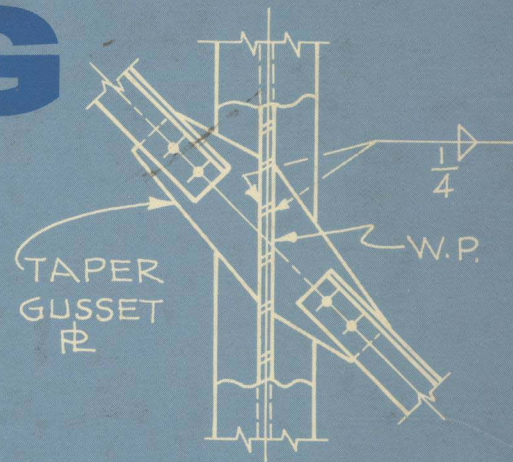
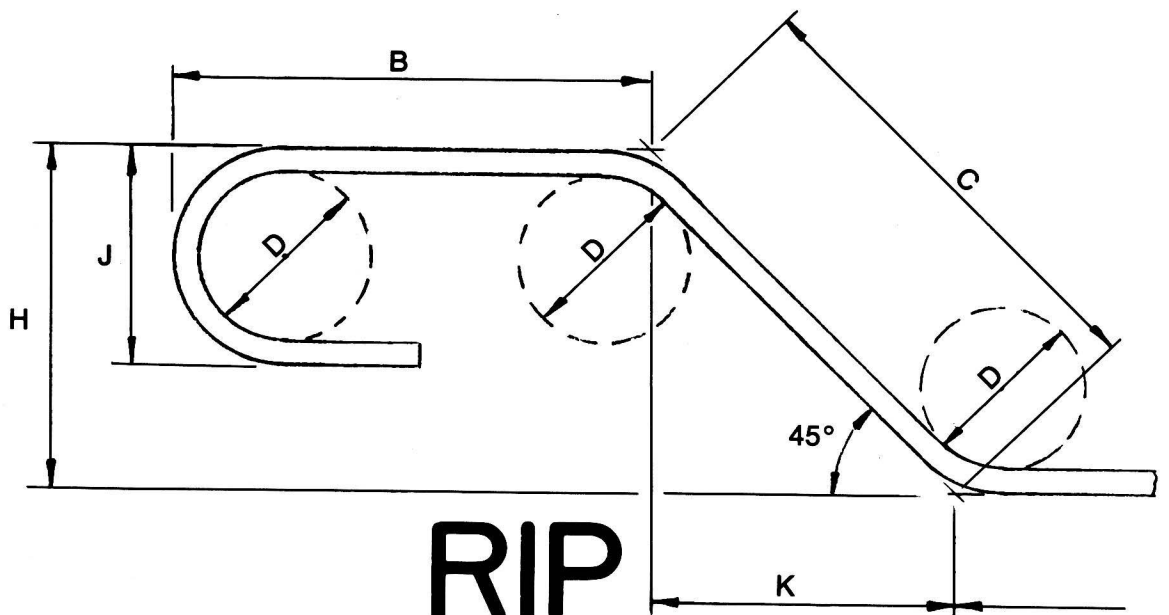


# STRUCTURAL DRAFTING

## RIP WEAVER



# STRUCTURAL DRAFTING



RIP

WEAVER



Gulf Publishing Company  
Book Division: Houston, Texas



**To Charlie Hamlin, the most influential person of my career. His leadership has been my constant inspiration. Without his urging, my books would remain unwritten.**

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# STRUCTURAL DRAFTING



**BOOKS BY THE AUTHOR**

**Process Piping Drafting**

**Process Piping Design, 2 Volumes**

**Modern Basic Drafting**

**Structural Drafting**

# INTRODUCTION

This book prepares the reader to enter the structural drafting field. After completing the book and the exercises, the student will have the equivalent of about one year's experience doing structural drafting. With this background the student can enter private business with sufficient job comprehension to perform the duties of a structural draftsman.

Beginning with structural terms, the reader is led, step-by-step, through the drafting room operations. The metric system is explained and many exercises call for metric units to be used. Concrete foundations are explained and the reader is asked to draw many of them. Structural steel arrangement drawings will be made and structural steel detailing is fully covered, including how to detail reinforcing bars. The reader is introduced to sewer systems, ladder and platform details, welding details, and many other disciplines the structural draftsman is often called on to perform.

The final chapter is the climax to the rest of the book. Here the reader is given a project to complete, exactly as might happen on a job. The student is asked to prepare foundations for vessels, exchangers and pipe supports, make steel pipe rack drawings from a sketch, make a foundation location drawing, and complete the rebar details. Basically these are the same duties that the student will be required to do once employed.

The structural drafting field is interesting, challenging, and financially rewarding. The author hopes that this book aids the reader who is seeking a career as a structural draftsman.

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# I. DUTIES DEFINED

Webster's dictionary defines *structure* as "something composed of parts." Any structure will be an assembly of various parts, similar to the pieces of an erector set. But the duties of a structural draftsman are much more varied and challenging than a mere erector set assembly. In most industrial firms the structural draftsman will be called on to make drawings of civil items, such as topographic contours, surface and underground drainage systems, equipment plot plans and foundation location plans, concrete foundations, elevated concrete structures, and the many types of steel structures.

To perform these duties, the structural draftsman must have a good knowledge of basic math, English and metric systems of weights and measures, equipment and materials terminology, welding and bolting, cost of materials and labor at the job site, and many other variables that are peculiar to the needed installation.

## **Job Opportunities**

What firms hire structural draftsmen? Companies that make drawings for part or all of the total structural drafting field. The following is a list of just a few of the many firms that offer work to today's structural draftsman.

1. Engineering-construction companies prepare the full scope of structural drawings and sometimes go beyond the normal scope of education for the discipline. These companies design refineries, chemical plants, paper mills, gas plants, pipe lines, and many other installations.
2. Structural steel fabricators employ hundreds of structural steel draftsmen. These firms receive the assembly drawings from other companies and prepare details of the actual pieces of the steel structure, fabricate the pieces, and ship them to the job site. To perform this drafting function requires a thorough knowledge of all steel members and the details associated with them.
3. Architects use structural draftsmen to prepare drawings of steel buildings, steel and concrete bridges, concrete and glass exterior buildings, which have steel frames, and shopping centers, which also usually have steel frames.
4. Prefabricated steel building fabricators use structural draftsmen to prepare the needed building assembly and erection drawings as well as the details of each piece for fabrication by their shop.
5. Oil, chemical, and pipe line companies use thousands of structural steel draftsmen to

prepare drawings of installations that the companies design themselves.

6. State highway departments employ thousands of structural steel draftsmen to make drawings of highways, bridges, and many other related items.

The individual with broad knowledge will be able to work for all of these firms and therefore will have many more job opportunities. Usually, the more knowledge needed to do the job, the higher the pay will be.

How does one, with no job experience get one of these jobs? By exhibiting perseverance, good work samples, and the desire to learn at the job interview. The novice should know that the firm does have a job opening. This may be learned from a friend, a teacher, the local want ads, an employment agency, or the state employment agency.

## The Job Interview

Once a job interview is arranged, the successful applicant must go prepared. This means the applicant should have copies of his or her work, a completed employment application form, preferably filled out with the applicant's free hand lettering, and a resume of past training and experience, if any. These items may have to be left with the interviewer so do not bring original tracings or resumes to the appointment. Figure 1-1 shows what information should be given on a resume.

The inexperienced draftsman may be required to take one or more tests at the initial interview. These tests might require the applicant to perform some drafting basics, such as dividing a line or angle into equal parts, drawing an octagon, or doing some basic math problems. Most of these tests are designed to evaluate the applicants basic skills and

## RESUMÉ

### **Name:**

Howard Charles Johnston

### **Personal Statistics**

Date of Birth: April 4, 1955.

Place of Birth: Claremore, Oklahoma

Marriage Status: Single

Military History: None

Social Security Number: 448-14-0831

### **Academic Achievement:**

Claremore High School, Claremore, Oklahoma. Diploma, 1973.

Three semesters of drafting.

Tulsa Junior College, Tulsa, Oklahoma. Graduated, 1975,  
school of drafting technology. Eight semesters of drafting.

### **Work Experience:**

Claremore Machine Shop, Claremore, Oklahoma.

Worked 9 months during my senior year of high school preparing shop drawings of various machine parts. Averaged about 15 hours a week after school.

Tulsa Oil Company, Inc., Tulsa, Oklahoma.

Worked 2 years part time while going to college. Prepared drawings of steel structures, concrete foundations for vessels and equipment and plant roadway and drainage systems.

### **Hobbies:**

Golf, bridge and fishing.

**Figure 1-1.** Typical resumé.



few of them can be completed within the allotted time. The idea is to get as many of them properly done as possible. It is a good idea to review drafting basics prior to the initial job interview.

The interviewer is busy, so do not take up time with useless conversation. It is proper to ask general questions about the firm and their future prospects. However, most of the interview should be spent answering the interviewer's questions. Finally, do not try to fool the interviewer with knowledge or experience you do not have. This individual is a professional at interviewing applicants and any such deceit will cost you the job.

### Job Descriptions

Entering a large company for the first time, the novice is often confused by the various titles assigned to the people around him. Usually very little effort is made to explain just who is in charge and how the titles fit in with the work to be performed. Figure 1-2 is a typical organization chart for a structural department. Several titles are shown in each box to depict titles used in business for the same basic job. The box shown with dashed lines is the individual that is over the head of the structural department.

#### Chief Structural Engineer

All structural work of the company is routed through the head of the structural department. This person often does all the hiring and firing of the structural staff. He assigns engineers, designers, and draftsmen to the work to be done. He also establishes or approves all design and drafting standards used by the firm. This position has final responsibility for all work performed by the department.

#### Senior Structural Engineer

This individual is assigned to a job or contract when it comes into the office or when work begins. He or she is responsible to the chief structural engineer for all work on the assigned contract.

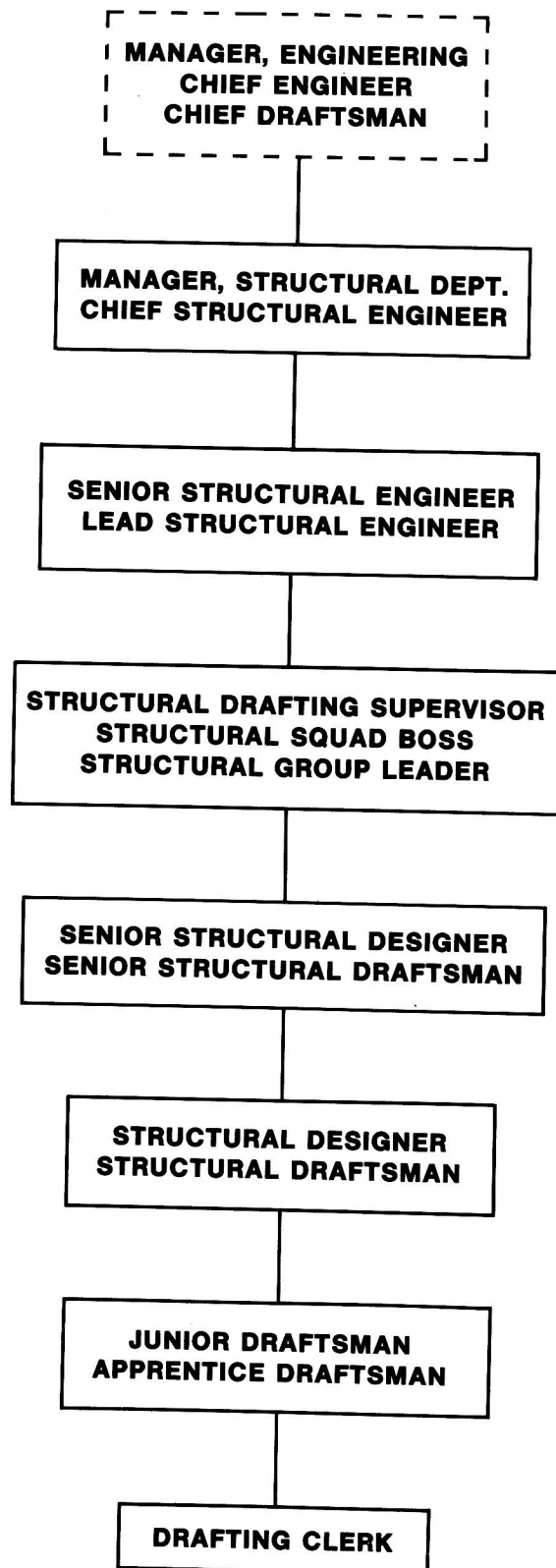


Figure 1-2. Structural department organization.

## **Structural Drafting Supervisor**

The supervisor, also assigned by the chief structural engineer, has responsibility for all drawings needed to complete the project. This includes assigning work to the drafting people and seeing that it is done properly, on schedule, and within budget. Normally this person will supervise 12 to 18 draftsmen. If it is necessary for more draftsmen to be assigned to the job to get it out on time, additional supervisors will be assigned.

## **Senior Structural Designer/Draftsman**

This position may be held by one or more of the more experienced people on the drafting crew. This senior person will assist the supervisor in job planning and supervision of the crew. As time allows, some checking of drawings may be done.

## **Structural Designer/Draftsman**

This position may have several levels of experience from two years on up. Some firms add a letter of the alphabet at the end of this title to designate proficiency and experience at the position. Note that experience is not the only criterion for advancement. Two people with five years of experience will not progress at the same rate. And five years of diversified experience is much better than one year's experience repeated five times.

This classification will be the bulk of the people on the job. They will prepare and check all the structural drawings for a contract. The supervisor will assign drawing and checking of more difficult items to those people of greater experience.

## **Junior or Apprentice Draftsman**

These are the people with a small amount of formal training and little to no experience. They are assigned the very easiest drafting jobs and spend a lot of time "scrubbing", erasing, and correcting original drawings prepared by others, using the checker's check print. As they gain experience and know-

ledge, they are promoted to more responsible duties.

## **Drafting Clerk**

Usually each job or contract has a drafting clerk to do filing, get supplies and prints, and do the most simple drafting jobs. With six or more months experience as a drafting clerk, they are promoted to junior draftsman.

## **Engineer—Designer—Draftsman Relationship**

The structural engineer has the education and experience to accept the responsibility for performing all the necessary calculations for the foundation or structural element, whether it be of steel or concrete. In most firms, the structural engineer, senior or otherwise in title, has full responsibility for the item designed by him and this includes all the detail drawings required for its construction. Consequently, the engineer has full authority over what the designer or draftsman shows on the drawings and how it is shown. In effect, the draftsman is making drawings for the engineer and full approval of the draftsman's work rests with the engineer.

The draftsman has many approvals to contend with before the drawing is released for fabrication. The supervisor will constantly be looking over his shoulder to see if the presentation meets with his or her approval. This review will be for general concept. Once the drawing is completed, it goes to a checker who will check presentation and dimensions for accuracy and completeness. The checker is usually a designer or senior designer with several years of experience.

Once the drawing is checked and corrected by the draftsman, the checker reviews it again and, if satisfied, signs the original as checked. Then it goes to the supervisor, engineer, and possibly the chief engineer for approval. Once past that hurdle, the project engineer gives it a quick review. After all these approvals and reviews, the drawing should be correct and ready for issue. But, the real proof of correctness lies in the craftsmen building the item from the drawings. If something isn't right, they delight in letting the engineering department know about it.

---

## 2. EQUIPMENT AND TERMS

Industrial plant equipment will vary with plant type. A paper mill will have vastly different equipment from a refinery, chemical plant, or other installation. But all plants have equipment that require foundations and anchor bolts to adequately support and hold the equipment in place. Foundation drawings are prepared by the structural draftsman and some equipment knowledge is necessary to make the drawings.

Since all the equipment, such as punch presses, drill presses, and conveyors, cannot be listed in this book, only equipment for refineries and chemical plants will be discussed. The draftsman that can prepare installation drawings for this type of equipment can easily adjust to the other types.

### Vessels

A vessel is like a large diameter pipe with end enclosures called **heads**. Vessels are given many names and the name is a clue to the vessel's function. A fractionating tower fractionates out a product, which leaves the top of the vessel in vapor form. Two examples of such vessels are Depropanizers, which fractionate out propane, and Debutanizers, which fractionate out butane. Figure 2-1 shows a Depropanizer elevation.

### Vertical Vessels

Vertical vessels are supported by **skirts**, which may be straight like the Depropanizer skirt in Figure 2-2, or they may be flared for very tall vessels as shown in Figure 2-3. The skirt detail supplies the data needed by the structural draftsman to prepare foundation drawings, such as anchor bolt size and bolt circle and base dimensions.

Short vertical vessels may be supported on legs, usually three, made of steel angles with a square base plate containing the anchor bolt hole.

Another vertical vessel is the **storage tank**, used to store feed stock, rerun stock, and products. Atmospheric pressure storage tanks are built in two basic styles, the floating roof design where the roof floats on top of the liquid, rising and falling with the level, and the cone roof design where the roof is fixed. Figure 2-4 shows the cone roof tank and Figure 2-5 shows the floating roof tank. In a refinery or chemical plant, storage tanks take up most of the plot area as shown by an aerial view of a refinery in Figure 2-6.

Atmospheric storage tank foundations are usually earthen, packed sand, sometimes with a concrete ring located under the tank's shell.

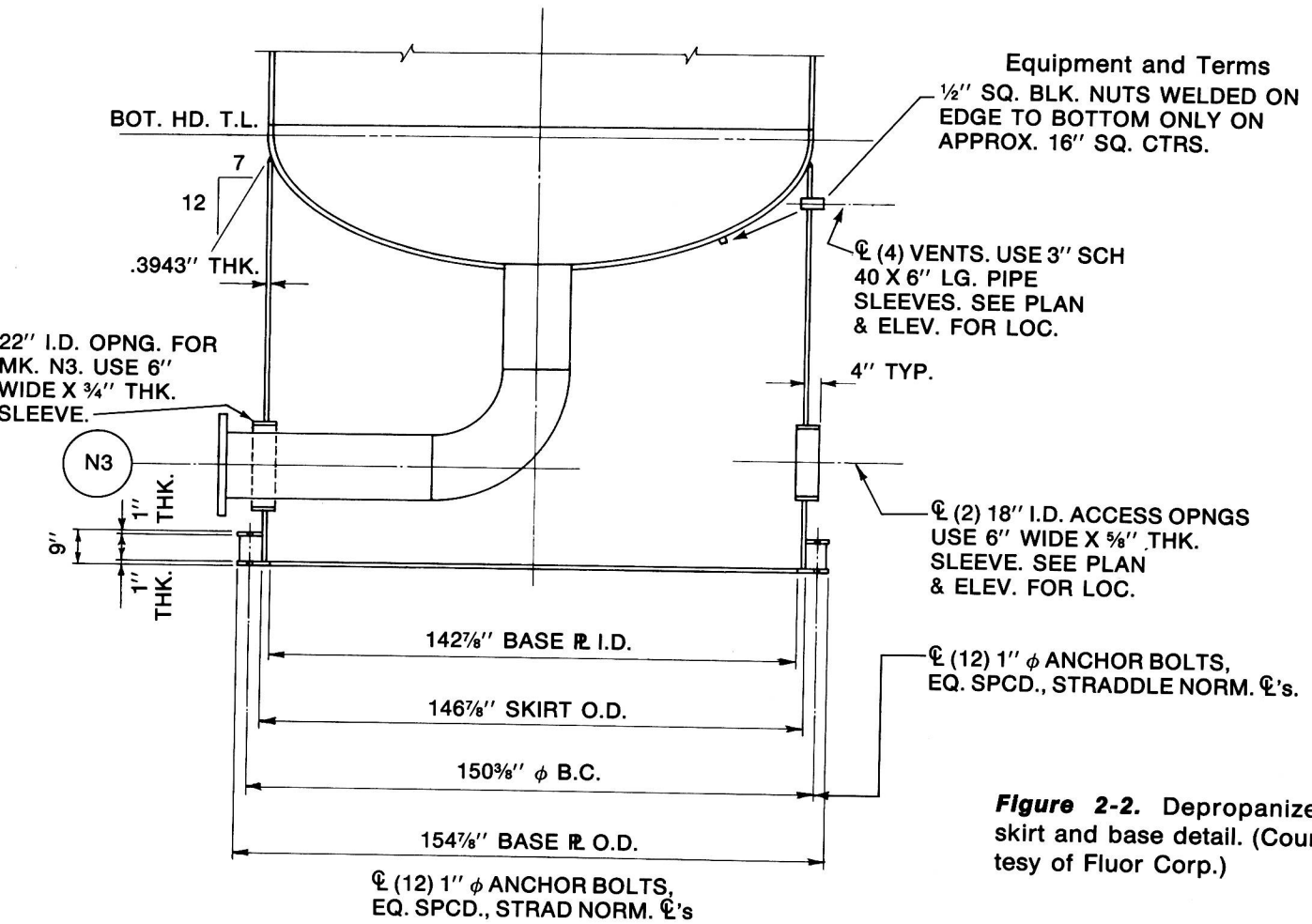
Light hydrocarbons, such as propane and butane, are stored under pressure to keep the product from

*(Text continued on page 9)*

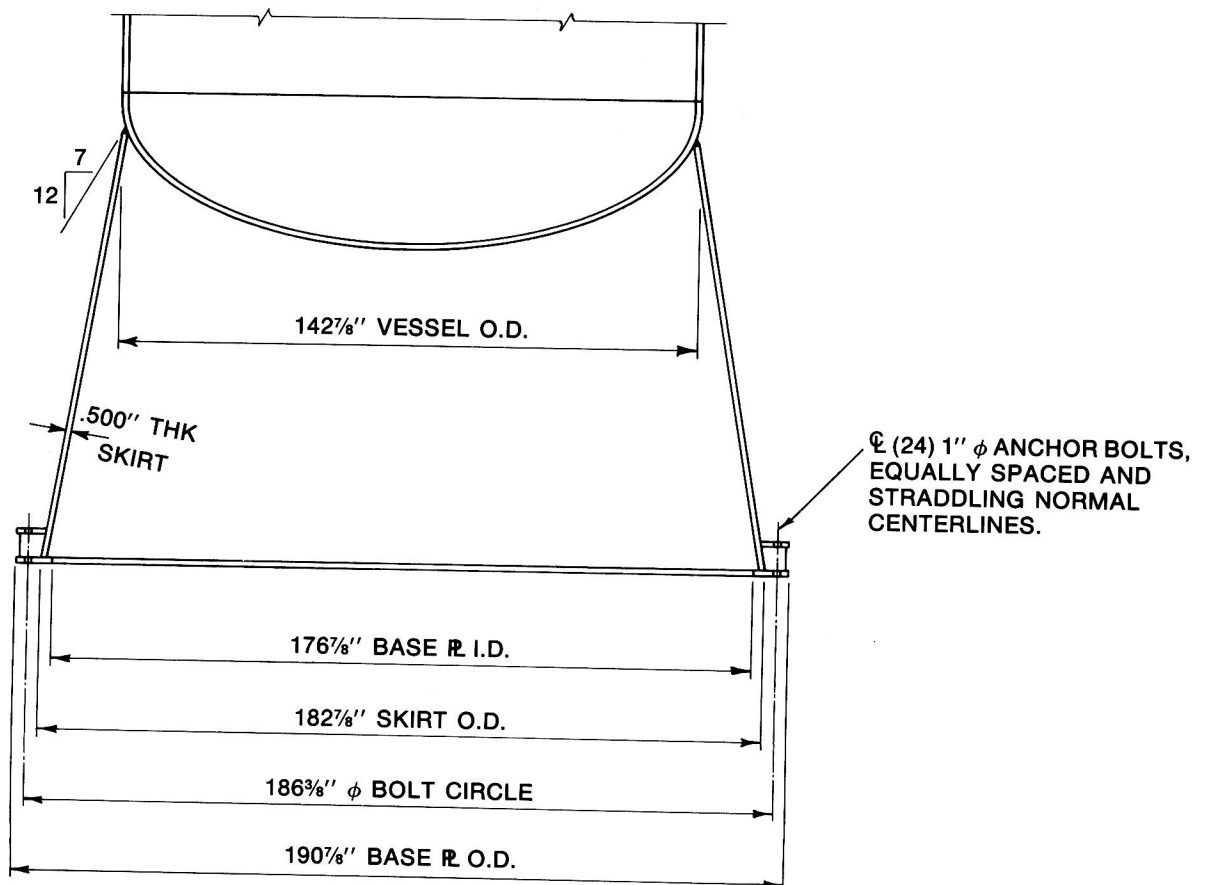




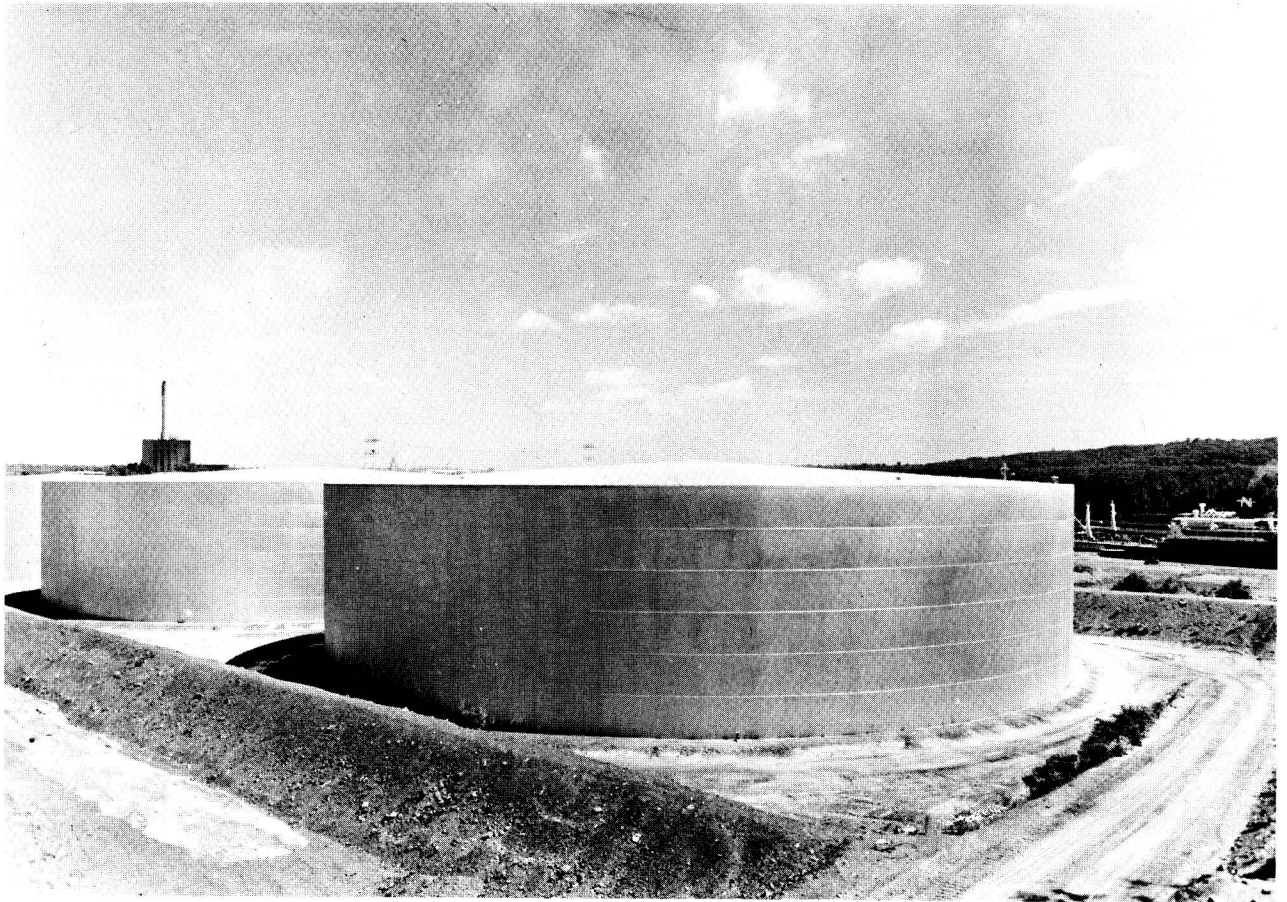
**Figure 2-1.** This a depropanizer elevation.



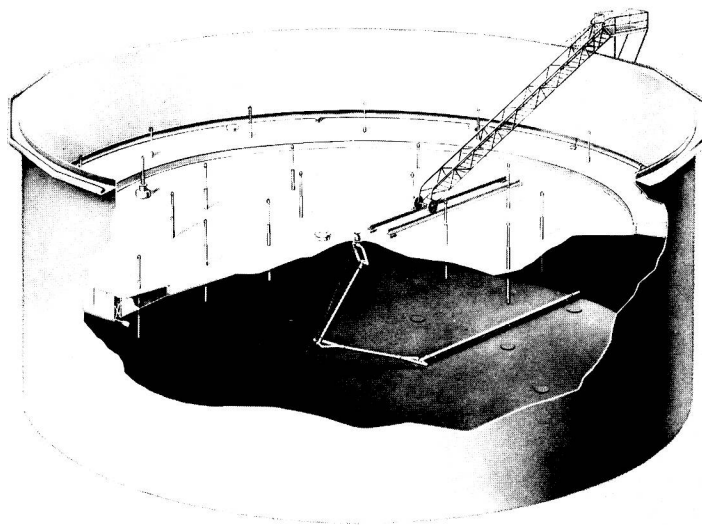
**Figure 2-2.** Depropanizer skirt and base detail. (Courtesy of Fluor Corp.)



**Figure 2-3.** Flared skirt.

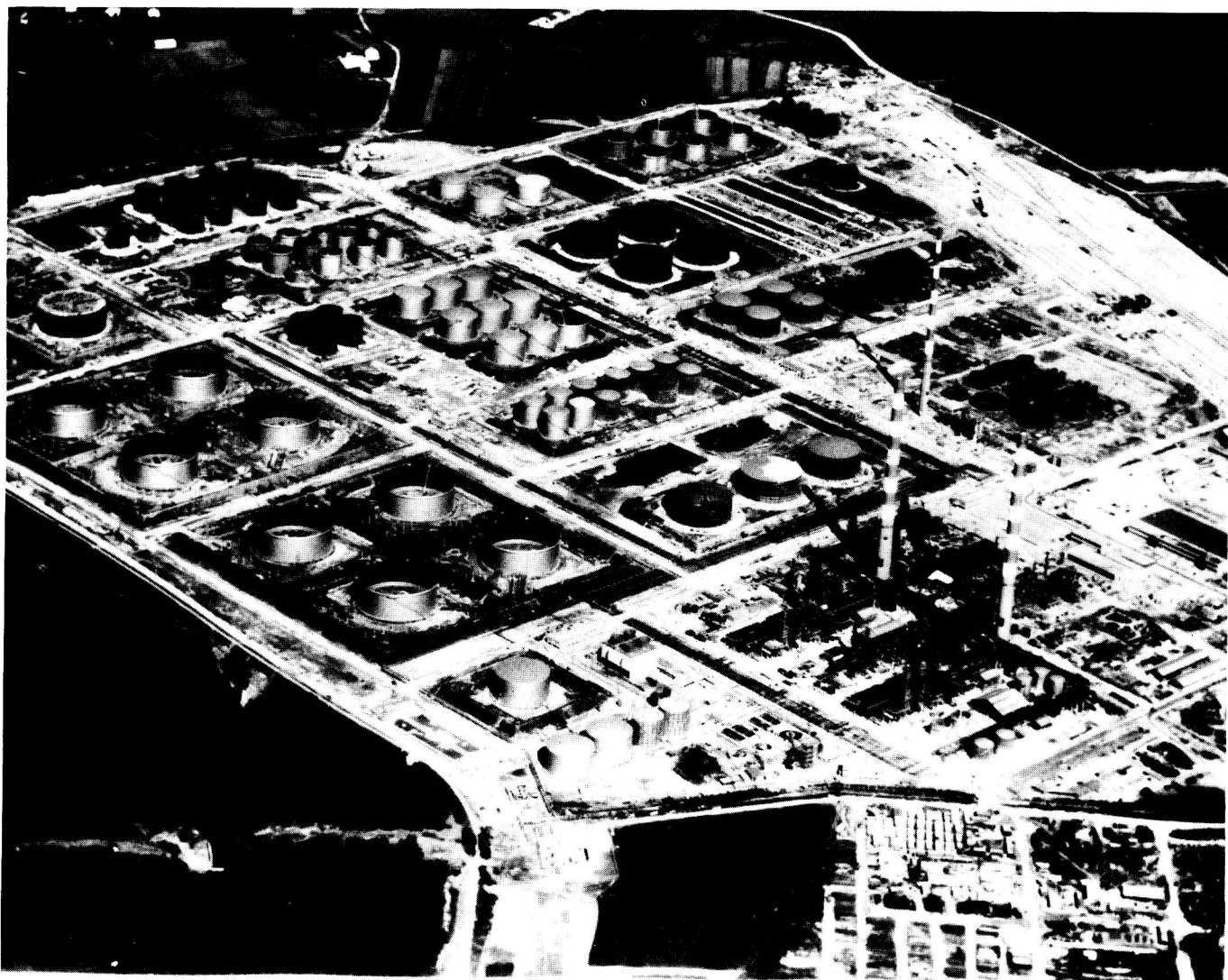


**Figure 2-4.** Cone roof tank. (Courtesy of Chicago Bridge and Iron Co.)



**Figure 2-5.** Pontoon roof design tank. This pontoon roof has a compartmented annular ring of pontoons and a single deck. (Courtesy of Chicago Bridge and Iron Co.)





**Figure 2-6.** Aerial view of British Petroleum's refinery in Germany. (Courtesy of Chicago Bridge and Iron Co.)

vaporizing. Smaller volumes are stored in long, horizontal vessels called **bullets** because of their shape. These bullets are about ten feet in diameter and eighty or more feet long. Greater volumes utilize the sphere for storage.

**Reactors** are vessels that are usually vertical but may be spherical or, in rare cases, horizontal. Reactors contain a catalyst which cause a chemical change in the fluid flowing through them. This fluid is usually vapor but may be liquid or a combination of liquid and vapor.

### Horizontal Vessels

The **overhead accumulator**, sometimes called reflux accumulator, is the process plant's most popular horizontal vessel. This is the vessel that is located near a fractionating tower and collects the overhead vapor after it is cooled and liquified. Figure 2-7 shows an overhead accumulator.

Horizontal vessels are supported by saddles, usually two in number but more may be used on extremely long vessels. The structural draftsman must