys.	✓	✓	✓	✓	✓	✓	✓	✓			✓
Clock & Program Sys.			✓								
Telephone Sys.						✓	✓				
Voice & Data Sys.								✓			✓
Intercom. System	✓	✓									✓
Closed Circuit TV Sys.				✓							
Local Area Network			✓								
Elect. Resistance Heating											
Elect. Heating Cables						✓	✓				✓
Controls											
Motor Gen & Iso. Transformer			✓								
Facilities Const. for HL&P				✓							
Concrete Poles				✓							

✓ Indicates that this item was in the specification

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Patrick Henry Caraway was born at Ladd, Air Force Base, Alaska, on 20 July 1960, the son of John W. Caraway and Lily Caraway. After graduating from Alamogordo Senior High School, Alamogordo, New Mexico in 1978, he entered New Mexico State University in Las Cruces, New Mexico. He received the degree of Bachelor of Science in Civil Engineering with Honors from New Mexico State University in May 1982, and was commissioned as a Second Lieutenant in the United States Army. He was promoted to Captain in November 1985. He served in various positions within Combat Engineer Battalions in Europe and at Fort Hood, Texas before being selected to attend graduate school to obtain a Masters Degree by the Army. In August, 1990, he entered The Graduate School of The University of Texas at Austin.

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