INTERN EXPERIENCE AT
THE UNION CARBIDE CORPORATION
TEXAS CITY PLANT

AN INTERNSHIP REPORT

by

Donald Dwight Tippett

Submitted to the College of Engineering
of Texas A&M University
in partial fulfillment of the requirement for the degree of

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December 1981

ABSTRACT

Intern Experience at the Union Carbide Corporation
Texas City Plant. (December 1981)
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This report presents a survey of the author's internship experience with Union Carbide Corporation's Texas City Plant during the period July 1, 1980 through May 15, 1981. The ten and one-half month internship was spent as an engineering intern attached to the Maintenance Department, with access to virtually every staff and line component of the organization. The intent of this report is to demonstrate that this experience fulfills the requirements of the Doctor of Engineering internship.

The author's internship activities can be divided into three major categories which correspond to the three principal internship objectives. The first objective required a study of the organization and how the individual parts function together to produce results. This study was conducted by taking part in various diverse orientations and small projects throughout the organization. The second objective called for development of interpersonal and management skills. This was accomplished by participating in all forms of daily business activities, talking with and observing managers, receiving formal management training and taking advantage of every

opportunity to practice these important skills. The third objective required an identifiable contribution be made to one or more particular projects. The three principal projects to which the author contributed involved inventory control, industrial hygiene, and maintenance workforce utilization.

The result of the internship experience was an appreciation for both the technical and non-technical aspects of operating a large chemical plant. The conclusion of the report is that the objectives were met and the internship requirement for the degree of Doctor of Engineering has been satisfied.

ACKNOWLEDGEMENTS

There are many people without whom this successful internship experience would not have been possible and are thus deserving of my sincere thanks. I would first like to express my gratitude to the many wonderful people at Union Carbide Texas City for their guidance, encouragement, and friendship. I am particularly indebted to Mr. John Knight, Mr. Jim Murray, Mr. Truman Blum, Mr. Joe Glass, my good friend, Mr. Steve Powe, and especially my Internship Supervisor, Mr. Merlin Lindsey. Mr. Lindsey's tireless efforts on my behalf, his wise counsel, and open door were the key to the success of the internship.

I am certainly grateful to Dr. M. J. Fox, Jr., my committee chairman during both my master's and doctor's degree programs, for his valuable advice and direction. I would also like to thank the other members of my committee, Dr. N. C. Ellis, Dr. J. U. McNeal and Professor C. L. Gilmore for their guidance and support of my graduate studies.

Most importantly, I wish to thank my wife, Sally, and my children, Timothy and Heather, for the many sacrifices they have so willingly made so that I might pursue my graduate degrees. Thank you family.

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DOCTOR OF ENGINEERING INTERNSHIP OF DONALD D. TIPPETT

UNION CARBIDE CORPORATION, TEXAS CITY, TEXAS

JULY, 1980 - MAY, 1981

CRITICAL OBJECTIVE

I. Observe the overall organization of the plant and learn how the individual parts function together to produce results. Place special emphasis on those areas with ongoing activities in my field of expertise so as to expand my education and broaden my knowledge.

SPECIFIC OBJECTIVES

An understanding of the functions of the various components of the plant organization will be gained by spending time on board each component and/or undertaking a specific project or projects in the particular area of concern.

A. Staff Components:

1. Employee Relations
   a. Ongoing exposure integral to several projects.
   b. At least one major project (see Critical Objective III).
   c. Attend monthly Plant Union Committee Meeting.
2. Industrial Hygiene - Major Project.
3. Job Analysis/Training - Orientation; possible major project.
4. Purchasing - Ongoing exposure integral to materials management project.
5. Environmental Protection - Orientation; possible minor project.
6. Corrosion Engineering Group - Orientation; possible minor project.

B. Maintenance Components:

1. Materials Management - Major project.

2. Maintenance Project Engineering - Major project.

3. Maintenance Planning - Exposure to Equipment Reliability, Instrument and Electrical Groups.

C. Operations Components:

1. Olefins Unit - Orientation tour of duty of about one week's duration.

2. Energy Systems - Orientation in following areas is planned:

   a. Water treating/cooling towers.

   b. Steam/Electrical generation.

   c. Shift Production Supervisor.

3. Inventory Planning and Control (IPAC) - Orientation.

4. Product Distribution (In-Plant and Marine Terminal) - Orientation.

D. Plant Managers' Department - Project (s) designed to provide perspective from the top of the organization. Specific activities yet to be identified.

CRITICAL OBJECTIVE

II. Take every opportunity to develop interpersonal and management skills.

SPECIFIC OBJECTIVES

A. Study and practice the techniques of the Union Carbide Management System (UCMS).

B. Participate in discussions involving philosophy of management and the organization with company managers. Remain alert for valuable information and experience to be gleaned from daily routine activities.

C. Organize and conduct effective business meetings involving numerous individuals from diverse parts of the organization and accomplish specific goals.

D. Study and participate in the Union Carbide Interaction Management Program for supervisors.

E. Attend Maintenance Department Awareness Program (DAP) to observe management practices and leadership exhibited by senior department managers.

F. Develop capability to compose effective memoranda, letters, and other types of written communication.

CRITICAL OBJECTIVE

III. Using the information gained in the previous objectives, make an identifiable contribution to one or more particular projects.

SPECIFIC OBJECTIVES: Major Projects

A. Materials Management Vendor Stocking/Inventory Reduction Program.

B. Employee Relations Project(s).

C. Industrial Hygiene Projects.

D. Maintenance Project Engineering Project.

APPROVED BY:

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The foregoing is the listing of objectives which was developed by the intern and the internship supervisor and submitted for Advisory Committee approval during the second month of internship. With one exception, each objective was met or exceeded. In fact, several additional activities, not originally listed, were carried out. These served to further enhance the internship experience.

The lone objective which was not met during the internship was Specific Objective B under Critical Objective III which calls for a major project in the employee relations area. While considerable exposure was gained to the Employee Relations Department and the Labor Relations Division during the course of other activities, no specific project in this area became available during the internship period.

INTRODUCTION

This report describes the author's Doctor of Engineering internship with Union Carbide Corporation's Solvents and Intermediates Division plant at Texas City, Texas. The internship began July 1, 1980, and ended May 15, 1981. The internship supervisor was Mr. Merlin D. Lindsey, a Senior Staff Engineer and Maintenance Department Head.

Administratively, the intern reported to the internship supervisor in the Maintenance Department during the entire internship (see Fig. 1). Functional control of internship activities was exercised by a number of different individuals throughout the organization, depending upon the particular project at hand.

Within the structure of the organization, the intern's principal function was that of an industrial engineer serving as a consultant to the various managers requiring assistance in this general area of expertise. Since the plant does not have its own industrial engineering group, there were many opportunities for project work in this field.

The internship was not limited to traditional engineering problems, however. Through the efforts of the internship supervisor, exposure was gained to virtually every staff and operational area by means of orientation visits and/or minor projects. Figure 2 shows the approximate percentage of the total internship period spent performing each of the several diverse activities which comprised the total internship experience.

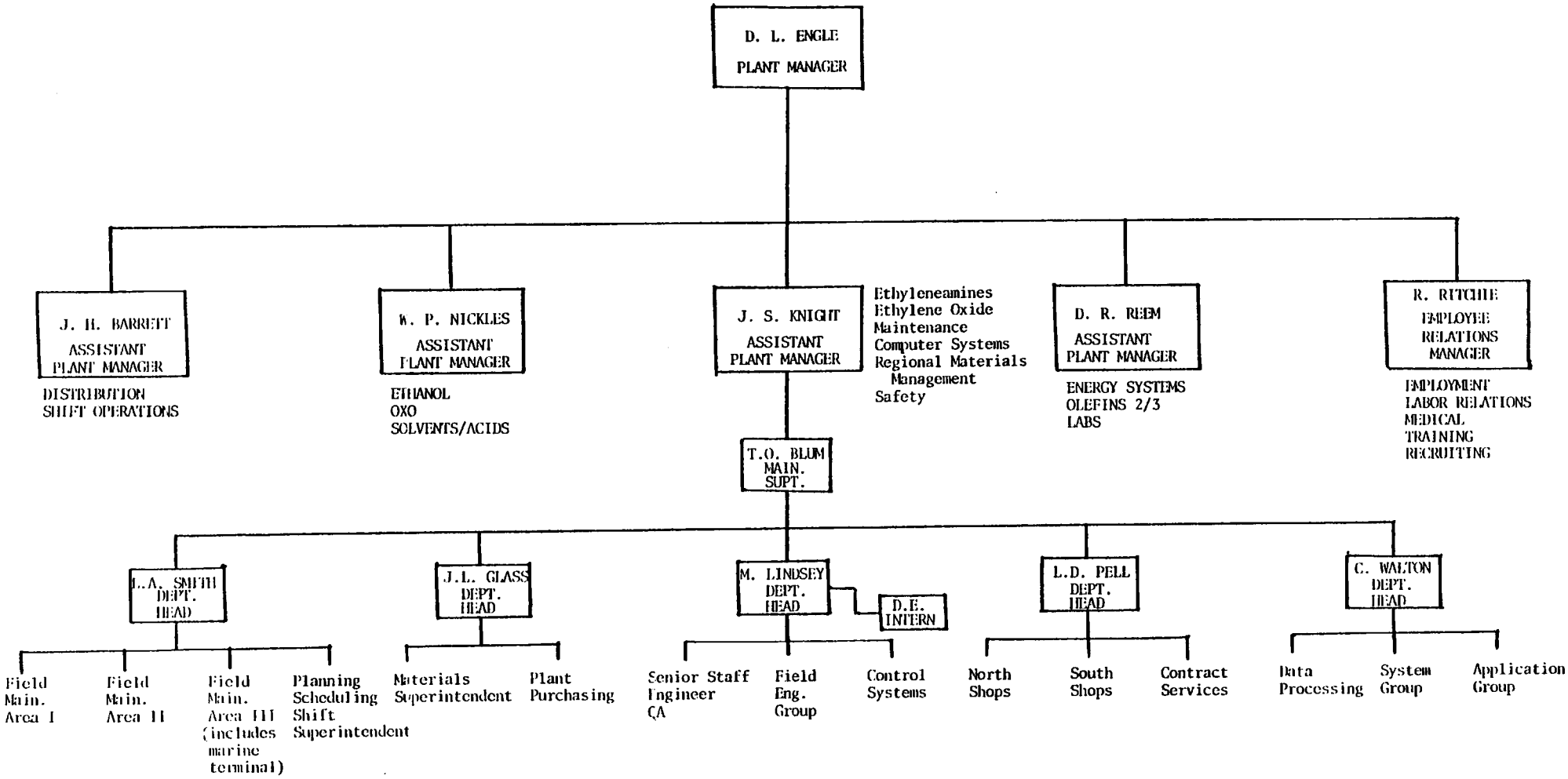

FIGURE 1 Texas City Plant Organizational Chart

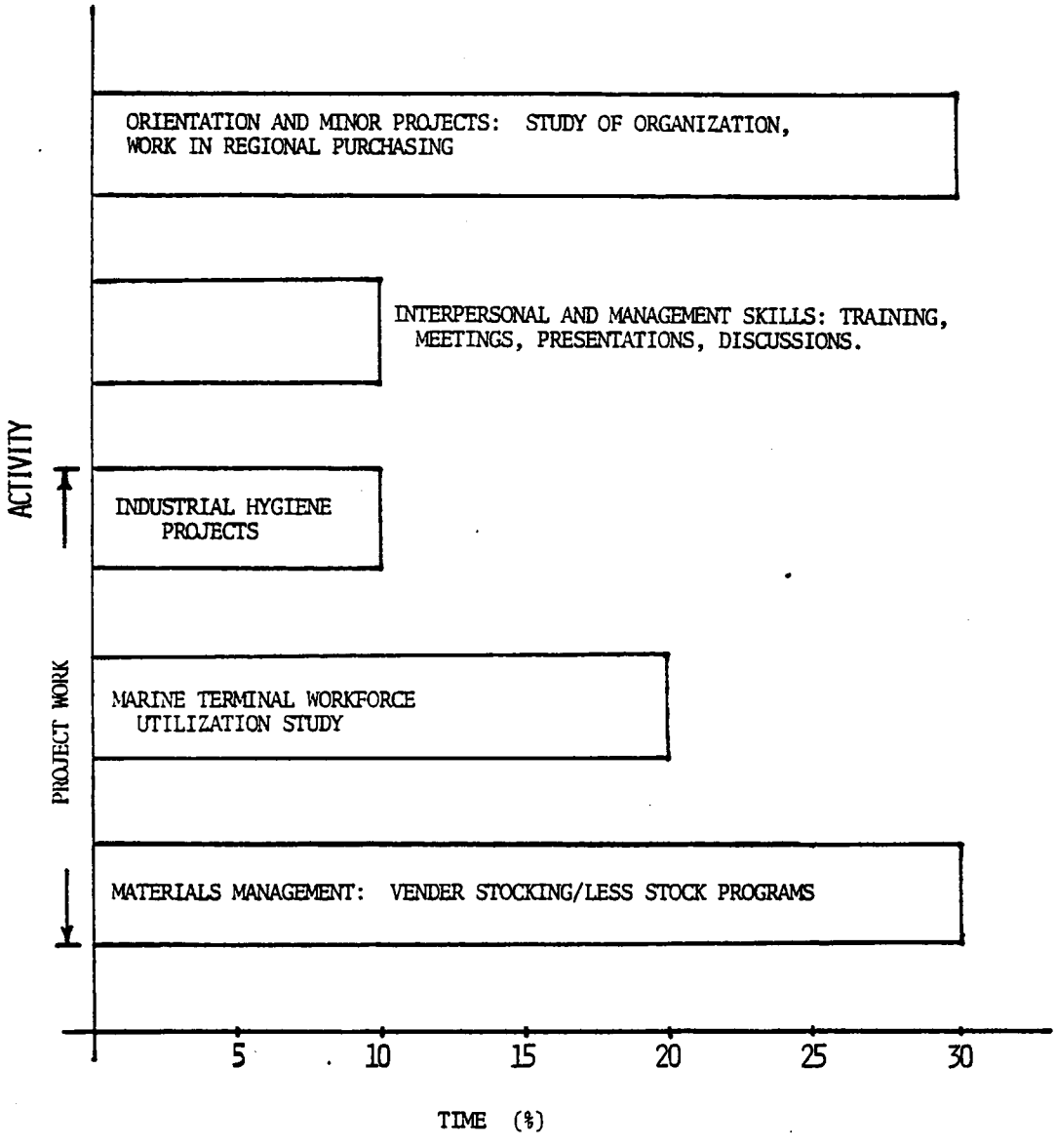

FIGURE 2 Time Allocation Among Internship Activities

The result of working in both traditional engineering roles and in other capacities throughout the organization has been an appreciation for both the technical and non-technical aspects of operating a large chemical plant. This variety of experiences has provided a broad view of the organization which could not be achieved in such a short time within the confines of a conventional job description.

The intent of this report is to show that the subject internship with Union Carbide Corporation satisfies the internship requirement of the Doctor of Engineering Program. This will be accomplished by demonstrating that each of the internship objectives has been met.

Following the next section, which describes the internship company, this report is divided into three main sections corresponding to the three Critical Objectives. Each section documents in detail the activities carried out during the internship which serve to fulfill the objectives addressed in that section.

The page numbering is continuous throughout the report with the number appearing in the upper right corner of the page. In addition, appendices with more than one page contain their own page number following the appendix letter at the bottom of the page. For example, the third page of Appendix N would have N-3 at the bottom, in addition to the number in the upper right corner corresponding to this report.

THE INTERNSHIP COMPANY

The Texas City chemical plant is the largest of seven producing locations that make up Union Carbide Corporation's Solvents and Intermediates (S&I) Division. The S&I Division employs about 2800 persons and realized sales of more than $691 million in 1980. If it stood alone as an independent company, it would rank 336 in the Fortune 500. The major products of the S&I Division are oxo alcohols, isopropanol, ethanol, and phenols. These chemicals are used in the manufacture of a wide variety of products from automobiles, appliances, furniture, and packaging to agricultural products, pharmaceuticals and synthetic lubricants.

The Texas City plant commenced operations May 21, 1941, and has been in continuous operation since then. It is a large plant which occupies 1,000 acres and contains over 250 buildings. Its workforce consists of about 2,450 persons including 1,700 hourly and 750 salaried employees. Of the total, roughly forty percent are concerned with maintenance, twenty-seven percent operations, ten percent distribution and the remainder is scattered among accounting, engineering, research, computing center, and others. The annual payroll exceeds $60 million.

The main raw materials used by the Texas City plant are natural gas, liquified petroleum gas (LPG) and various chemicals manufactured at other Carbide plants. These natural and refinery gases are compressed, heated, and cracked to form ethylene, propylene, acetylene and many other chemicals. Sixty different chemicals and three plastic

resins along with Prestone II Anti-Freeze compose the list of end products which leave the plant. These in turn are the building blocks for hundreds of common consumer products from aspirin and skin lotion to plastics, film, and detergents.

The bargaining unit at the Texas City plant includes most production and maintenance employees with the exception of the security force, salaried technical employees, certain clerical employees, and supervisors. Members of the bargaining unit are represented by the Texas City, Texas Metal Trades Council, AFL-CIO. This is a composite organization composed of representatives from the various craft and operator's unions whose members are employed by plants in the Texas City area. Figure 3 lists the member unions of the Council which are associated with the Union Carbide Texas City Plant.

In addition to the four major plant components, Maintenance/Materials Management, Energy Systems, Operations, and Distribution, the Texas City plant maintains a number of staff support groups. Among these are Accounting, Engineering, Environmental Protection, the Computer group, Industrial Hygiene, Safety, the Laboratory, and Employee Relations. Also located at the plant is the Gulf Coast Regional Purchasing group which has the responsibility for consolidated multiplant purchasing for the four Carbide plants on the Gulf Coast.

Boilermakers, Iron Ship Builders, Blacksmiths, Forgers & Helpers, No. 132

Bridge Structural & Ornamental Ironworkers No. 135

Carpenters & Joiners Local No. 973

Electrical Workers Local No. 527

Heat & Frost Insulators No. 105

Instrument Local No. 903, I.A.M.

International Association of Machinists No. 1446, Affiliated with District No. 37

International Union of Operating Engineers Local No. 450

Operating Engineers No. 347

Painters & Paperhangers No. 585

Pipefitters Local No. 211

Sheet Metal Workers Local No. 54

FIGURE 3 Texas City, Texas Metal Trades Council, AFL-CIO, Member Unions

SECTION ONE

Critical Objective I: Observe the overall organization of the plant and learn how the individual parts function together to produce results. Place special emphasis on those areas with ongoing activities in my field of expertise so as to expand my education and broaden my knowledge.

A logical first order of business upon joining any new organization is to observe the workings of the various parts and learn how they interact with each other and with the external environment. Certainly this approach is in concert with the Doctor of Engineering Program's requirement for the intern to become familiar with the various components of the organization and their methods for problem solving, in addition to traditional engineering design and analysis. Accordingly, study of the internship organization was made a major and ongoing activity throughout the course of the internship.

Orientation visits and minor projects formed the basis for study of the various component parts of the organization. Using these vehicles, a working knowledge of virtually every line and staff group in the plant was developed.

The documentation of this study which follows is divided into five parts: staff components, maintenance components, operations/distribution components, management components, and general orientation. Although somewhat more concentrated in the early stages of the

internship, the study of the organization and how its parts function together was basically continuous during the entire ten and one-half months. Consequently, the activities reported upon in this section took place throughout the course of the internship and are not necessarily in chronological order.

Staff Components

Employee Relations

The Employee Relations Department contains a number of important staff components such as training, labor relations, community relations, medical, and security (see Fig. 4). Although the opportunity to work on a major project in this area did not present itself, familiarity was achieved with most of the functions of this department through orientation sessions, attending various meetings, and dealings with its divisions during the normal course of employment.

Training. A visit with the Training Division revealed that this plant, in concert with the local Monsanto Company plant, is using the task inventory method for conducting job analysis of the various maintenance crafts which are common to both locations. The first step in this method is to formulate a comprehensive task listing for each craft. Then a sample of the incumbents in that craft use this task inventory to indicate how much time they typically spend on each of the tasks. Based on the task inventory results, an apprentice training program is designed. This method produces a craftsman who is more thoroughly trained in the specific skills he

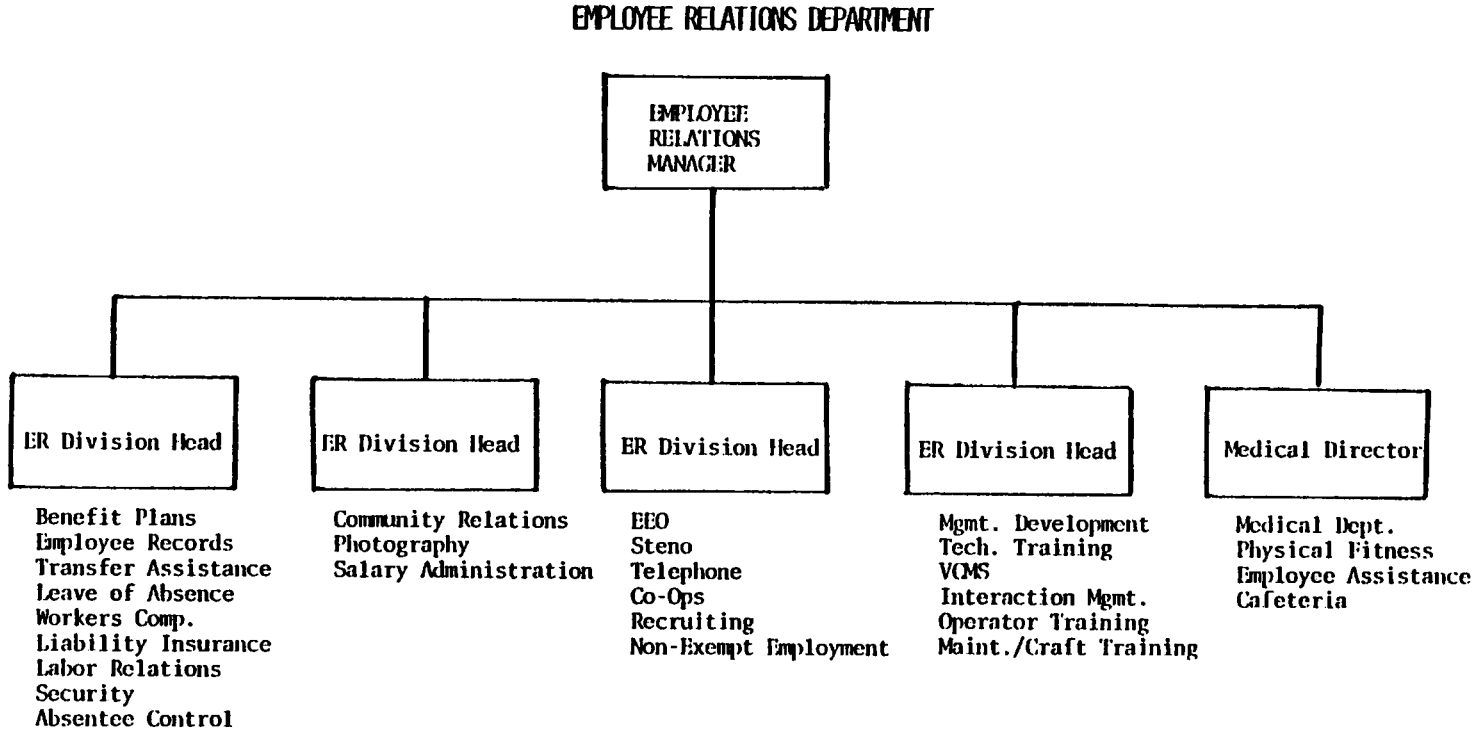

FIGURE 4 Employee Relations Department Organizational Chart

will actually need to practice his trade. It also eliminates invalid training requirements which could be challenged in court. Knowledge gained in Job Analysis (IEn-689B) was very helpful during the study of this program.

The attendance at four Maintenance Crafts Apprenticeship Program Committee meetings was also helpful in achieving understanding of the apprenticeship program. At these meetings, the progress of various individuals was discussed. Also, future requirements were analyzed to determine how many apprentices must enter the program now in order to fill craft needs four years hence. Since it does take four years to train a journeyman, the continual proper management of this training program remains crucial to the plant's having adequate numbers of skilled craftsmen in future years.

Labor Relations. While the opportunity for a major project in the area of labor relations did not arise during the internship, considerable exposure to the Labor Relations Division was gained during the course of other projects. This was especially true of the vendor stocking/less stock project. Its labor relations aspects will be detailed in Section Three of this report.

Attendance at several monthly Plant Union Committee meetings provided an excellent opportunity to observe the Texas City labor-management relationship in action. This particular meeting serves as the fourth step in the grievance process as well as a general communications device. It is attended by representatives of the Labor Relations Division, interested managers, area union stewards

from throughout the plant, and union business agents.

These meetings were generally cordial and reflected the overall relationship that exists between the two parties in the plant. This relationship has been a fairly noncombative one and there has not been a strike at Texas City in over thirty years.

The Labor Relations Division itself seems to stand on some neutral ground between management and labor rather than functioning as purely a management representative. It appears to be more of a conciliator for the two parties instead of serving as management's voice in the labor-management relationship. This arrangement was a totally unexpected one and was interesting to witness.

Observation and study of labor relations at Carbide Texas City was particularly enjoyable because of the excellent preparation and background previous coursework provided. It seems certain that an engineer who enters industry without some foundation in labor relations will soon find that his training is lacking a major ingredient.

Industrial Hygiene

An important staff function at any chemical plant is industrial hygiene. Three industrial hygienists and seven technicians operate a fully equipped laboratory accredited by the American Industrial Hygiene Association. This group performs various kinds of personnel monitoring as well as survey type services for all plant operations. Internship involvement in this area took the form of a major project and several minor projects which will be discussed in Section Three. Again, prior coursework was very helpful in allowing an immediate contribution to be made in this area.

Purchasing

Purchasing is a vital staff component of almost any type of business organization. Carbide Texas City has two distinct purchasing groups - Plant Purchasing and Gulf Coast Regional Purchasing. Plant Purchasing consists of a purchasing agent and four buyers. Their job is to supply plant users with the myriad of diverse items necessary to operate and maintain such a large facility on a day-to-day basis. Plant Purchasing, which may be called upon to buy anything from business cards to hundred thousand dollar turbine rotors, does most of its buying on a spot basis.

Blanket contracts for repetitive buying of the same commodity over the long term are the province of the Gulf Coast Regional Purchasing group, which is headquartered at Texas City. This group handles large scale regional contracts which address the common needs of all four Carbide chemical plants on the Gulf Coast. The group includes two purchasing agents, seven buyers, and administrative personnel.

Internship involvement was considerable with both groups. Liaison with Plant Purchasing was integral to both the vendor stocking/less stock and the industrial hygiene projects which will be discussed later. However, the most direct intern exposure to the purchasing function occurred when the opportunity arose to fill a temporary vacancy at a buyer's desk in Regional Purchasing for about six weeks.

The stint in Regional Purchasing proved to be a tremendous learning experience involving both purchasing practices and procedures and interorganizational business dealings in general. As a

regional buyer, the intern was given responsibility for a number of major commodities such as carbon and stainless steels, copper, steam traps, weld rings, laboratory glassware, nozzles, monel, and laboratory equipment. Every phase in the administration of these commodities was encountered from qualification of vendors, requests for bids, and bid evaluations, to the drawing up and awarding of blanket contracts and the periodic evaluation of vendor performance. Contact was maintained with and feedback sought from the plant user, invoice auditing, and the receiving departments in addition to vendor representatives. During the course of this tour of duty, a number of contracts were awarded including one for slip blinds and weld rings for $80,000 and one for containers for $25,000.

The six weeks as a regional buyer provided a detailed understanding of the purchasing function. They also offered the unique opportunity to represent the company, speaking for it during intercourse with the outside business community. The intern's immediate supervisor during the period in Regional Purchasing was Mr. J. E. Murray, Materials Manager, Southern Region.

Environmental Protection

A brief orientation visit was paid to the Environmental Protection group, which performs functions that are growing increasingly important in the current atmosphere of extensive government regulation and public awareness of environmental concerns. Specifically, this group covers two significant activities: first, the monitoring, collection, and disposal of plant process wastes in accordance with existing schedules and standards as set by various

regulatory agencies; and second, liaison with plant managers, engineering, production, and business managers working to improve new and existing processes to meet anticipated future pollution control requirements. The group consists of about twenty full-time employees. The visit with this group provided some appreciation for the magnitude of the influence of environmental considerations on the present day corporation's way of doing business.

Corrosion Engineering

The study of materials of construction and their corrosion properties is an important function in the design, construction and operation of a chemical plant. At Carbide Texas City there are two corrosion engineers and several technicians who deal with these problems on a full-time basis. The intern was fortunate to have the opportunity to attend a two-day training course dealing with materials and corrosion which was sponsored by the corrosion group. The training proved to be a good refresher of previous academic coursework received as a mechanical engineering undergraduate. It also provided an appreciation for the magnitude of the corrosion problem in a large chemical plant. Aluminum, copper, nickel, iron, steel, titanium, zirconium, and their alloys were evaluated as construction materials. Also, ten different types of corrosion were investigated.

This concludes the discussion of the intern's study and orientation activities involving functions classified here as being staff components. Certainly a number of the other groups encountered during the internship are designated as staff functions in some

instances. However, these groups will be dealt with in turn under other headings. The intern's study and familiarization activities involving the organization's maintenance components will be discussed next.

Maintenance Components

The Carbide Texas City Maintenance Department includes over forty percent of the plant's workforce, or about 950 people. A large portion of this number are either journeymen or apprentices in one of the sixteen maintenance crafts found in the plant (see Figure 5 for craft listing). Also members of the department are laborers, stores and receiving clerks, toolroom attendants, general helpers, oilers, and truck drivers. The Maintenance Department has the considerable responsibility for both the scheduled and unscheduled maintenance of the vast amounts of sophisticated equipment operated by the several units in the plant.

The Maintenance Department was the intern's sponsor and base of operations during the entire internship. Operation of the department is the responsibility of the Maintenance Superintendent who has five department heads reporting to him (see Fig. 1, p. 6). One of these department heads served as the internship supervisor. As a result of this arrangement, the intern became quite familiar with the basic workings of the department and with some of the satellite functions attached to the department.

For regular maintenance functions, the plant is broken into three maintenance areas, each being the responsibility of a second

Air-Conditioning and Refrigeration Mechanic

Automobile Mechanic

Boilermaker, Blacksmith

Carpenter

Electrical Worker

Equipment Operator

Fire Protection Mechanic

Instrument Repairman

Insulator

Ironworker and Rigger

Leadburner

Machinist

Painter

Pipefitter and Pipe Welder

Test and Inspection Mechanic

Sheet Metal Worker

FIGURE 5 Carbide Texas City Maintenance Crafts

line supervisor known as an area superintendent, who reports to a department head. Each area has a complement of daytime craftsmen and other assets sufficient to handle normal maintenance requirements in that area. There is also a shift maintenance group which provides for maintenance needs after normal working hours.

Another major component of the Maintenance Department is the group of maintenance shops such as the machine shop, sheet metal shop, carpenter shop, instrument shop, garage, pipe shop, and welding shop. These shops have more extensive capabilities than can be provided by the craftsman in the field.

Also reporting to the Maintenance Superintendent are a number of support functions such as field engineering, control systems, data processing, and equipment reliability. These groups serve both the Maintenance Department and others who need assistance throughout the plant.

Materials Management

The Plant Materials Manager reports to the Maintenance Superintendent and is considered a Maintenance Department Head. He is responsible for the plant stores operation and plant purchasing. Since the optimal handling of inventory is one of the interests of the industrial engineer, the intern spent a great deal of time working in this area in many different capacities. A general description of Materials Management will be provided here. More detailed information concerning intern involvement will follow in later sections.

Working for the Materials Superintendent, who reports to the Materials Manager, are three first-line supervisors. These supervisors

oversee such functions as receiving, bulk stores, the toolroom, small stores, satellite stores, investment recovery, expediting, and stores issue. The maintenance of computer order controls is also handled by this group. Each of these functions became very familiar to the intern during the course of several internship projects.

In the area of specific orientation activities and minor projects, one of the first assignments given the intern by the Materials Manager, Mr. J. L. Glass, was to evaluate the existing method for supplying compressed gasses to the remote Marine Terminal facility which lies a few miles east of the plant on Galveston Bay. Consideration was to be given to some type of vendor stocking arrangement whereby the vendor would bypass plant stores and deliver directly to the Marine Terminal on an as needed basis. This would eliminate some handling of the cylinders and lower in-plant storage costs. It would also reduce demands on the storeroom's delivery truck.

Study of the problem indicated that bypassing the storeroom was likely to cause the stores clerk's union (the Operating Engineers) to object that their work was being eliminated since they would no longer be checking in and delivering the gas cylinders. Liaison with Employee Relations suggested that a confrontation with a union was not desired on this relatively minor issue. This, along with the fact that the Marine Terminal's requirements for cylinder deliveries were infrequent, dictated a recommendation of no change in the current stocking method.

However, during the course of the investigation, it was discovered that the Carbide cylinder delivery truck was not complying

with Department of Transportation (DOT) regulations requiring a detailed bill of lading when it left the plant to travel to the Marine Terminal. This matter was researched with the Distribution Department's DOT expert and recommendations were made to bring the procedure into compliance with regulations.

This small project required contacts be established with several groups within the plant. It provided a feel for some of the government regulations encountered in business and proved to be an excellent introductory assignment.

Another small orientation type project which was assigned early in the internship by the Materials Manager was to conduct an evaluation of consignment buying, as presented in a magazine article*, for the purpose of assessing its value as an inventory reduction tool. Consignment buying involves the purchase of a large quantity of a commodity, possibly a year's usage, then having the vendor retain title to it until it is needed. The material may either be stored at the vendor's location or on the user's property. The idea is for the user to gain a measure of price protection and avoid inventory costs while giving the vendor a large order so he may take advantage of economies of large scale.

The memorandum presented in Appendix A was the result of a preliminary investigation into consignment buying possibilities at Carbide Texas City. Experienced purchasing personnel were interviewed

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*Myron Frye, "Beef Up Buying Clout With Consignments," Purchasing, October 9, 1980, pp. 52-59.

along with storeroom supervisors. Various commodities regarded as possible consignment candidates were evaluated. Also the few commodities already operating under similar arrangements were researched. As a result of the facts discovered in this evaluation, it was decided not to move forward with consignment buying at the present time. However, a great deal of knowledge about purchasing and stores was gained in this small project.

Short Courses

On a number of occasions during the internship the opportunity arose to attend short courses on various technical and professional subjects. Four of these courses dealt with maintenance related subjects: vapor cloud training, a safety relief devices seminar, a gear seminar, and pre-startup safety review training.

The vapor cloud training was a general safety lecture on procedures to follow in the event a toxic cloud should be released either by a Carbide unit or by one of the neighboring plants. The safety relief devices seminar was presented by Mr. Otto Cox, Safety Relief Device Specialist from the South Charleston, West Virginia Carbide Technical Center. This informative session covered all aspects of relief devices including the types available, how to select the proper device, proper installation, and new developments. Again, earlier mechanical engineering training was helpful in realizing the full benefits of this lecture.

The gear seminar was presented by Prager, Inc., a custom gear manufacturer. It dealt with all types of gears, their proper applications, and troubleshooting gear problems.

Before any unit or major piece of equipment is placed into service, a pre-startup review is conducted by an independent team consisting of from two to five members. The purpose of this review is to assure management that a facility is safe to operate by confirming that all aspects of safety and health have been considered and implemented in the design, installation, startup, and continued operation of the specific area of review. Several months after receiving this training, the intern was requested to participate on an actual pre-startup safety review team for a large new forklift truck being placed into service by the storeroom. A copy of the review team's report is included as Appendix B.

Equipment Reliability Group

The Equipment Reliability Group is concerned with the analysis of the reasons for equipment breakdowns. It is also concerned with the testing and evaluation of operating equipment in order to discover possible trouble signals which can be used to predict and avoid breakdowns. The intern observed the testing of a large internal combustion engine where electronic analyzers were employed to evaluate vibration signals emanating from the machine. This data was then used to pinpoint the cylinders and valves in need of overhaul during an upcoming scheduled shutdown. Activities such as these result in the realization of considerable dollar savings and more efficient maintenance operations.

Maintenance Planning

Scheduled periodic maintenance is a continuous process in a

chemical plant. Countless tasks must be performed on a regular basis just to stay even with normal wear and tear on equipment. The coordination and scheduling of the men and machines required to conduct this preventative maintenance is the responsibility of the Maintenance Planning Group. Maintenance planners estimate the number of craftsmen from each craft required to complete each task during a scheduled shutdown period. The use of major pieces of equipment must also be coordinated. Limited resources must often be apportioned among several simultaneous major shutdowns; unpredictable emergency breakdowns, which can ruin the best of plans, may occur at any time. Thus, the planning function can become a very complex undertaking.

The intern had the opportunity to follow the maintenance planning sequence for the overhaul of a large separation column with one of the maintenance planners. The entire operation, from initial estimates of time and resources required through completion of the actual overhaul, was closely monitored. This worthwhile experience provided an appreciation for the function of the Maintenance Planning Group.

Instrument/Electrical Groups

Some exposure to the instrument and electrical maintenance groups was gained during the course of two of the major internship projects. The intern worked closely with the instrument group during the industrial hygiene project and had close contact with members of the electrical group while working on the reduction of electrical cable inventory.

This concludes the discussion of activities classified as maintenance orientation. Certainly much additional knowledge of the

Maintenance Department was gained during the course of the three major projects discussed in Section Three, since each of these projects was heavily involved with maintenance functions. Study and orientation activities involving operations and distribution components will be presented next.

Operations/Distribution Components

While a large portion of the internship was centered around maintenance functions, there were ample opportunities to study operations and, to a lesser extent, distribution components as well. The main internship involvement with Operations consisted of two one-week tours of duty: one each with the Operations Shift Organization and the No.3 Olefins Unit. An orientation tour and the evaluation of a possible intern project involving the Prestone II canning line rounded out study of the Distribution Department.

Operations Shift Organization

The first and most comprehensive involvement with the operations side of the plant was a one-week tour with the Operations Shift Organization. At the suggestion of the Internship Supervisor, this tour was spent on the 3:00 p.m. to 11:00 p.m. evening shift. The main purpose of working on the evening shift was to gain an understanding of the different organizational environment and modified responsibilities/line of authority which exist in the plant during a non-day shift.

In the absence of the day staff, the plant is in the charge of the Shift Superintendent. Reporting to him are five Shift Production

Supervisors (SPS). Each SPS has responsibility for a different area of the plant. Reporting to them are the Chief Operators of the various operating production units. Also reporting to the Shift Superintendent is the supervisor of the shift maintenance crew.

During the intern's week with the Operations Shift Organization, a day was spent with each of the SPS's. In this way, exposure was gained to virtually every operating unit in the plant. Also, a thorough understanding of the overall operations side of the plant and how shift hourly personnel interface with the production day staff was developed. A list of the facilities visited includes water treating/cooling towers, ethanol, Olefins No.2 and No.3, power plants Nos. 1, 2, and 3, oxo/syn gas and ethyleneamines.

The week with the shift organization was one of the highlights of the internship and one of the most productive learning experiences. It was a unique opportunity which a new engineer might not ordinarily have. Appendix C presents a memorandum to the Internship Supervisor listing the objectives which were established prior to the assignment with the shift organization. It also includes some observations made by the intern at the conclusion of the assignment.

No.3 Olefins

Following the orientation tour with the Operations Shift Organization, it was decided that a logical follow up would be to select one of the operating units visited earlier and study it in greater detail than was possible during the first limited visit. It was further decided that this orientation would also take place on the evening shift, when the operators would have more time to spend with the intern.

The No.3 Olefins unit was selected because it is the largest and one of the most technically advanced units in the plant.

The memorandum presented as Appendix D reported the results of the No.3 Olefins visit to the Internship Supervisor. This orientation tour of duty was most interesting as it enabled the intern to get an in-depth look at a particular operations unit and thus round out the study of the operations side of the plant.

Inventory Planning and Control

One other experience with an operations function came in the form of a brief visit with Inventory Planning and Control (IPAC). This important group, whose manager reports directly to the Plant Manager, sets priorities for the allocation of resources such as raw materials, energy, and maintenance crews. It also determines how much of each product should be made. The IPAC people at Texas City maintain close liaison with other locations and with higher level corporate decision makers in order to keep abreast of ever-changing production requirements.

Distribution

The Plant Distribution Department is divided into three groups: Plastics/Antifreeze, Chemical, and Order Processing and Scheduling. Each group is responsible for moving its respective products safely and efficiently into and out of the plant and the Marine Terminal. The intern's contact with the Plant Distribution Department came during a project at the Marine Terminal, which will be discussed in Section Three, and an orientation visit to the

Prestone II Antifreeze canning facility.

The visit to the canning facility was made for the purpose of evaluating a possible intern project in that area. This project would have involved evaluating the antifreeze filler machine and making recommendations as to how greater fill-weight consistency could be achieved. It had been estimated that over-fills were costing about $100,000 per year. Some preliminary work was done on this project and some suggested areas for further study were given to department engineers. However, before an in-depth analysis could be made, the opportunity for a project in the Plant Managers' Department arose. On the recommendation of the Internship Supervisor the canning project was not undertaken. Still, during the evaluation of this project, a basic understanding was gained of the Plant Distribution Department's structure, functions, and typical problem areas.

The study of Operations/Distribution Components was especially valuable as this was an area in which the intern had relatively little prior knowledge. Next, study and orientation activities involving plant management components will be discussed.

Management Components

The Plant Managers' Department consists of the Plant Manager and five Assistant Plant Managers (APM) who report directly to the Plant Manager (Fig. 1, p. 6). The APM's in turn, are responsible for the various units throughout the plant and have the respective department heads reporting to them.

It was felt that some direct involvement with the Plant Managers' Department would be both appropriate and necessary in any attempt to obtain a complete picture of the organization and how its components interact. Accordingly, the Internship Supervisor approached Mr. J. S. Knight, the APM in charge of the Maintenance Department, about securing some type of exposure to the Plant Managers' Department.

Mr. Knight, who took a personal interest in the internship, responded by assigning the intern to work with him on a project involving an evaluation of the current duties, responsibilities and composition of the plant's Operational Health and Safety Team (OHST). The project also involved an examination of the OHST's current relationship with the three other principal plant safety groups and a determination as to what part each group should play in the overall safety effort.

Essentially, the intern's assignment consisted of attending meetings of the OHST, chaired by Mr. Knight, and serving as a consultant and resource person to this group. During the early meetings it was discovered that much confusion existed as to what the proper role should be for each of the several plant safety committees and especially what the specific responsibilities of the OHST should be. After much staff work and discussion, it was decided that the OHST should be a coordinating and technical advising body, serving as a link between the various other groups. Creation of the simplified diagram shown in Figure 6 helped to clarify the OHST's role.

The intern's principal contribution to this project was to take the large volume of involved information generated in committee

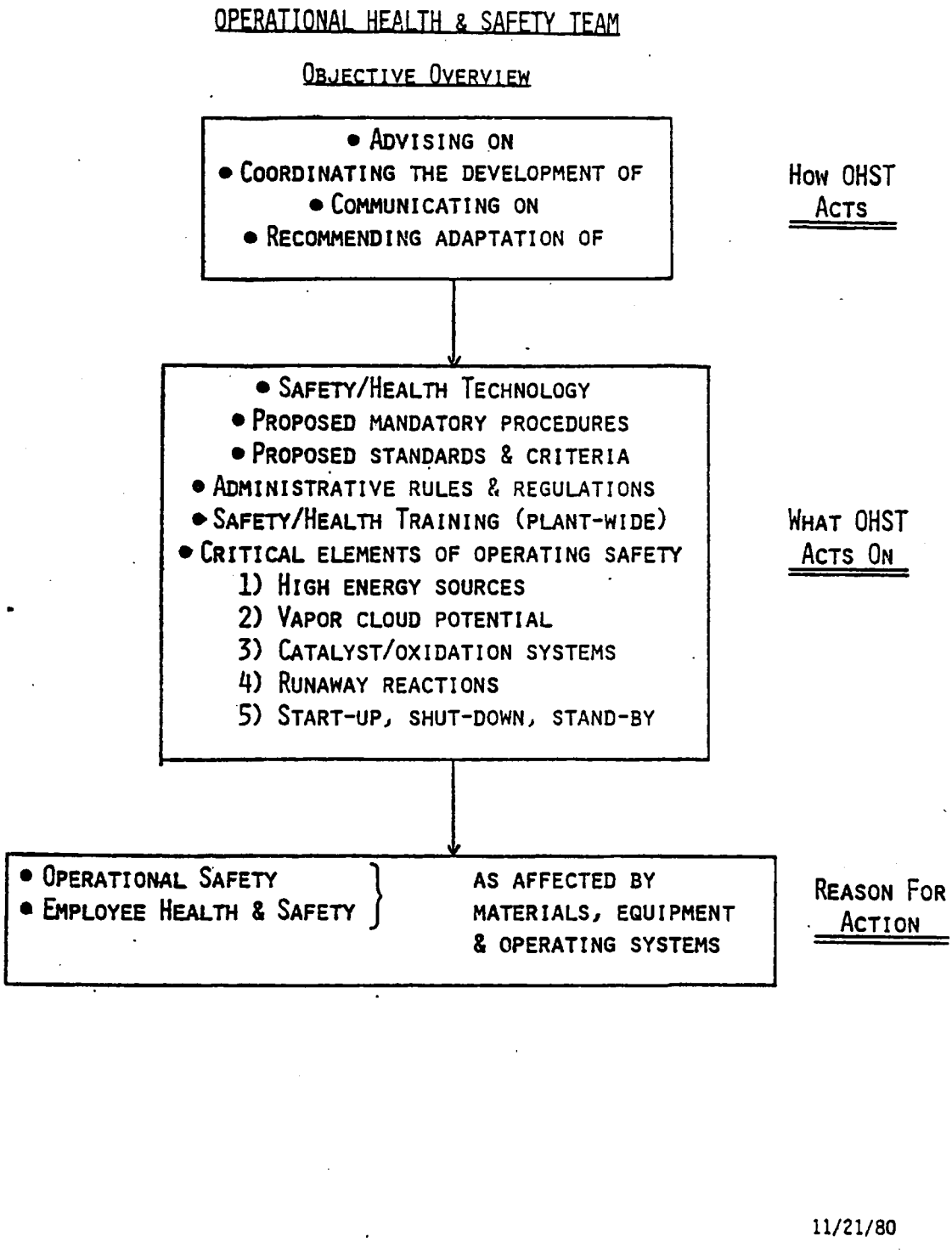


FIGURE 6 Role of the Operational Health and Safety Team

discussions and condense it into a readable, workable, set of objectives and standards for the committee. This document, presented as Appendix E, was adopted by the committee and became its charter.

The culmination of the project occurred when the intern was asked to accompany Mr. Knight to a plant managers' meeting, at which the results of this work were presented to Plant Management for consideration and approval. This was a rare opportunity, afforded to few junior members of the organization, to witness the activities of senior level management. The visit was especially satisfying because the proposals made at the meeting were eventually approved.

This project, which encompassed several months of staff work and meetings, was a valuable learning experience. It was an opportunity to see senior managers in action and to be seen by them. It was also a chance to work at the top of the organization and look down on it from above. This is precisely the type of activity which makes the D.E. Internship a unique experience.

An excellent opportunity to gain exposure to top level management occurred when the intern was able to attend the "State of the Division" presentation given by Solvents and Intermediates Division President Loy A. Wilkinson to Texas City exempt employees in mid January. It was interesting to get top management's view of current conditions in the business world and to obtain some insight into the thought processes which occur at the top.

General Orientation

Two major orientation activities of a general nature occurred

during the internship and they will be reported upon here. The first was a one-day New Hire Orientation Conference and the second was a one-week visit to the extensive Carbide facilities in and around South Charleston, West Virginia.

The New Hire Orientation Conference, which takes place in the plant each year, features speakers from some twenty-four plant organizations who present a brief overview of their particular group. Such subjects as the group's composition, function, assets, and primary output were covered. The conference was an excellent vehicle for gaining an appreciation of the scope of activities carried out in the plant. Examples of groups heard from include employee relations, health services, IPAC, accounting, the laboratory, maintenance, and the production units.

One of the highlights of the internship was the one-week trip to South Charleston, West Virginia. In that immediate area, Union Carbide has two chemical plants, each of which is the approximate size of the Texas City plant. Also located there is the Union Carbide Technical Center which is a massive complex housing research and development facilities, sophisticated engineering groups of all kinds, and extensive computer facilities. In addition, headquartered in this same general area, known as the Kanawha Valley, are numerous staff groups which render support and assistance to Carbide locations throughout the United States.

The purpose of the intern's visit to the Kanawha Valley was twofold: to study the vendor stocking programs being developed there and to become acquainted with some of the people and facilities at

this huge Carbide nerve center.

Vendor stocking program development was a significant part of the major Materials Management project reported on in Section Three. It was interesting to be able to visit people who were in the process of developing similar programs and to compare and contrast progress they were making with that being made at Texas City. It was a productive visit resulting in a position paper on vendor stocking which will be presented in Section Three.

Perhaps an even more rewarding aspect of the Kanawha Valley trip was the opportunity to gain an appreciation for the vast resources of the corporation. During the week, the intern was able to visit most of the major facilities albeit only very briefly in many cases.

Since the Materials Systems and Services Group was the main host of the trip, more time was spent in its areas of responsibility. One high point was a meeting with the Materials Systems and Services Manager, Mr. R. O. Spencer. Other stops on the trip included the Kanawha Valley Purchasing Group, the Management Information Systems Group, the Technical Center Industrial Engineering Group, Materials Systems Data Processing, Invoice Auditing, and the Materials Management Department at the Institute, West Virginia chemical plant.

This trip provided a great deal of perspective for the overall study of the organization and how each piece fits into the whole. It was fortunate that the trip came toward the end of the internship when the plant organization was fairly familiar. It tended to shift the focus of the "study of the organization" from the plant organization to the corporate organization and to tie together much of what had

been learned previously. It was an extremely rewarding and worthwhile educational experience.

Summary

Section One has documented the study, orientation activities, and minor projects carried out during the internship which have provided the intern with an understanding of the various parts of the organization and how they interact with each other and with the external environment to produce results. It has thus been demonstrated that Critical Objective I has been satisfied.

The opportunity to study the organization in detail and how its various components contribute to the whole is, in some respects, the most important feature of the Doctor of Engineering Internship. Certainly the orientation tours and projects serve to create a clear distinction between the internship and a conventional job. They constitute a unique opportunity for the intern which would be difficult to duplicate, and provide a richness to the internship experience which, in itself, makes the internship worthwhile.

In Section Two, activities related to the development of interpersonal and management skills are discussed. The intent is to show that Critical Objective II has been met.

SECTION TWO

Critical Objective II: Take every opportunity to develop interpersonal and management skills.

A body of knowledge which is difficult to pursue within the confines of the formal education process is the one associated with the development and practice of interpersonal and management skills. However, the Doctor of Engineering Internship is particularly well suited for this purpose. It affords the intern the opportunity to observe professional managers in action. It can also provide a chance for the intern to practice and develop his own personal management skills. Accordingly, it was resolved that the intern should take full advantage of every opportunity for growth in this area.

The purpose of this section is to present those activities carried out during the internship which provided the intern with an opportunity to develop his own interpersonal and management skills. Some of these activities consisted of actual participation, while others involved observation of others.

Union Carbide Management System

The Union Carbide Management System or UCMS is used extensively by managers at all levels of the company. It was encountered by the intern in the first week of internship during the beginning of the first major project. It became immediately clear that the ability

to follow the techniques and talk the language of the UCMS was an important step in becoming an effective, contributing member of the organization. Consequently, it was resolved to develop this ability as soon as possible.

Publications on the subject were obtained for self study and this, coupled with conversations involving the Internship Supervisor and other managers, provided a sound basis in the principles of the UCMS. During the fifth month of internship, the opportunity to attend a two-day formal UCMS training program was made available. This course further solidified the intern's understanding of and ability to use the techniques of the UCMS.

Study revealed that the UCMS is not a particularly exotic or revolutionary program but rather is founded on the well-known functional approach to management involving the four major management functions: planning, organizing, directing, and controlling. The basic principles of this approach were quite familiar from earlier coursework.

Also included in the UCMS is an orderly problem solving technique which was found to be a useful framework for approaching a difficult problem or project. Closely resembling what was previously known by the intern as the engineering approach to problem solving, the UCMS involves the careful setting of objectives and developing standards with which to measure how well the objectives have been met. It includes the examination of alternatives and selection of the best alternative. The main feature which made the system unique is the distinctive set of vocabulary which has developed around it.

An understanding of this vocabulary was particularly important in daily dealings with people at all levels of the organization.

While not revolutionary, the UCMS problem solving technique is effective. It was used during all three major projects, for some smaller assignments, and in the development of the final set of objectives for this internship. Learning and using the UCMS was an interesting and rewarding experience.

Manager Observation/Interaction

Another beneficial activity in connection with the development of interpersonal and management skills was carefully observing the organization's managers in action and having informal conversations with them about managing the various resources they had available. While this activity is difficult to document, it was nevertheless one of the most valuable and meaningful learning experiences during the internship.

The intern and the Internship Supervisor established the practice of meeting every Friday. At these meetings, in addition to the progress of the internship, many other topics were discussed. These related to the structure of the organization, individuals within the organization, methods for dealing with people, management styles, and other similar subjects. A fine rapport developed which resulted in open, frank discussions. This relationship was conducive to learning and was probably the key to the overall success of the internship.

Additionally, the intern was careful to be alert at all times

for the opportunity to observe managers in action. Special notice was taken of management styles, and of techniques for handling different situations. One-on-one discussions involving the organization and the philosophy of management were held whenever possible. Some techniques were seen to work for some, while not for others. Different situations often seemed to call for different styles of management from the same individual. It was most interesting to compare the traits of ineffective managers with those of effective ones.

Business Meetings

Among the managers at Carbide, the business meeting is a common feature of almost every business day. It is easy to recognize the fact that the ability to conduct an effective business meeting is a fundamental skill that every aspiring manager must learn.

The intern had little choice but to develop this skill as rapidly as possible. During the third day of internship, he was asked to chair a start-up meeting concerning the vendor stocking project. In this meeting were people from different parts of the plant, and all knew more about the subject of the meeting than its chairman. This technique of learning, called the sink or swim technique, was rather frightening but worked out well in the end.

Since the importance of business meetings was established very early in the internship, it was resolved to attend as many meetings as possible and to develop the ability to conduct effective meetings. Staff meetings of the Equipment Reliability Group and the Materials

Management Department were attended. The weekly meetings of the Maintenance Second Line Supervisors were visited regularly for several months. Later in the internship, a Plant Managers' meeting was observed. Numerous other diverse meetings were attended when the opportunity arose. The attendance of these meetings not only helped to develop a feel for the characteristics of a good meeting, it also provided a valuable insight into the events taking place throughout the plant.

From the observation of the various meetings, some of the keys to conducting an effective meeting became apparent. The most important factor was seen to be preliminary preparation by the chairman and the creation of a thoughtful pre-published agenda. During the meeting, it is important to have a comfortable, well ventilated place to work. It is essential to keep the meeting moving, to avoid being led off the subject or having the meeting dominated by one forceful person, and to follow the agenda as closely as possible. The best meeting is short, concise, and to the point.

The intern organized and chaired numerous business meetings in connection with each of the three major projects discussed in Section Three. Most of these meetings included experienced people from many different plant groups. As the internship progressed, the chairing of these meetings became a pleasurable experience and a source of pride.

A major quarterly meeting in which the intern took part four times was the Materials Management Department Quarterly Results Review (QRR). This meeting is chaired by the Materials Manager and

is held at the end of each quarter to present senior management representatives, from both the plant organization and the Corporate Headquarters in New York, with the highlights of departmental activities during the quarter. At the first of these QRR's, the intern presented the objectives and action plans associated with the vendor stocking and inventory reduction projects. The second through fourth presentations consisted of update reports on the progress of the project. Appendix F is an outline of the intern's presentation at the second of these meetings.

Another major meeting which the intern regularly attended was the Maintenance Department Awareness Program (DAP) meeting held each month. This meeting, attended by all exempt maintenance personnel, was used as a communications tool by departmental managers. A typical agenda included such topics as safety, new or recently altered plant regulations, department policy, and informational items of general interest.

The intern was invited to make a presentation on work sampling to the one hundred or so maintenance personnel present at the December DAP meeting. This subject was of particular interest because the intern's Marine Terminal work sampling study was being conducted at that time. An outline of the DAP work sampling presentation is presented in Appendix G.

Conducting and participating in business meetings is an important part of the manager's day. For the intern, this activity was not only a skill to be learned, it was also a vehicle with which to gain exposure to many key people in the plant and to observe various components

of the organization in action.

Interaction Management Program

Development of supervisor interpersonal skills seems to be of much concern to Carbide management. A number of training programs are available which are designed to meet the needs of all levels of supervision, from first-line supervisor to department head.

The cornerstone of the supervisory training effort is the Interaction Management Program. This training package was purchased by Carbide from Development Dimensions International of Pittsburgh, Pennsylvania. It is given at the first opportunity to newly selected first-line supervisors and technical/professional new hires.

The intern was very fortunate to have the opportunity to attend the Interaction Management four-day course. The training was practice oriented and involved the utilization of simple key principles to guide the supervisor in handling the common interpersonal situations he encounters each day. Figure 7 lists the three Interaction Management Key Principles. Also shown are the ten training modules covered in the four-day course.

It is felt that the Interaction Management training was well conceived, exceedingly practical, and personally rewarding. It is certainly a valuable addition to anyone's set of interpersonal skills.

Interaction Management Training

A. Key Principles

1. Maintain or enhance the employee's self-esteem
2. Listen and respond to the employee with empathy
3. Ask the employee for help in solving the problem

B. Modules Covered

1. Improving employee performance
2. Improving work habits
3. Maintaining improved performance
4. Utilizing effective follow-up action
5. Utilizing effective disciplinary action
6. Improving attendance
7. Delegating responsibility
8. Motivating the average performer
9. Handling employee complaints
10. Overcoming resistance to change

FIGURE 7 Interaction Management Training

First-Line Supervisor

During the Christmas holidays, the intern was asked to serve as a vacation relief supervisor in the Stores Department on two occasions lasting one week each. These two brief stints provided the chance to actually practice supervisory interpersonal skills and to develop some insight into the daily problems faced by the key individuals known as first-line supervisors.

The two supervisory jobs came in the seventh month of internship, after the intern had been working in the materials management area for some time and was reasonably familiar with the stores operation. The first supervisory relief tour was served in the Plant Receiving Department. The second tour involved serving as the supervisor of Bulk Stores, Investment Recovery and the Tool Room. Each of these activities entailed the supervision of ten to fifteen stores personnel, and one or two leadmen, in the performance of routine stores functions. The intern's immediate supervisor during this assignment was Mr. J. L. Christensen, Materials Area Superintendent.

The job of first-line supervisor was found to be a critical one. He, perhaps more than anyone else, must balance the needs of the organization against the demands of the union. He can be the cause of a problem or the key to the solution, depending upon his initial reaction. The first-line supervisor is the heart of management and a vital element in labor relations and the productivity of the organization.

This particular internship activity was worthwhile for several reasons. It allowed the intern to fill a legitimate need of the organization by standing in for absent supervisors. It promoted a better understanding of the materials management function. It provided both insight into the role of the first-line supervisor and an opportunity to develop supervisory interpersonal skills. Finally, it supplied the intern with his sole opportunity during the internship to serve in a line function.

Interviewing New-Hire Candidates

The Texas City plant conducted plant visits for a large number of college seniors majoring in engineering during the December-January semester break. The purpose of these visits was to identify candidates to fill the twenty to twenty-five vacancies for entry level engineers existing in the plant.

It was not uncommon during this period for the intern to be invited to lunch with the visiting new-hire candidate and his plant host, particularly if the candidate was an industrial engineer. On three occasions the intern was requested to serve as one of the interviewers of a visiting candidate. This involved conducting a thirty minute interview of the candidate and completing the standard Carbide interview forms which were then forwarded to the appropriate Assistant Plant Manager for review. The APM also interviewed the candidate. Based on this interview and the evaluations submitted to him by the other interviewers, the APM made a decision as to whether or not the candidate would receive an offer.

Seeing the plant visit from the company's side of the table was a new and illuminating experience. It was also interesting to converse with the upcoming graduates and listen to their goals and expectations.

Other Interactions/Communications Activities

Numerous other internship activities contributed to the development of interpersonal and management skills. Interactions with many different people about a myriad of subjects took place each day. This was especially true during the purchasing assignment when sensitive conversations with vendors sometimes occurred regarding substandard performance, contractual requirements, and the like. The experienced buyers were available for consultation whenever a difficult question arose in this area.

A great deal of practice was gained in composing memoranda, letters and reports, as this was an almost daily requirement. Examples of these can be found in the Appendices. The intern was fortunate to occasionally receive feedback on how the various forms of written communication could be made more effective.

One rather unique activity involving the development of interpersonal skills was the making of a short video tape. The tape is a brief overview of the Texas City Plant and the various internship activities documented in this report. It is meant to serve as an introduction to the oral presentation of this internship.

The script for the tape was written by the intern. The tape was filmed and edited in the small plant television studio by Carbide

cameraman Walter Kline. Mr. Kline is the creator of many valuable training tapes which are used throughout the plant.

Being on television is a singular experience which can be difficult for the uninitiated. The intern was fortunate to have been previously interviewed on tape at the campus studios of KAMU-TV during an exercise sponsored by the Doctor of Engineering seminar (Engr-681). This exercise experience proved to be a great help in making the internship tape.

Annual Performance Appraisal

The culmination of internship activities dealing with the development of interpersonal and management skills came near the end of the internship when the intern was given an Annual Performance Appraisal (APA) by the Internship Supervisor. The APA is an annual evaluation, counseling, and career development session given to all professional Carbide employees. In the intern's case, inputs were solicited from a number of senior managers with whom significant contact had been made over the course of the internship. These included an Assistant Plant Manager, the Superintendent of Maintenance and several department heads.

At the APA session itself, performance over the previous year is discussed in light of previously established goals and objectives. Also covered are suggestions for improvement, career development, and long range objectives. The APA is a valuable personal development tool. The intern was fortunate to have had the opportunity to participate in this beneficial program.

Summary

Section Two has documented internship activities which have resulted in significant growth and development of the author's interpersonal and management skills. Thus, Critical Objective II has been satisfied.

The internship's personal and professional development activities are especially significant when their quality and quantity are considered. It is felt that few conventional jobs could offer comparable breadth and depth of experience in such a short time.

In Section Three, major internship projects, which resulted in significant contributions to the organization, will be presented. The intent is to show that Critical Objective III has been met.

SECTION THREE

Critical Objective III: Using the information gained in the previous objectives, make an identifiable contribution to one or more particular projects.

The true measure of an intern's experience, education, and preparation is the extent to which he is able to make an identifiable contribution in an area of practical concern to the internship organization. This section documents contributions made by the intern to the three major projects on which he was assigned to work during the internship.

The three projects to be discussed deal with materials management, industrial hygiene, and field maintenance engineering. These three projects ran simultaneously during much of the internship. It should also be noted that the project work ran concurrently with the various other activities covered in Sections One and Two.

Materials Management Project

The materials management project was the first project assigned and had the longest duration of the major projects. During this project, the intern was under the functional supervision of Mr. J. L. Glass, the Materials Manager. Administrative supervision remained with the Internship Supervisor, just as it did for all activities undertaken during the internship.

The essence of the materials management project was working in

various ways to reduce or reverse the tremendous increases which had been taking place in maintenance, repairs, and operating (MRO) inventory. Some urgency was involved because the Materials Management Department had made a commitment to finish calendar 1980 with the same MRO inventory dollar value that was on hand at the end of 1979.

Figure 8 illustrates the situation which existed at the beginning of this project. At the top of the figure, the 1979 year-end inventory is given as $13.78 million. By the end of May 1980 this had already grown to $14.34 million. Projected growth at that rate gave a 1980 year-end estimate of $15.13 million. The goal of the project was to finish 1980, not with $15.13 million as projected, but $13.78 million, the 1979 figure.

The bottom of Figure 8 shows how this goal was to be accomplished. As seen in the Total for Year column, reductions of some $1.2 million were needed to offset the projected and unavoidable growth due to inflation, new items being placed in stock, and quantity on hand change.

Three methods were to be used to effect the needed reductions: terminations, the reduced amount to order (RATO) program, and vendor stocking programs. The terminations effort involved the use of an experienced machinist to track down obsolete spare parts still being carried in inventory. RATO was an arbitrary fifteen percent across the board reduction in the amount to order calculated by the computer. Vendor stocking programs were the part of the project for which the intern was responsible. As shown in Figure 8, an ambitious objective of achieving a $500,000 inventory reduction by December 31, 1980, was

TEXAS CITY MRO INVENTORY

M$

1979 Year-End Inventory	13,778
Inventory as of 5/31/80	14,341
1980 Year-End Inventory Projection (No Action Plans)	15,134
1980 Year-End Inventory Goal	13,778

Steps to Achieve Zero Inventory Growth During 1980

	Total For Year	Total for Second Half
New Items	225	135
Terminations (Includes Tech. Obsol.)	- 300	- 165
Inflation	400	222
Quantity on Hand Change	575	145
Reduced Amount to Order (RATO)	- 400	- 400
Vendor Stocking Programs	- 500	- 500
Net Inventory Change	-0-	- 563

Figure 8 Texas City MRO Inventory Status and Goals

established for vendor stocking programs or VSP's.

The intern was assigned to this project on the first day of internship. Two days later, the first of many VSP meetings was convened. It included the key materials management people who worked with the intern throughout the course of the project. This group typically consisted of the Materials Area Superintendent and his three first-line supervisors, the Plant Purchasing Agent, a representative from the Regional Materials Management Technical Services group, and the intern. One or more buyers from Plant Purchasing and Regional Purchasing were often in attendance along with an Employee Relations representative, and various inventory users from throughout the plant.

The initial meeting of this group considered the objectives to be pursued and began working on action plans to meet these objectives, always with the December 1980 deadline in mind. The emphasis in the beginning was on inaugurating one or more successful vendor stocking programs.

Under a VSP, an agreement is made with the vendor that he will dedicate a specific amount of his inventory to fill the needs of the buyer's plant. However, this material will not be delivered until the need arises. The advantage is that large amounts of contingency inventory do not have to be carried in the company warehouse where they contribute to overhead. Instead, only that material which is needed immediately is purchased. The brunt of the carrying cost is borne by the vendor. This plan also results in newer material, fewer losses due to pilferage and aging (rusting, cracking, drying out), and

less storage space required. The vendor usually receives a longer term contract and some assurance of a stable, long-term relationship with a substantial customer. If the vendor has efficient inventory control, his additional inventory burden will be minimal.

As time went on, the groundwork was laid for the inauguration of the first VSP commodity, which was lumber. It was a complex task to formulate the many purchasing procedures such as requisitioning, releasing, receiving and delivery. It was also necessary to incorporate a new form and conduct training in its use. Vendors had to be qualified, bids received, a contract awarded, and procedures worked out with the selected vendor.

By the end of August, the preparations were completed and lumber was placed in the VSP. At this writing the lumber VSP is still operating and the inventory of lumber has stabilized at about five percent of its former value.

In January, another commodity, janitorial supplies, was also placed in the VSP and it has also been successful. Both of these VSP efforts have resulted in low inventories while retaining excellent service.

Fairly early on, however, the VSP group realized that, in light of the many complexities involved in setting up a completely new program like VSP, it was not going to be possible to meet the December 31, 1980, inventory reduction goal using VSP alone. Therefore, other methods were sought. The two other approaches adopted were the less stock approach and the disposal of certain parts which were grossly overstocked.

Both of these supplementary approaches were enthusiastically pursued by the group. The less stock or vendor meeting approach, as it was sometimes called, was particularly successful.

Complete details of the VSP group's activities, including the VSP and less stock programs, are given in Appendix H. This is a VSP/less stock situation report, written near the end of the internship period, to document for management the actions taken with regard to less stock and vendor stocking. It describes the current status of these programs at Texas City and makes some recommendations regarding future actions needed to enhance these programs. It also includes a discussion of current limitations to program growth. This paper was written after the Kanawha Valley trip and it contains some comparisons to programs seen there.

Appendix I presents an excess parts disposal proposal made by the intern to the Materials Manager. This illustrates one of the inventory reduction approaches taken to supplement progress made under the VSP. In this example, the intern worked through a regional buyer, Mr. D. J. Hymel, to locate a potential buyer for excess safety valve parts. Once a buyer was found, a formal disposal proposal was submitted to the Materials Manager for approval. Some of these proposals were approved and some were not, depending upon long range planning judgements made by upper level managers. This approach resulted in the successful disposal of a number of excess inventory items, most notably electrical cable and flanges.

Appendix J is the intern's report to the Internship Supervisor which describes the year-end inventory reduction results. While the

VSP group did not achieve its ambitious goal of attaining a $500,000 reduction in inventory, it did achieve a permanent $225,000 reduction. With Carbide's holding cost of thirty percent per year, this amounts to a $67,500 recurring annual savings.

Management was pleased with the final results which are shown in Enclosure 1 to Appendix J-1. The Texas City plant realized only a 2.8 percent increase in inventory during 1980 as compared to a 9.8 percent mean increase for eleven sister plants. These results and the contributions made by the VSP group were particularly well received by the corporate materials management representative who attended the Fourth Quarter Plant Materials Management Results Review (QRR). Much interest was also expressed in the two pilot VSP commodities set up by the group. It is expected that this concept will now continue to grow at Texas City. At the close of the internship, preliminary work was being initiated to place steel plate and shapes on VSP.

The role of the intern in this project could be described as the project manager, the action person or focal point for inventory reduction activities. As time went on, people with questions, problems, or suggestions relating to inventory reduction began to recognize the intern as the one to see.

This project required knowledge of a fairly broad range of subjects, and was thus particularly well suited for a Doctor of Engineering internship project. An understanding of the basic principles of inventory control was necessary, along with some knowledge of Carbide's particular system. Figure 9 is a schematic of Carbide's stores and acquisition system. It is similar to the

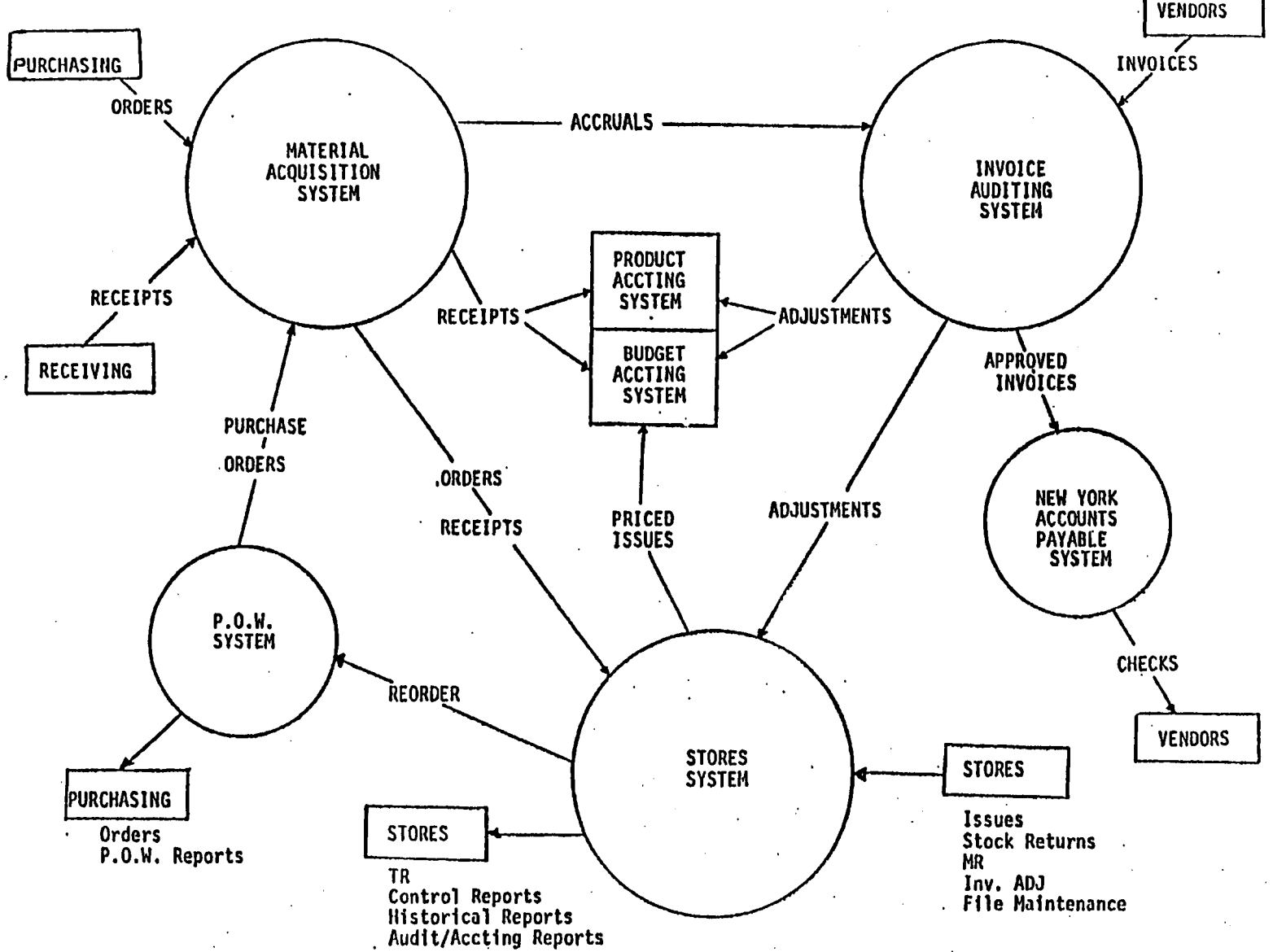


FIGURE 9 Stores and Acquisition System

standard computer system covered in Production and Inventory Control (IEn-615). Also helpful on the project was a basic knowledge of data processing, accounting, engineering economy, and the principles of management and interpersonal relations.

Labor relations played a major role in this project, particularly in the setting up of the new VSP commodities. As pointed out in Appendix H, labor relations considerations must be among the major concerns of the VSP planner. Again, previous training served the intern well in this area.

Probably the most valuable aspect of the materials management project was the opportunity to manage a group of diverse people in an effort to reach a common goal. Such a task requires one to call upon all his education and experience, both technical and non-technical. The successful completion of this project was extremely satisfying. It is difficult to imagine a project better suited to a Doctor of Engineering internship.

Industrial Hygiene Project

The industrial hygiene project is actually composed of three projects: two relatively minor tasks and one fairly substantial assignment. Interest in seeking some form of involvement in the area of industrial hygiene was kindled by previous coursework (S.Eng-680, Industrial Hygiene) in this field. This interest was reinforced early in the internship as industrial hygiene was found to be a particularly important activity at a chemical plant.

The Texas City Industrial Hygiene group is a very active

organization. However, the various individual managers are also genuinely concerned with industrial health considerations and often seize the initiative themselves. Usually, once a problem is identified by the Industrial Hygiene group, the individual managers take charge of finding a remedy. In fact, all three of the industrial hygiene projects reported on here were assigned to the intern by the Internship Supervisor, who saw them as legitimate concerns in his area of responsibility in the Maintenance Department. Of course the Industrial Hygiene group maintained its role as consultant and expert in the field and made judgements as to the acceptability of proposed solutions to industrial hygiene problems.

The three projects to be covered in this report deal with hearing protection, lead exposures for fertile females, and carbon monoxide monitoring. All three projects involve activities carried on in the Maintenance Department.

Hearing Protection

The hearing protection project was an assignment to determine what action should be taken with regard to a noise level survey conducted in several Maintenance Department shops by the Industrial Hygiene group. This survey indicated there were instances of inadequate hearing protection and lack of proper warning signs in the areas surrounding certain pieces of noisy machinery.

Specifically, this survey found that some employees were not being required to wear protective devices in areas where noise levels

exceeded the 90 dBA** maximum set by government and plant regulations. Further, in many of these instances, proper "Hearing Protection Required" signs were not posted.

The approach to this assignment was to visit all of the areas cited in the survey, observe the equipment and its surroundings, and talk to the supervisors and employees involved. This investigation revealed several pertinent facts: 1) awareness of noise hazards and supervisory concern was high in some shops and very low in others, 2) machines were often in close proximity to one another and to other work areas, thus the noise from one machine could affect the operators of several others, and 3) some of the offending equipment was portable and used in many different areas.

These findings led to the conclusion that the solution to this problem was not a simple one such as affixing a caution sign or warning a supervisor. Instead it was seen as a people problem involving a need for genuine supervisory concern and awareness, and general education of all shop employees.

Appendix K is the author's report to the Internship Supervisor which describes the situation and makes recommendations for resolution of the problem. In general, these recommendations were implemented.

**A decibel (abbreviated dB) is a unit of measure of sound intensity or pressure change on the ear. Weighting networks labeled A, B, and C on most sound pressure-level meters correspond roughly to human ear response at low, moderate, and high noise levels, respectively. The A network readings have been well correlated with noise induced hearing loss in man and, therefore, are most widely used. dBA then refers to the overall sound pressure level in decibels measured with A weighting.

A second survey was not taken by Industrial Hygiene but it is felt that employee exposure to excessive noise levels was greatly reduced.

Female Lead Exposures

There are a number of areas in the plant where it is possible to encounter some exposure to lead, such as the lead shop, the paint shop, and the sandblast shop. While such exposures should be minimized for all employees, it is particularly important to minimize, or prevent altogether, any exposure of fertile females to lead. This is due to the potential harm which lead could cause an unborn fetus being carried by a female worker.

The Occupational Safety and Health Administration (OSHA) makes no distinction between fertile females and other employees in setting the threshold limit value (TLV) for lead at 50 mg/m^3 for an eight hour time-weighted average. However, Union Carbide has gone further. The Texas City plant's Fetal Protection Policy restricts fertile females from any exposure to lead. At the same time, areas containing lead concentrations are being cleaned up wherever possible to obviate the need for restrictions on anyone.

It came to the attention of the Internship Supervisor that certain females among the Contract Services group might be getting exposed to lead in some of his shops. Consequently, he assigned the intern to investigate the matter and make a report of findings and recommendations.

Appendix L is the required report. Essentially, the investigation revealed that some fertile females who were members of the Contract Services janitorial staff were working in areas where

exposure to lead was possible. It was also discovered that certain female Carbide engineers were entering the areas in question. Therefore, in accordance with current plant policies, it was recommended that immediate action be taken to eliminate the possibility of any fertile females becoming exposed to lead, regardless of her work unit. This was done.

Carbide Monoxide Monitoring Project

During certain plant operations, such as the sandblasting of piperacks, it is necessary for a worker to wear a hood, which is supplied with breathing air by a portable air compressor. If the portable compressor is of the oil-lubricated type, there is a possibility that, should overheating of the compressor occur, some of the lubricating oil will be decomposed. One of the substances formed during such a chemical reaction is carbon monoxide or CO.

CO is a colorless, odorless, tasteless gas which interfers with the transport of oxygen by the blood to the body's cells. The ultimate effect of contact with CO is death by asphyxiation; however, a gradual onset of unsteadiness followed by collapse characterizes the early symptoms.

The danger to a sandblaster working fifteen to thirty feet above the ground in piperacks is not death by asphyxiation. The danger is that even a relatively small amount of CO introduced into the worker's breathing hood could result in enough unsteadiness to produce a serious or even fatal fall.

During much of the internship, the Internship Supervisor had

responsibility for the paint shop, which routinely uses portable air compressors to supply breathing air during sandblasting operations. When the potential hazards of this operation were reported by the Industrial Hygiene group, a meeting was held to develop an action plan to address the problem. Appendix M presents that action plan, which assigns the intern the task of designing a continuous carbon monoxide monitoring system for all oil-lubricated compressors used to supply breathing air.

Most of the oil-lubricated compressors were fitted with high temperature alarms. However, it was felt that these were not sufficiently sensitive or reliable for personnel protection. While OSHA standards only specify "frequent sampling" of breathing air produced by these compressors, it was Carbide Texas City's judgement that only a continuous monitoring system would provide adequate protection for personnel.

Working with a technician from the instrument group, the intern investigated the various types of CO monitors on the market. Most of these were designed for fixed installation and required AC power. Many were much too heavy for portable applications. It was decided that the whole unit should weigh fifty pounds or less (the maximum one man is allowed to carry in the plant).

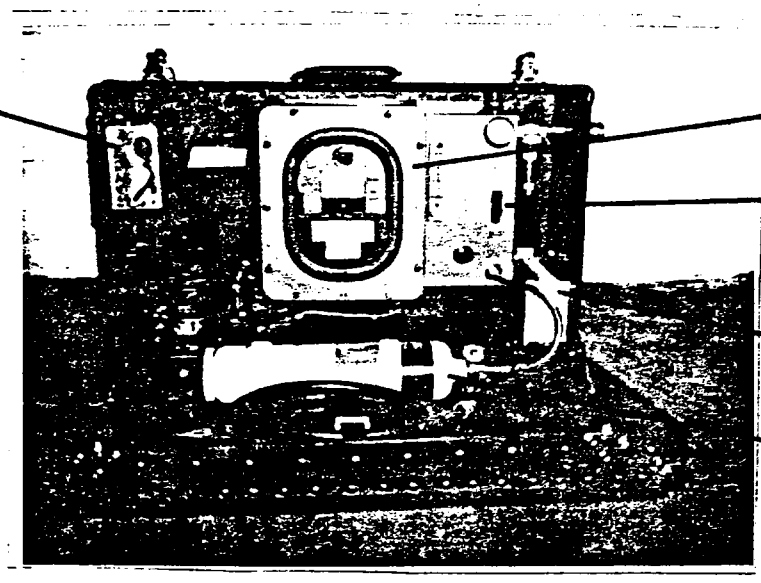
The compressors were found to possess DC electrical systems, and each unit had its own peculiarities with regard to wiring. This situation made the AC monitors an unattractive choice since inverters (to convert DC to AC) would need to be fitted to each compressor. The peculiar wiring setup of the various compressors also made the DC

monitors seem a poor alternative since a different modification would have to be designed for each individual compressor. It was decided, therefore, that the most desirable design for the CO monitor would call for a rechargeable battery power source. This would eliminate the need to interface with the electrical systems of the individual compressors. Accordingly, rough specifications were developed and the search began for a suitable unit.

Through contacts with various vendors and talking with other plants, a monitor which might satisfy the requirements was located. This was the Ecolyzer Model 4120. Working with the vendor, Vallen Corporation of Houston, and the plant Instrument Group, a portable CO monitor package that would meet plant needs was designed.

Figure 10 presents a listing of the final specifications for the CO monitor unit. Also shown is a picture of the actual unit as delivered to the Texas City plant. The unit weighs only forty pounds and is powered by a rechargeable gell cell battery capable of about three-hundred hours of operation between charges. A small battery charger is included. A 97 dBA alarm rings if the preset concentration of CO is reached in the breathing air line. A pressure regulator and flow regulator adapt incoming air to the monitor's requirements. As an added safety feature, a warning beeper sounds, should the battery go below ten volts. The whole unit is arranged compactly in a suitcase which can be carried by one man. Other than the air hookup, no other connection is required.

The unit's battery would normally be recharged at night. On a typical morning, the unit is disconnected from the charger and



UNION CARBIDE CORPORATION SPECIFICATIONS FOR PORTABLE CO MONITOR

A. MONITOR: ECOLYZER MODEL 4120 - Inline CO Monitor. (4930F Sensor)

B. KIT: 1) Dimensions 9" Wide
15" High
25" Long
40 lbs. (approx)

2) Components:

a. Battery - 12 v 6ah Gell Cell PS 1260 - Power Sonic

b. Charger - 13.5 - 14.7 v at .50/.60 amp automatic dual range PSC 12500A

c. Audible Alarm - Model 450 12 v 97 dBA at 10 ft.

d. Pressure Regulator with calibration gas cylinder

e. Low Battery alarm system with warning beeper

f. 10 feet of connecting hose

FIGURE 10 Carbon Monoxide Monitor Illustration and Specifications

transported to the work site. Once the compressor is started and stabilized, the monitor is hooked to a T-fitting in the hood air line. The pressure and flow are adjusted. The monitor is then ready for the day's work.

Following delivery of the two monitors ordered, a successful field test was conducted. The monitors were then presented to the paint shop for service.

Summary

The three industrial hygiene projects, reported upon here were interesting changes of pace from other internship activities. They required a basic knowledge of the principles of industrial hygiene as well as engineering design and project management. They also provided the opportunity to interact with, and thus learn about, various groups such as the Industrial Hygiene Group, the Instrument Group, Contract Services, the user shops, and outside vendors.

It is felt that the industrial hygiene projects were well suited to the internship's needs and objectives. It is also felt that they constituted a real contribution to the organization.

Field Maintenance Engineering Project

For maintenance purposes, the plant is subdivided into units called maintenance areas. Each maintenance area has an area superintendent who supervises the men and equipment which compose the maintenance assets for that area. Thus, when a maintenance job is to be done in a particular area, the area superintendent and his organization have primary responsibility for its completion.

One of the assets each area superintendent and the production units in his area have at their disposal is the Field Maintenance Engineering group. An engineer from this group is assigned to each of the plant maintenance areas. The duties of field maintenance engineers are many. Some examples would include providing reliability studies of machinery, specifying and coordinating repairs to equipment in a down status or troubleshooting systems requiring technical expertise, providing maintenance representation for capital projects, coordinating engineering activities for expense projects, and providing all types of technical support for the area supervisors.

Discussions with the Internship Supervisor concluded that an assignment involving field maintenance engineering would be a highly desirable and appropriate internship project. Accordingly, the Field Maintenance Engineering group leader, Mr. Bruce Rook, was approached about a possible project.

Mr. Rook had received several requests from the operations unit and the maintenance group at the Marine Terminal for some type of evaluation of the current utilization of maintenance assets at this facility. It was hoped that such an evaluation would produce recommendations which would result in more efficient and effective use of maintenance resources at the Terminal.

It was decided that this was an appropriate assignment for which the intern was qualified. The project was begun during the fourth month of internship.

As can be seen by the general statement of the problem above, the charge to the intern was a broad one. Very little additional

guidance was given other than to study the whole maintenance situation at the Marine Terminal and make recommendations which would lead to better maintenance asset utilization.

After a few preliminary visits to the Marine Terminal and discussions with the various principals involved, an approach to the problem was chosen. It was decided that the evaluation of maintenance activities at the Marine Terminal would be based upon work sampling and personal interviews and observations.

No further details of the study will be given here because the complete report, which was presented to management at the conclusion of this project, is included as Appendix N. This report includes a discussion of the background of the study, methodology, a presentation and interpretation of the findings, and detailed conclusions and recommendations.

The recommendations made in this report were implemented on a trial basis in March 1981. At the conclusion of the internship on May 15, 1981, the new procedures seemed to be working as planned. The Marine Terminal Maintenance Supervisor was pleased with the new arrangements. He reported a slightly decreasing backlog in work requests while operating with fewer craftsmen. He also felt he had greater control of his group and that it was working more efficiently and safely under the new recommended procedures.

About two months after the internship ended, in late June 1981, the intern learned that management had decided to implement the recommended changes at the Marine Terminal on a permanent basis. This decision was based not only on satisfaction with the new procedures

among the people directly involved, but also on a productivity improvement report (Appendix O) which shows that the new plan will result in an approximate recurring annual cost reduction of $224,420 per year.

This project was satisfying to the intern because it involved directly helping and working with people as opposed to manipulating inventory or designing devices. It was also rewarding because it was broad in scope and called for the type of experience and education found in the Doctor of Engineering Program.

Summary

Section Three has documented internship activities which resulted in significant and identifiable contributions to the internship organization. Thus, Critical Objective III has been met.

While the study of the organization and developmental activities reported in the first two sections were rewarding personally and professionally, a true feeling of satisfaction with the internship experience can only result when the intern has shown he can carry his own weight or pay his own way. So, in this sense, the success of the major internship projects as established in Section Three was the most gratifying aspect of the total internship experience.

SUMMARY

The ten and one-half month internship with Union Carbide Corporation's Texas City Plant, which is documented in this report, satisfies the internship requirement for the degree of Doctor of Engineering. Appendix P, the Internship Supervisor's final letter report to the chairman of the intern's advisory committee, confirms that the internship objectives have been met.

Personally, it is difficult to imagine a better internship. The intern was able to study and gain exposure to practically every part of the organization. The major projects were both challenging and rewarding. The positive, candid relationship that developed with the Internship Supervisor, Mr. Merlin D. Lindsey, helped to make the internship both productive professionally and enjoyable personally.

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APPENDICES

APPENDIX A

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES DIVISION P. O. BOX 671, TEXAS CITY, TEXAS 77590

October 20, 1980

TO: Joe Glass

SUBJECT: Consignment Buying

In some limited applications, consignment buying may have something to offer our inventory reduction program. Interestingly, though, our purchasing people tend to disagree with the article in terms of what applications would best lend themselves to consignment buying.

Whereas the article claims price breaks are to be expected, it is felt that premiums would actually be required in some commodities. Reasons for this are: 1) such a program hampers the vendor's turn on his inventory (which is where he makes his money), and 2) in these times the vendor would be reluctant to give a year's price protection without trying to protect himself in some way.

In our particular situation, we would immediately be faced with disposition of our considerable on-hand inventory. We would need new methods and procedures for dealing with the consignment material separately from regular stores material. We might also find ourselves faced with labor relations difficulties.

The consensus seems to be that such a plan might be workable for some speciality items. (This is counter to the article which says specials would not be suitable). In fact, we have a couple of modified consignment buying plans in effect at present (furnace tubing and copper specials) and they seem to be going well. Vendors are not so worried about inventory turn and price guarantees on specials. It is felt that a consignment type program is worthy of further study for certain other specials such as compressor parts.

Don Tippett

D. D. Tippett

A

APPENDIX B

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES DIVISION

P. O. BOX 471, TEXAS CITY, TEXAS 77590

TO (NAME) J. L. Christensen

COMPANY

LOCATION TEXAS CITY PLANT

DATE December 30, 1980

COPY TO
T. O. Blum
H. K. Decker
J. L. Glass
B. H. Hunter
J. S. Knight
M. D. Lindsey
S. F. Powe
B. G. Rook
R. J. Taylor

SUBJECT Pre-Startup Safety Review - Forklift Truck at Bldg. 63

A pre-startup safety review of the new forklift truck, Caterpillar - V50C, Serial #39Y00854 - (UCC Prop. #6809-27059) has been completed. The review included: applicable OSHA requirements, Exhibit "F" Lift Trucks - Check, and demonstration of the truck features.

The following deficiences were noted by the Review Team:

1) Two rear view mirrors should be mounted at the appropriate position on the forklift truck.

2) Load capacity chart should be highly visible for the truck operator. Recommendation: Capacity chart to be mounted on the fork main mast, in front of the operator.

3) Forklift truck must be equipped with a yellow flashing beacon, which should come on with the ignition.

4) Forklift truck must be equipped with 2 head and 2 tail lights.

5) Forklift truck should be equipped with backup alarm horn.

6) Hour meter on the truck should be repaired.

7) Operators should be made fully aware of the operating instructions of the machine.

The Review Team feels that, with the exception of Item Number 6, the seriousness of the above listed deficiences warrants keeping the machine out of service until each deficiency is corrected.

If there are any questions or comments to this review, please feel free to contact the team members.

Sincerely,

A. N. Jivan

A. N. Jivan

Don Tippett

D. Tippett

Bill Bratsen

B. Bratsen

/ir

APPENDIX C

UC 149-2

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES DIVISION

P. O. BOX 471, TEXAS CITY, TEXAS 77590

November 7, 1980

To: Mr. M. D. Lindsey

Subject: OPERATIONS SHIFT ORGANIZATION ORIENTATION (November 3-6, 1980)

Prior to my orientation tour with the Operations Shift Organization, the following objectives were established in accordance with our conversations:

1. Experience and understand the different organizational environment and modified responsibilities/line of authority which exist in the plant during after-hours shift work.

2. Gain a perspective with regard to the overall operations side of the plant in preparation for subsequent tours of duty with various operating units.

3. Develop a basic understanding of the function of the plant shift organization and the interface between shift/hourly operators and production day staff.

4. Be alert for any unique contractual issues which may exist with hourly operators such as safety, work practices, industrial hygiene, etc.

Having completed my scheduled four days with the Operations Shift Organization, my assessment is that the visit was highly informative and worthwhile and that each of the objectives was met.

Certainly I was able to experience the different organizational environment that exists in the plant after hours. While the operators remain responsible to the department heads and other day people in many ways, the after hours organization itself is greatly simplified and more straightforward. It is divorced from some of the administrative activities of the day time and more intent on just keeping the machines running properly.

One of the most interesting aspects of my visit was a conversation with a Shift Superintendent regarding labor/personnel matters. I discovered that operations has experienced problems in losing good people to maintenance and in adequately training operators. They share a number of operating problems with maintenance due to the common contractual restrictions on flexibility to manage.

I am confident I now have an adequate feel for the perspective of the operations side of the plant and will have no trouble putting future tours of duty with specific operations units in the proper context.

In summary, I was very impressed both by the machinery I observed and the people I met during my tour. The operators were extremely knowledgeable, enthusiastic about their jobs, and anxious to answer all my questions. The whole experience was a very positive one and a highlight of my internship to date.

Don Tippett

D. D. TIPPETT

DDT/lf

APPENDIX D

UC 149-2

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES DIVISION

P. O. BOX 471, TEXAS CITY, TEXAS 77590

November 20, 1980

To: Mr. M. D. Lindsey

Subject: ORIENTATION WITH NO. 3 OLEFINS UNIT (November 17-19; 1980)

The objective of my orientation tour with No. 3 Olefins was to select a specific operating unit and observe its operations and organization in greater detail than I was able to do during my earlier, more general tour with the Operations Shift Organization. Having now completed an informative visit with No. 3 Olefins, I believe this objective has been accomplished.

I saw a different picture of the operations side of the plant during my Olefins visit than I obtained during the earlier tour with the Shift Production Supervisors. I was able to explore the various relationships among day staff, hourly operators, and the Shift Organization. I had some interesting conversations with both departmental managers and hourly personnel about problems faced by the unit.

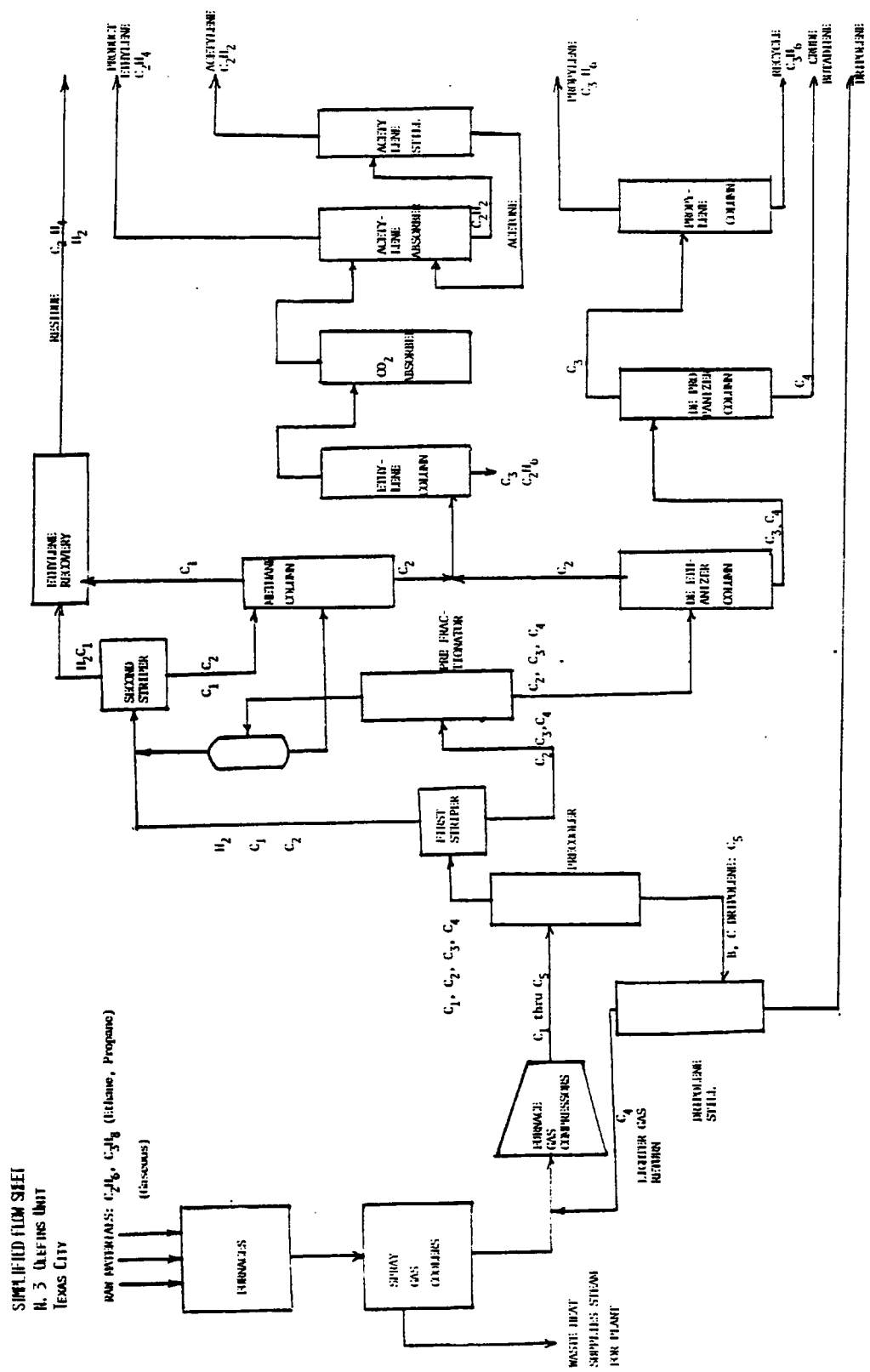
While at Olefins, I spent a good deal of my time outside in the unit with the outside operators. Using the enclosed schematic we first discussed what was happening in each piece of equipment, then went outside to observe it firsthand. I also was able to participate in lighting off several of the furnaces. This "hands on" time in the unit was particularly enjoyable.

In summary, I feel my time was well spent at No. 3 Olefins. I now have a much better feel for the operating units' position in the plant structure and a rudimentary knowledge of the machinery/processes used in an operating unit.

Don Tippett

D. D. TIPPETT

DDT/lf


SIMPLIFIED FLOW SHEET
N. 5 OLEFINS UNIT
TEXAS CITY
RAW MATERIALS: C_2H_6, C_3H_8 (Ethane, Propane)
(Gaseous)
FURNACES
WASTE HEAT STEAM SUPERHEATERS FOR PLANT
QUENCH GAS COOLERS
FURNACE GAS COMPRESSORS
C_1 thru C_5
C_1, C_2, C_3, C_4
H_2 C_1 C_2
FIRST STRIPPER
DEETHANIZER
C_2, C_3, C_4
PRE FRACTIONATOR
C_2, C_3, C_4
H_2, C_1
SECOND STRIPPER
C_1 C_2
METHANE REFRIGERATED CONDENSER
C_1
C_2
C_2
DEMETHANIZER
C_3, C_4
C_3
C_4
ETHYLENE RECOVERY
RESIDUE C_2H_4 H_2
ETHYLENE C_2H_4
ACETYLENE C_2H_2
ACETYLENE STILL
ACETYLENE ABSORBER
C_2H_2
ACETYLENE
CO_2 ABSORBER
ETHYLENE REFRIGERATED CONDENSER
C_3 C_2H_6
PROPYLENE REFRIGERATED CONDENSER
PROPYLENE C_3H_6
DEETHANIZER
DEPROPANIZER
C_3, C_4
C_4
RECYCLE C_3H_6
CRUDE BUTADIENE
BUTYLENE
DEBUTANIZER
C_5
B, C BUTADIENE
BUTADIENE STILL
HEATER GAS RETURN
C_4

APPENDIX E

OPERATIONAL HEALTH & SAFETY TEAM

Objectives & Standards

OBJECTIVES

1. To coordinate the operational health and safety aspects of the Texas City Plant Accident Prevention and Loss Control Program.

2. To provide advice for, make recommendations to, seek problem resolutions with, and serve as the communication link between the various Plant Health and Safety Teams.

STANDARDS

1.0 Membership

1.1 Chairman shall be a member of the PMH&SC.

1.2 The OHST shall have an organizational structure which adequately represents all segments of the Plant concerned with operational health and safety. (See Page III).

1.3 Each APM Area shall be represented at all times.

1.4 One-third of the OHST membership will be changed each year.

1.5 Each OHST member shall be responsible to provide an alternate in his/her absence.

2.0 Charters

2.1 The OHST Charter shall be reviewed during the fourth quarter of each year and updated as appropriate.

2.2 Permanent charters shall exist for all standing OHST subcommittees.

2.3 Proposed charters shall be provided as necessary to the PMH&SC, PH&ST and DAPC to assure compatibility and traceability of objectives.

2.4 Objectives, leadership, standards and a time table shall be provided for all temporary subcommittees.

3.0 Action Steps

3.1 To publish minutes to the PMH&SC and to all DAPC Chairmen.

3.2 To actively solicit areas of concern in the field of operational safety and health from the DAPC's, PH&ST, PMH&SC, SHARE, etc.

11/21/80

OPERATIONAL HEALTH & SAFETY TEAM
Objectives & Standards - Cont'd.

3.3 To meet with DAPC Chairman as a group a minimum of twice per year to foster two-way communications.

3.4 To provide regular guidance to the DAPC's on potential agenda items and current action plans.

3.5 To obtain plant resolution to proposed policies, standards and procedures via the DAPC Chairman.

3.6 To direct personnel safety items to the PH&ST.

3.7 To make recommendations for action steps and the setting of priorities to the PMH&SC, and other Plant Committees and Departments as appropriate.

11/21/80

APPENDIX F

VENDOR STOCKING AND RELATED INVENTORY REDUCTION PROGRAMS

I. VENDOR STOCKING

- A. FIRST COMMODITY (LUMBER) IMPLEMENTED AUGUST 27.
- B. USE OF NEW FORM
- C. 90% INVENTORY REDUCTION
- D. OTHER POSSIBILITIES
- E. PROBLEMS IN ADAPTING OTHER COMMODITIES TO VSP

II. RELATED PROGRAMS

- A. ORDER CONTROL REVIEW/VENDOR MEETING APPROACH
  - 1. ADVANTAGES
  - 2. THE PROCEDURE
  - 3. REDUCED STOCK-OUTS
  - 4. ABOUT 18 COMMODITIES TO DATE
- B. DISPOSAL OF EXCESS INVENTORY
  - 1. PROBLEMS
  - 2. COMMODITIES

III. WHERE WE STAND

- A. PROGRESS TO DATE
- B. POTENTIAL

APPENDIX G

DAP WORK SAMPLING PRESENTATION 12/15/80

A. Work Sampling is a statistical tool designed to be used for:

- Suggesting ways to promote more efficient use of scarce resources
- Helping to set realistic and attainable goals

B. Work Sampling is not:

- A tool to be used for evaluating the performance of supervisors

C. Steps in Work Sampling Study:

- Set up categories/activities to sample
- Take samples on random basis (supervisor takes samples)
- Augment sampling process with personal interviews and observations
- Process data, obtain manpower utilization values
- Formulate recommendations
- Present results for management consideration

DDTippett/lf
2/5/81

APPENDIX H

UC 149-2

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES

P. O. BOX 471, TEXAS CITY, TEXAS 77590

April 14, 1981

TO: R. F. Casella
J. L. Christensen
D. E. Cook
J. L. Glass
M. D. Lindsey
J. E. Murray
M. L. Zander

Subject: Texas City Vendor Stocking/Less Stock Situation Report

Since my internship here at Carbide Texas City will soon be ending, it seems appropriate at this time to document my activities in the vendor stocking/less stock area for future reference as needed. Accordingly, I am enclosing a position paper on this subject which is intended to present the current status of these programs at the Texas City plant, and to discuss the existing limitations which affect the feasibility of larger scale programs in the future.

Don Tippett

D. D. Tippett

DDT/js
Attachment

SITUATION REPORT

Texas City Vendor Stocking/Less Stock Programs

April 1981

UNION CARBIDE CORPORATION

Donald D. Tippett

WP#0749A/0062A:AH

Introduction:

The intent of this report is to present the current status of vendor stocking/less stock programs at the Texas City Plant, and to discuss the limitations which presently affect the feasibility of large scale implementation of vendor stocking at this location.

Current Programs:

Vendor Stocking: In May-June, 1980, the Texas City Materials Management Department set a goal to finish calendar 1980 with the same MRO inventory which was on hand at the end of calendar 1979. One result of this effort was the establishment of a trial vendor stocking program (VSP).

Conscious of the fact that an early misstep would greatly harm the chances for creating a large scale VSP program later, the first commodities were selected very carefully. Common, stable commodities were sought which would have readily available alternate sources in an emergency. It was decided that the new vendor stocking form developed in the Kanawha Valley should be used along with a Type II Contract so that usage data could be captured and better control could be exercised over the commodity. It was also decided that a small safety stock would be kept, at least initially, for emergency purposes. Finally, criteria were developed for judging potential VSP vendors (Enclosure 1) and a suggested agenda for meetings with potential plant VSP users (Enclosure 2) was established.

Lumber, the inaugural commodity, was placed on VSP in August, 1980. Releases are made by the Carpenter Shop Supervisor who also keeps track of the safety stock, which is stored at the Carpenter Shop. The delivery truck stops by the storeroom where paperwork is processed before it proceeds on to the Carpenter Shop for unloading. A stores clerk usually accompanies the delivery truck to the shop and assists in the unloading. The lumber VSP has been running very smoothly for seven months and has resulted in a reduction in lumber inventory of over 90 percent (from over $22,000 to about $2,000).

The other VSP commodity currently in operation is janitorial supplies which was first proposed for inventory reduction because of the large amount of space these supplies occupy in the storeroom. The first VSP release of this commodity was made in January, 1981. Releases are made weekly by an non-exempt stores employee after he receives a listing from the janitors containing their requirements for the coming week. Delivery is made to the storeroom which immediately breaks down the order and disperses it to janitors throughout the plant. The small safety stock, which is kept in the storeroom, is tracked by the computer which issues a POW-K release when order points are reached. To date, janitorial supplies inventory, has been reduced more than 50 percent.

The two commodities currently on VSP are significant first steps in the establishment of a future large scale vendor stocking program at Texas City. However, the creation of these programs pointed up the existence of several stumbling blocks which must be overcome before more ambitious VSP projects are feasible. These limitations will be discussed later in this report.

Less Stock Program: When it became clear that vendor stocking was not feasible on a large scale at the present time, another inventory reduction approach was sought. The simple less stock approach which was developed can be used for almost any commodity for which the VSP is not feasible or not desirable.

Candidates for the less stock program were initially identified through an Assist Program (see example Enclosure 3) which shows value of One Month Supply vs Value on Hand for all requirement orders in effect. Those commodities which represent significant dollars and display a considerable difference between the two figures were selected for further study. Purchasing was queried as to the stability of the market for that commodity and the dependability of available vendors. Assuming no problems here, further Assist Programs (see examples, Enclosures 4 & 5) were run which detail usage patterns and provide the basis for making order control cuts. A meeting was then held with the principal plant users of the material. The user was shown the usage data and his opinions on the proposed inventory reduction were solicited. Assuming no problems emerged up to this point, proposed order control reductions were worked out and approved by the user in a second meeting.

One of the key parts of this less stock approach is the meeting with the vendor which is the next step in the procedure. At the vendor meeting, the vendor's representative is informed of our order control reduction and our reliance upon his prompt response to releases (ten day delivery time is desired).

The vendor is given our best usage data at this time. Also, his past performance is reviewed, including number of deliveries per release, delivery lead time, packaging, shipping procedures, etc. After receiving assurances of support from the vendor, and with the U/A of the user, the order controls are reduced and inventory drain-down to the lower level begins.

Some 17 commodities have been processed in this manner (see Enclosure 6) and the approach seems to be quite successful. Inventories of the affected commodities have been reduced several hundred thousand dollars over the past nine months and the drain-down is continuing. Also noteworthy is a lower level of stockouts in these commodity areas, which may be attributable to the face to face vendor meetings. In general, this seems like a good on-going procedure to keep on top of major commodity inventories. Of course vendor stocking still holds the greatest potential for inventory reduction.

Current Limitations on VSP Development

In the initial effort to reduce inventory through vendor stocking, several serious problems were encountered when major commodities with many items were considered. The first problem is the non-existence of a consolidated user's catalogue including a commodity item section. This is desirable so that a user needing a National 50571 mechanical seal, for example, can readily determine its item code and be in a position to expeditiously and succinctly relay this information to the releasor. The releasor needs to be able to quickly verify this information and

determine the proper source from which to obtain the requested item. At present the translation from a description of the required item to the item code is usually accomplished by a stores clerk. He either obtains the item code from one of the various cross references held in stores or simply locates the bin by memory and copies down the item code as he pulls the material for issue. Neither of these methods lends itself to a large scale vendor stocking program.

Another major problem is the lack of some viable system to make VSP releases when many commodities are involved which contain thousands of items and which have multiple users throughout the plant. There is no system in Texas City comparable to the "expeditor" system at Institute in which each area's expeditor procures supplies for his area whether they come from the VSP or stores. When a commodity is used throughout the plant, there is no obvious person to do the releasing, and stores has no extra personnel for this function.

Institute has had good sucess with their expeditor VSP system. They currently have over 3000 line items in their vendor stocking program. Some example commodities are bearings, belts, bolts, conduit, coveralls, hose, insulation, pipe, pipe fittings, flanges, rainwear, seals, and stud bolts. No serious limitations of the expeditor system have been exposed so far, and it or something comparable seems to be a key requirement for a large scale VSP.

A major consideration in setting up future VSP's, and certainly one of the biggest factors influencing the development of the current program is labor relations. The VSP planner must try to anticipate what

objections may arise and be prepared to deal with them. If the VSP planner does not give proper consideration to the potential labor relations impact of his plan from the very start of the planning process, he may find he has designed a program which is unworkable within the constraints of the real world plant labor environment. To further illustrate this point, consider the following example:

> Some of the largest potential savings vendor stocking promises are in the area of reduction in material handling: receipt, putting up, pulling, and delivery. Ideally, from the planner's point of view, a VSP item would be delivered straight to the user's location and receiving paperwork would be filled out on the spot and mailed to the receiving department later. This is precisely the type of procedure which would be most strongly objected to by the union. The union would have the material unloaded at the storeroom and then reloaded on a UCC delivery truck and taken to the user. At the very least it would want the vendor delivery truck to stop by stores and pick up a stores clerk who "makes sure" the item gets delivered.

This example illustrates the type of disagreemnt which may quickly arise. The decision dictating the zeal with which the plan is pursued in the face of labor's objections must be made by management. However, the important thing is that the planner anticipates potential problem areas during the planning process and does not set himself up for unwelcome surprises later.

One of the most popular bases for labor objections is the so called "past practice" rule which holds that management cannot unilaterally alter long-standing conditions of work other than through the collective bargaining process. It might be suggested that the advent of the new MADP II system could offer some hope in relieving past practice constraints on VSP. An argument could be made that, in going to this totally new system, old procedures will need to be altered to conform to the new system requirements. Hence, many of the old past practice arguments no longer apply. If this approach were taken from the beginning, it could offer some relief for this particular problem.

It is certainly true that overcoming these labor problems is not an easy task. In fact all of the limitations discussed above are challenging. However the potential rewards are also great. The elimination of the 30 percent annual holding cost on a large number of items promises a significant reduction in overhead. Also to be considered are potential reduction in the labor force, generally fresher material on hand, and the reduced need for material storage facilities.

One last factor which is needed in all VSP's is some type of Market Awareness Program. This would be a mechanism where someone would monitor market conditions and predict coming shortages of VSP commodities in time to build a safety stock. This mechanism would also determine when this safety stock is no longer necessary. This would probably be a purchasing function. The safety stock itself could be monitored by the computer and ordered in POW-K releases.

SUMMARY

In conclusion, it is felt that VSP holds the greatest potential for efficient material management in the future. Because of this tremendous potential it is recommended that the major limitations be tackled immediately so they can be removed in time to make the most effective marriage possible between VSP and the coming MADP II.

VSP VENDOR CHECKLIST

This is a proposed checklist of items which should be considered by the buyer who draws up and executes a VSP Contract.

1) Vendor performance record and future potential performance and reliability.

2) Competitive pricing.

3) Frequency of deliveries to be made; response time.

4) Provision for irregular hours, holidays and weekends.

5) Delivery during strikes, crossing picket lines. Alternatives.

6) Sufficient breadth and depth of inventory to meet our needs in numbers/types of materials or willing to expand their inventory if necessary. A visit to the vendor's facility will normally be necessary.

7) Able to handle our requirements in adverse market conditions.

8) Vendor management commitment/capability.

9) Consideration of non-standard material peculiar to UCC--Is it included? If so, what additional commitment must be made?

ENCLOSURE 1

VSP USER MEETING AGENDA

Topics to be Covered:

1. Objective of VSP, UCC commitment to reduce inventory
2. Normal Usage
3. Critical Items
4. Obsolete Items
5. Suggested Additions to VSP Item List
6. Vendor History
7. Emergency Stocks
8. Delivery Frequency
9. Emergency Deliveries
10. Paperwork Procedures
11. Identify Authorized Requisitioners
12. Start-up Procedures

ENCLOSURE 2

REPORT CD20 VENDOR STOCKING PROGRAM PAGE 1

	REQ ORDER NUMBER	VENDOR CODE	BUYER	CODE	COMD CODE	VALUE OF ONE MONTH SUPPLY	VALUE ON HAND	
TOTAL BY REQORDNO	003001	01870000	365	0171A		1173	8227	FASTENERS
TOTAL BY REQORDNO	003007	37123100	380	5760A		9213	60078	
TOTAL BY REQORDNO	003009	15342300	380	0240F		548	6054	FITTINGS & STEEL PLATE
TOTAL BY REQORDNO	003011	52797500	380	2040A		246	6241	MACHINE SHOP WORK
TOTAL BY REQORDNO	003015	42924000	357	2071F			2447	SPARE PARTS - ALLEN-[illegible] COMPRESSOR
TOTAL BY REQORDNO	003026	73778702	406	0350F		1532	7318	[illegible]
TOTAL BY REQORDNO	003029	64724802	380	0660A		218	10279	[illegible]
TOTAL BY REQORDNO	003033	25806301	380	5640A		5112	41728	CARBON STEEL PIPE
TOTAL BY REQORDNO	003036	08604101	406	0200A		7515	71519	FITTINGS
TOTAL BY REQORDNO	003042	58951304	365	1890A		2575	23396	SAFETY SHOES
TOTAL BY REQORDNO	003045	83182800	406	0280A		3654	9001	GAUGES
TOTAL BY REQORDNO	003048	08604101	380	0250A		1852	14237	FITTINGS, ALLOY PIPE
TOTAL BY REQORDNO	003052	68933805	380	0240A		261	2871	FITTINGS
TOTAL BY REQORDNO	003058	45162500	406	0451A		1540	18687	THERMOMETERS
TOTAL BY REQORDNO	003062	34026600	406	0451A		838	9753	"
TOTAL BY REQORDNO	003066	98387300	356	0640F		738	1826	PAINT
TOTAL BY REQORDNO	003068	64902002	364	2383A		346	18088	SPARE PARTS ELECTRICAL SWITCHGEAR
TOTAL BY REQORDNO	003077	69046301	406	0240A		5620	76586	FITTINGS
TOTAL BY REQORDNO	003083	59297401	356	0640A		2016	5111	PAINT
TOTAL BY REQORDNO	003087	25440906	357	2071F			11713	SPARE PARTS - ALLEN-[illegible] COMPRESSOR
TOTAL BY REQORDNO	003088	55566200	356	0640A		2139	1734	PAINT
TOTAL BY REQORDNO	003089	44016301	356	0640A		3004	3099	"
TOTAL BY REQORDNO	003093	03911400	365	1870A		586	1503	SAFETY EQPT.
TOTAL BY REQORDNO	003097	25440902	357	2071A			995	STEAM PACKING FOR COMP.
TOTAL BY REQORDNO	003099	64902002	364	0160A		4216	19276	ELECTRICAL SUPPLIES
TOTAL BY REQORDNO	003101	29286308	357	0193F		239	6076	PLANT EQUIP.
TOTAL BY REQORDNO	003102	34140300	406	0352F		55	13743	INSTRUMENT SPARE PARTS
TOTAL BY REQORDNO	003104	54343202	357	2071F			4880	SPARE PARTS ALLEN-[illegible] COMP.
TOTAL BY REQORDNO	003105	83457900	357	2071F			2205	"
TOTAL BY REQORDNO	003112	88752100	364	0172A		268	2161	PIPE FITTINGS
TOTAL BY REQORDNO	003116	08604101	406	0930A		2686	25234	VALVES VALVE PARTS
TOTAL BY REQORDNO	003120	92792900	365	1870A		1463	1764	SAFETY EQPT.
TOTAL BY REQORDNO	003124	22263001	364	0040F		1321	69697	BEARINGS & SEALS
TOTAL BY REQORDNO	003127	36718400	406	5670A		5784	14721	CARBON STEEL PIPE
TOTAL BY REQORDNO	003130	57623305	380	0910A		136	1694	WELDING EQPT.
TOTAL BY REQORDNO	003135	35720001	365	1040A		149	2271	DATA PROCESSING SUPPLIES
TOTAL BY REQORDNO	003140	64902002	364	0151A		5712	76379	ELECTRICAL WIRE
TOTAL BY REQORDNO	003143	75782800	357	3011A		250	6475	SPARE PARTS - SIEMENS TURBINE
TOTAL BY REQORDNO	003148	42671200	364	0500A			3848	POWER TRANSMISSION EQPT.
TOTAL BY REQORDNO	003157	30369400	406	0200A		868	10347	FITTINGS
TOTAL BY REQORDNO	003160	20978100	406	0350A		737	1494	INSTRUMENTATION
TOTAL BY REQORDNO	003163	41381200	406	0352A			9127	SPARE PARTS - INSTRUMENTS
TOTAL BY REQORDNO	003165	44363401	364	3191F			13492	SPARE PARTS MECHANICAL EQPT
TOTAL BY REQORDNO	003166	36894900	364	0130A		3333	15323	CONDUIT
TOTAL BY REQORDNO	003169	45199200	406	0390A		3155	9768	EXCHANGERS
TOTAL BY REQORDNO	003172	91079000	380	4620A		571	3488	BOTTLES / JARS
TOTAL BY REQORDNO	003174	36894900	364	2383A			1473	SPARE PARTS ELECTRICAL SWITCHGEAR

ENCLOSURE 3

ITEM CODEUM	BIN NUMBER	DESCRIPTION	Q*	ORDER POINT	SECND PRIOR YEAR ISSUE QTY	FIRST PRIOR YEAR ISSUE QTY	Y-T-D ISSUES	UNIT COST	ISS FREQ	QTY IN BIN	ONE MONTH USAGE	VALUE OF ONE MONTH SUPPLY	VALUE ON HAND
57359066 FT	975	PIPE 304SS 5S P60A 6	76	68	61	334		$11.59		100	12	139	1159
57359154 FT	975	PIPE 304 SS 10S &S	34	107	199	20		$1.87		312	7	13	585
57359155 FT	975	PIPE 304SS 10S P60A .75	85	238	414	36		$1.36		240	14	19	327
57359156 FT	975	PIPE 304SS SCH 10S P60A 1	391	270	1235	718	717	$2.48	13	377	86	213	934
57359158 FT	975	PIPE 304SS 10S P60A 1.5	192	148	895	886	202	$3.38	6	286	63	213	968
57359159 FT	975	PIPE 304SS 10S P60A 2	204	187	2406	1064	898	$4.21	26	213	140	590	898
57359161 FT	975	PIPE 304SS 10S P60A 3	88	167	1353	1277	770	$6.72	24	134	109	732	900
57359163 FT	975	PIPE 304SS 10S P60A 4	60	98	1103	669	393	$8.92	15	12	70	625	107
57359165 FT	0000975	PIPE 6" 304SS SCH 10S	51	68	922	679	865	$14.47	10	126	79	1143	1824
57359167 FT	0000962	PIPE 8" 304SS SCH 10S	34	34	135		96	$27.78	2	25	7	194	694
57360052 FT	0000938	PIPE 304 SS STD IPS &25	85	68	61	42	20	$1.14	1	125	3	3	143
57360053 FT	179	PIPE 304 SS STD WLD &375	68	34	130	143	20	$1.36	1	84	9	12	114
57360054 FT	0000938	PIPE 304 SS STD RL &5	160	153	627	296	271	$1.79	9	298	38	68	535
57360056 FT	975	PIPE 304SS 40S P60A 1	106	119	795	601	443	$2.81	14	209	59	166	588
57360057 FT	975	PIPE 304 SS 40S STD 1.25	65	108	174	171	40	$3.45	2	140	12	41	484
57360058 FT	975	PIPE 304SS 40S STD 1&5	85	85	415	484	161	$4.24	5	130	34	144	551
57360059 FT	975	PIPE 304 SS STD RL 2	104	161	929	935	165	$5.93	7	187	65	385	1109
57360061 FT	975	PIPE 304SS 40S STD 3	65	85	160	370	206	$11.41	9	59	23	262	673
57360063 FT	0000975	PIPE 4" 304SS SCH 40S	17	17	105	61	81	$16.72	4	43	7	117	719
57360066 FT	975	PIPE 304 STD BUTT WLD 6	34	20	82	229		$16.15		150	10	161	2422
57360067 FT	975	PIPE 304SS 40S STD 8	13	13	20			$28.85		119			3434
57360161 FT	939	PIPE 304 SS XH 3	17	17	25	44		$21.31		21	2	42	447
57360254 FT	0000938	PIPE 304SS SCH16 &S	21	21	62			$5.68		44	2	11	250
57360255 FT	0000939	PIPE 304SS SCH160 &75	17	17	66			$7.56		27	2	15	204
57360281 FT	0000939	PIP 304SS XH 1&315X&358 1	17	9				$11.26		86			968
57360283 FT	179	PIP SS304 XH 1&9X&400 1&5	17	9				$7.69		24			184
57364051 FT	0000961	PIPE 1"IPS 316L SS SCH10S	170	85	2006	146	60	$4.58	1	262	71	325	1201
57364055 FT	0000961	PIPE 3"IPS 316L SS SCH10S	50	95	286	761	82	$13.05	2	125	36	470	1632
57364057 FT	0000961	PIPE 4"IPS 316L SS SCH10S	250	70	361	1085		$6.53		114	46	300	744
57364061 FT	0000961	PIPE 6"IPS 316L SS SCH10S	22	43	221	30	48	$23.76	1	66	9	213	1568
57365058 FT	0000939	PIPE T316 SCH.80 1-1/2"	17	85	140	43	83	$17.59	4	83	8	140	1460
57365060 FT	0000939	PIPE 2" 80 316 SS	34	17	103			$17.02		63	3	51	1072
57365066 FT	0000939	PIPE T-316 SCH.80 6"	1	40	44			$107.47		91	1	107	9780
57365067 FT	0000103	PIPE T316 SCH.80 8"	34	34	21	41	39	$135.56	2	71			9625
57374063 FT	975	PIPE 316 SS 5S P60A 4						$4.44		72			320
57374066 FT	975	PIPE 316SS 5S P60A 6	38	28		41	59	$21.76	2	63	3	65	1370
57374067 FT	975	PIPE 316 SS 5S 8	17	51	108	21		$18.54		66	4	74	1224
57374155 FT	975	PIPE 316SS 10S P60A .75	136	68	60	60	41	$1.98	2	343	5	9	679
57374156 FT	975	PIPE 316 10S P60A 1 IPS	100	200	306	1359	344	$4.58	10	283	64	293	1297
57374158 FT	975	PIPE 316 SS 10S P60A 1&5	152	138	1279	796	204	$4.71	7	648	73	344	3053
57374159 FT	975	PIP 316 SCH 10S P60A 2	84	189	931	1277	1290	$7.80	29	124	112	874	968
57374160 FT	975	PIPE 316 SCH 10S P60A 2&5	1	48	20	108	21	$11.40	1	302	4	45	3442
57374161 FT	975	PIPE 316SS 10S P60A 3	63	127	1012	1245	414	$13.07	14	239	86	1124	3125
57374163 FT	975	PIPE 316SS 10S P60A 4	105	105	426	1102	250	$15.46	9	107	57	881	1654
57374168 FT	962	PIPE 316 SS SCH 10S 10	34	17			20	$37.35	1	41			1531
57374169 FT	962	PIPE 316 SS SCH 10S 12	17		2		47	$68.59	2	24	1	68	1646

TIPPETT
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REPORT AD20 REQ. ORDER NO. 003990 Stainless Steel Pipe 09/09/80 PAGE 1

ITEM CODE	P F M	S P C L	AVG DEMAND	AVG DF	AVG LT	LAST LEAD TIME	2ND LEAD TIME	JAN D	FEB D	MAR D	APR D	MAY D	JUN D	JUL D	AUG D	SEP D	OCT D	NOV D	DEC D
57359066	L	0	26.8	.4	14	44	4												
57359154	L	0	.0	.0	9	16	26												
57359155	L	0	35.0	1.0	10	9	56											36	
57359156	F	0	90.2	1.2	32	122	2	140 4			274 2	23 1	180 3	100 3		20 1	42 1	60 2	100 1
57359158	F	0	44.1	1.0	12	13	8	21 1	161 4		20 1				20 1	42 2	144 6	82 4	42 2
57359159	F	0	118.2	3.7	11	14	15	105 5	272 4	104 5		249 8	21 1	147 3	41 2	252 10	20- 11	180 4	123 6
57359161	F	0	107.6	3.0	23	8	29	144 5	294 5	103 5	42 2	62 3	20 1	105 3	62 3	207 7	41 5	70 3	200 2
57359163	F	0	69.4	2.4	13	13	18	21 1	20 1	20 1	63 2	63 3	81 2	125 5	52 4	183 5	151 5		60 2
57359165	S	0	159.0	1.2	13	8	7	661 3				20 1	80 3	64 3	24 1	556 5	535 4		
57359167	L	0	6.4	.3	14	14	6					48 1	48 1						
57360052	L	0	12.2	.3	13	32	17						20 1						
57360053	L	0	10.1	.4	13	16	20		20 1							21 1	21 1		
57360054	F	0	43.2	1.0	16	27	57	100 3	20 1			62 2	20 1	60 2	41 2	21 1	21 1	146 2	
57360056	F	0	52.0	1.3	14	14	7	154 3	21 1	123 6	105 2	20 1	20 1		42 1		84 1		60 1
57360057	S	0	12.1	.4	25	35	45	20 1				20 1				20 1		67 2	
57360058	S	0	31.7	.7	17	7	35		60 1			40 1		61 3		21 1	63 3	105 1	

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ENCLOSURE 5

REPORT 6950

INVENTORY REDUCTION PROGRAM
PLANT 515

COMMODITY	REQ. ORDER NO.	VENDOR	STARTING DATE	STARTING INVENTORY	VALUE ON HAND	INVENTORY REDUCTION
ACIDS	000001	VAN WATERS & ROGERS	08/15/80	$700	$694	$6
CABLE, ELECTRICAL	000002		07/20/80	$186,160	$155,204	$30,956
FURANCE TUBING	000003	KOKOMO TUBE	10/15/80	$506,793	$458,182	$50,611
FITTINGS, CS	003036	BAY SUPPLY	07/20/80	$71,519	$63,456	$8,063
FITTINGS, SS	003077	PIPING & EQ. CO.	08/06/80	$76,586	$66,963	$10,623
VALVES, BRONZE	003116	LUNKENHEIMER	08/06/80	$25,234	$21,096	$4,138
V-BELTS	003275	CUNNINGHAM	09/09/80	$11,348	$9,587	$1,761
PLUMBING SUPPLIES	003305	BAY SUPPLY	08/22/80	$30,075	$25,641	$4,434
LEAD	003329	LONESTAR LEAD	09/23/80	$19,138	$38,455	$19,317-
STEEL, SS, PLATE	003359	GREAT WESTERN	08/28/80	$90,078	$59,692	$30,386
TUBING, SS	003557	PIPING & EQ. CO.	08/22/80	$20,700	$12,590	$8,110
VALVES , SS	003721	NORVELL WILDER	08/22/80	$48,273	$30,575	$17,698
PIPE, CS	003752	BAY SUPPLY	09/15/80	$46,027	$52,446	$6,419-
MILL SUPPLIES	003843	TEXAS MILL SUPPLY	09/04/80	$59,986	$49,473	$10,513
MILL SUPPLIES	003844	TEXAS MILL SUPPLY	09/04/80	$37,483	$32,252	$5,231
FLANGES	003935	BAY SUPPLY	08/06/80	$108,981	$79,928	$29,053
PIPE, SS	003990	PIPING & EQ. CO.	08/06/80	$127,359	$106,939	$20,420
LUMBER	005600	HOFFMAN	07/11/80	$22,695	$2,031	$20,664
JANITORAL SUPPLIES	005605	BRAWNER PAPER CO.	08/15/80	$14,839	$11,747	$3,092
TOTAL BY PLT				$1,505,974	$1,275,951	$230,023
FINAL TOTAL				$1,505,974	$1,275,951	$230,023

TOTAL NUMBER OF ITEMS RETRIEVED 19

ENCLOSURE 6

APPENDIX I

UC 149-2

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES DIVISION

P. O. BOX 471, TEXAS CITY, TEXAS 77590

October 29, 1980

To: Mr. J. L. Glass

Copy to: Mr. D. J. Hymel
Mr. M. D. Lindsey

Subject: EXCESS VALVES/PARTS DISPOSAL

Mr. R. L. Fleming, T&I Supervisor, has identified certain of the Crosby and Lunkenheimer valves and valve parts which need no longer be kept in Stores. The enclosed fact sheet displays pertinent data on these items.

Also enclosed is a proposal from Texas City Armature concerning these parts. A similar proposal is expected from Southern Instrument shortly.

Essentially, the enclosed proposal would remove $64,812.00 from the inventory at a cost to overhead of $52,320.00. It should be noted that over 50 percent of the disposal items have not moved in nearly three years. This would tend to indicate they are not needed even when we do our own valve repair. Also, under this proposal, these parts would be available for buy back in the future for 25 percent should we need them.

An alternative would be to scrap the disposal items, however, Salvage feels there would be only a negligible scrap value involved.

Don Tippett

D. D. TIPPETT

DDT/lf
Encl. (2)

CROSBY AND LUNKENHEIMER SAFETY VALVES/PARTS DISPOSAL DATA SHEET

	CROSBY	LUNKENHEIMER	TOTAL
TOTAL NUMBER OF ITEMS	221	84	305
TOTAL VALUE ON HAND 10/22/80	$93,644	$22,729	$116,373
NUMBER OF ITEMS DESIGNATED FOR DISPOSAL	173	62	235
BOOK VALUE OF DISPOSAL ITEMS	$55,237	$ 9,595	$ 64,812
less: 708 Value of Disposal items	- $10,387 (61 items)	- $ 2,105 (33 items)	- $ 12,492(19.2%)
EQUALS: AMOUNT TO BE WRITTEN OFF TO OVERHEAD	= $44,850	= $7,470	= $ 52,320
NUMBER OF DISPOSAL ITEMS NOT USED IN AT LEAST 2 YEARS, 9 MOS.	100	19	119

= 50.6% of disposal items. 94 of these have 708 value

VALVE REPAIR SERVICE
21–20th St. S.

ELECTRIC MOTOR SALES
112 Hwy. 146

TEXAS CITY ARMATURE WORKS INC

ELECTRIC MOTOR REPAIR
101 Hwy. 146

MACHINE WORKS
101 Hwy. 146

P.O. BOX 2126
TEXAS CITY, TEXAS 77590
945-9791 – 488-1445 (Hou.)

October 9, 1980

Union Carbide Corporation
Regional Purchasing
Mr. Darryl Hymel
P.O. Box 471
Texas City, Texas 77590

Subject: Surplus Material Proposal

Dear Mr. Hymel:

The following is in response to your request for assistance on the excess valve parts inventory.

Texas City Armature Works, Inc. and its subsidiary, Texas Valve Repair and Sales have contracted with Union Carbide to provide a salvage valve program under Contract 515-5250-4. I propose the following addendum to the existing contract.

A. Union Carbide Corp. places the excess valve parts inventory into salvage.

B. Texas Valve Repair and Sales will receive and inventory parts for contract purposes.

C. Texas Valve Repair and Sales will provide these parts for Union Carbide Corp. valve repair needs at 25% of listed inventory price as our salvage fee.

D. This charge will only be incurred as parts are used in Union Carbide Corp. valve repair.

E. Quarterly reports of parts usage will be included in present quarterly salvage valve report.

F. All valve parts will be reserved for Union Carbide Corp. exclusively with the following exceptions:

1. Texas Valve Repair and Sales may purchase parts from Union Carbide Corp. for resale with the permission of Union Carbide Corp.

2. The purchase price will be at 25% of listed price on the inventory list.

3. No parts will be purchased for non Union Carbide Corp. valves if that purchase jeopardizes parts replacement for Union Carbide Corp. This can be determined when purchase request is made by Texas Valve Repair and Sales to Union Carbide Corp.

It is my hope that this proposal will be considered, accepted and incorporated into the existing salvage contract. If further information is required I am at your service.

Sincerely,

M.E. "Moe" Bedar
Texas Valve Repair and Sales
Supervisor

MEB/pz

APPENDIX J

UNION CARBIDE INTERNAL CORRESPONDENCE

SOLVENTS & INTERMEDIATES DIVISION P. O. BOX [illegible], TEXAS CITY, TEXAS [illegible]

February 2, 1981

TO: Mr. M. D. Lindsey

SUBJECT: 1980 Inventory Control Results

The enclosed material summarizes the results of the 1980 inventory control effort which began at the end of May 1980. The inventory then stood at $14,340,702 and the projection for the end of the year at the then prevailing rate of increase was $15,133,562. The goal set was to end 1980 with the same inventory which we had at the beginning of the year ($13,777,824).

Enclosure 1 shows a breakdown of the final results. Actual 1980 year-end inventory was $14,168,485 (up 2.8% from 1979 ending inventory). At the bottom of the page is a breakdown of the results for supply (controllable) items. The "Quantity on Hand Charge" is where my work shows up. The reductions I achieved are included in the $411,871 figure. I can account directly for about $225,000 of that. The rest was accomplished by RATO (reduced amount to order).

Enclosure 2 shows the leveling-off of the rising inventory line which was accomplished in 1980. Enclosure 3 depicts the downward trend in inventory which began at the end of May when the various inventory reduction efforts first began.

Enclosure 4 shows how our 1980 inventory performance stacks up against that of 11 sister locations. The mean increase for the 12 locations shown is 9.8% for 1980 as compared to our own 2.8% here at Texas City.

I am pleased about the overall outcome of the 1980 inventory reduction efforts here at Texas City and proud of my contribution to these efforts. I believe it is an "identifiable contribution" to the organization which will fit in very well with the objectives of the D.E. Internship.

Don Tippett

D. D. Tippett

DDT/lf

Enclosures

TEXAS CITY
MRO INVENTORY ANALYSIS
M$

OVERALL

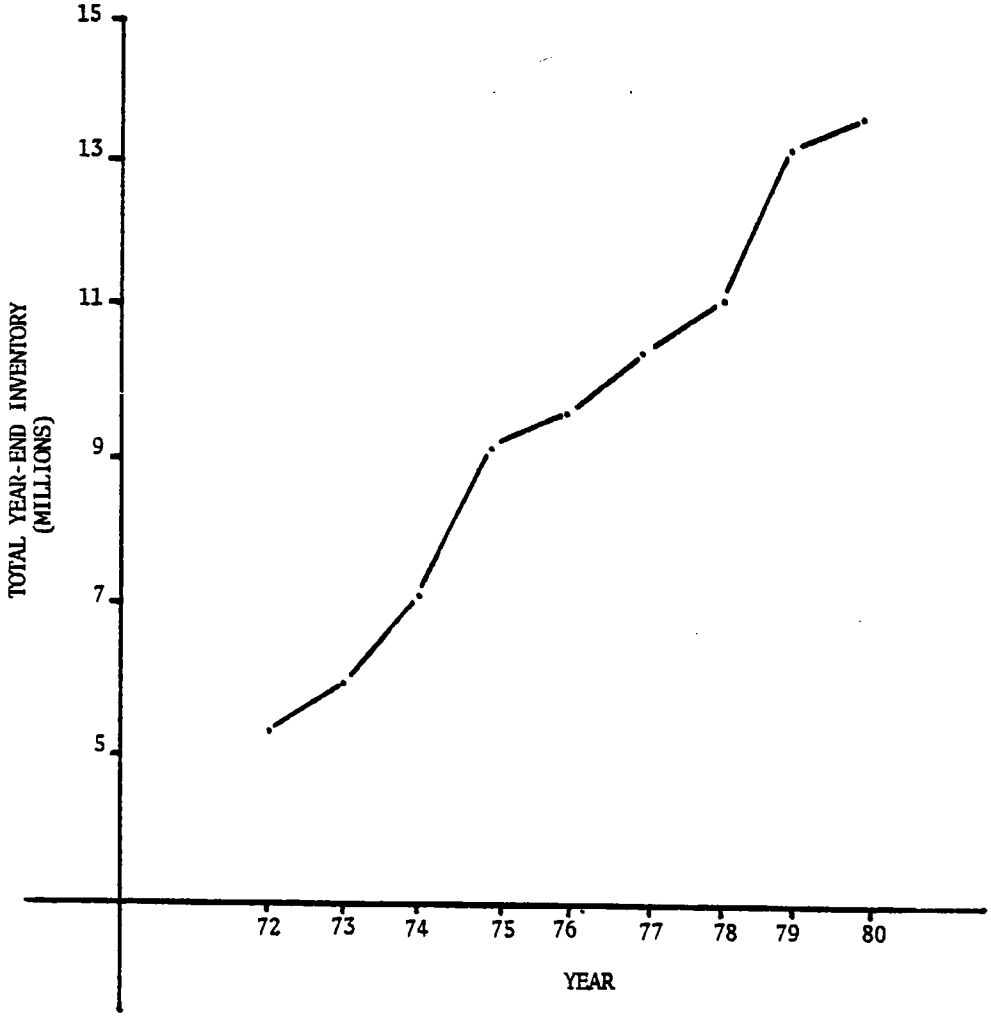
Beginning Inventory (12/31/79)	13,777,824	
NEW ITEMS	402,247	(2.9%)
TERMINATIONS	-496,694	(-3.6%)
INFLATION	466,825	(3.4%)
QUANTITY ON HAND CHANGE	18,283	(0.1%)
ENDING INVENTORY (12/31/80)	14,168,485	

	12/31/79	12/31/80
Controllable (Supply Items)	5,018,531	4,851,382
Non-Controllable (Spare Parts)	8,759,293	9,317,103
	13,777,824	14,168,485

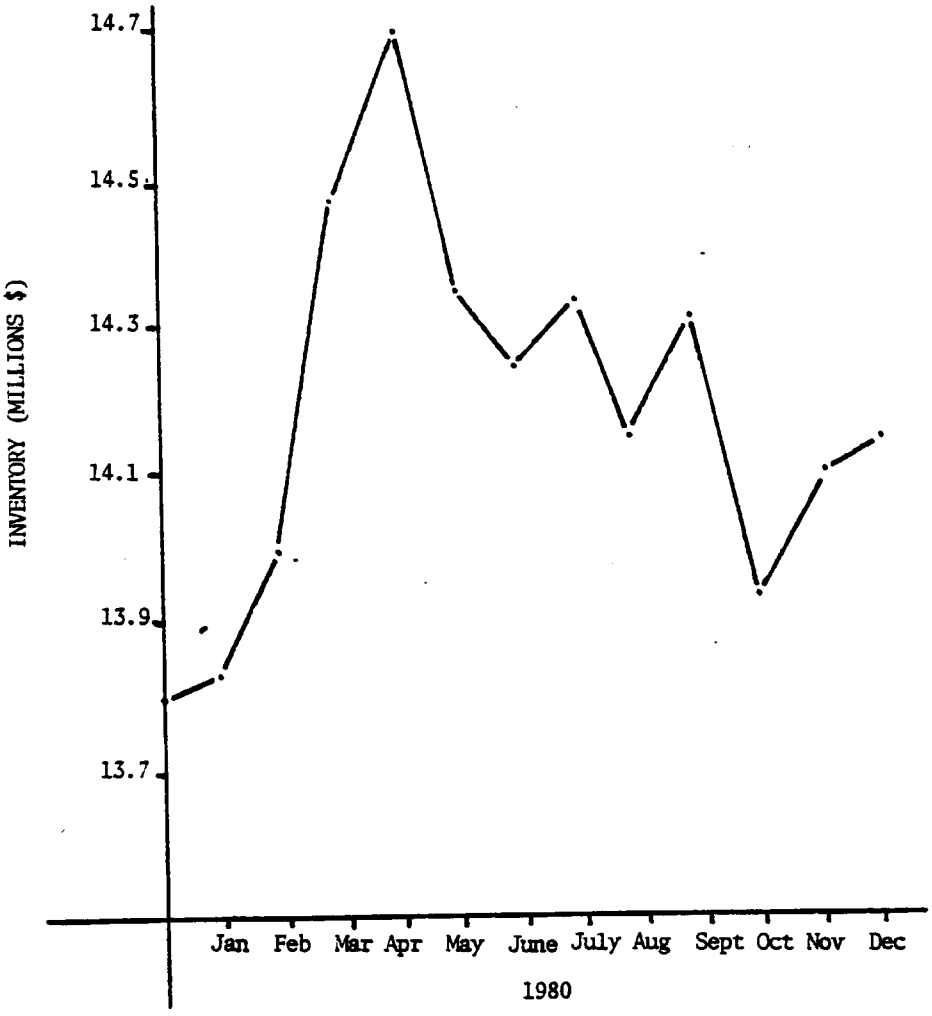
SUPPLY ITEMS

Beginning Inventory (12/31/79)	5,018,531
NEW ITEMS	67,941
TERMINATIONS	-175,543
INFLATION	352,324
QUANTITY ON HAND CHANGE	-411,871
ENDING INVENTORY (12/31/80)	4,851,382

ENCLOSURE 1


15
13
11
9
7
5
TOTAL YEAR-END INVENTORY
(MILLIONS)
72
73
74
75
76
77
78
79
80
YEAR

ENCLOSURE 2


14.7
14.5
14.3
14.1
13.9
13.7
INVENTORY (MILLIONS $)
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
1980

Enclosure 3

MRO INVENTORY

Location	Percent Increase 1980 Actual vs 1979 Actual	Rank: Least to Most Increase
293	6.5	4
312	2.6	1
314	14.7	10
380	12.3	9
510	9.9	6
511	7.2	5
512	10.3	7
513	20.2	12
514	10.8	8
515*	2.8*	2*
519	5.1	3
526	15.2	11

MEAN = 9.8%

*Texas City Plant

ENCLOSURE 4

APPENDIX K

UC 149-2

UNION CARBIDE INTERNAL CORRESPONDENCE

P. O. BOX 471, TEXAS CITY, TEXAS 77590

September 4, 1980

From: Mr. D. D. Tippett

To: Mr. M. D. Lindsey

Subject: HEARING PROTECTION REQUIREMENTS

1. BACKGROUND: In February, representatives of the Industrial Hygiene Department conducted a noise level survey in several Maintenance shops. The results of this survey (Enclosure 1) indicate that high noise levels are present during the operation of some of the machines in the various shops.

2. DISCUSSION: Personnel in some shops were discovered to be aware of the noise hazards present and relatively faithful in using hearing protectors around the noisy equipment. Personnel in other shops seemed quite unconcerned about noise hazards and were using no protection. Some of the machines sampled by the Hygiene Department survey were fitted with "Hearing Protection Required" signs, and others were not.

3. RECOMMENDATIONS: Since some shops have little or no hearing protection program and others could benefit from a re-enforced effort in this area, the following recommendations seem appropriate:

   a) Supervisors should be appraised of the dangers of noise hazards in general, including the standard requiring hearing protection for exposures which exceed 90dbA. They should be further advised as to specific machines/tools used in their respective areas which constitute particular hazards.

   b) Supervisors should be directed to conduct a training program for their people concerning noise hazards in general and own shop equipment in particular.

   c) All machines identified as noise hazards should have "Hearing Protection Required" signs prominently affixed.

   d) Supervisors should be directed to remain conscious of noise exposures on a daily basis. They should guard against unprotected employees working in the vicinity where high noise machines are being operated by others.

In general, the problem is seen as one of supervision and education. Safe practices must be established and maintained on the shop level. An effective long term hearing protection program in the shops will depend on a continuing commitment by first line supervision.

Don Tippett

D. D. TIPPETT

DDT/lf

Enclosure - Industrial Hygiene Department Sound Survey

AUG .5 1980
MAINT DEPT.

Industrial Hygiene Department PRELIMINARY REPORT	TEXAS CITY Date: August 13, 1980	DISTRIBUTION: TO: M. D. Lindsey CY: D. H. Glenn, MD J. B. Leverton A. P. Yalcinkaya

SUMMARY: A survey of the Maintenance Shops was conducted in order to determine which tools require "Hearing Protection Required" signs posted.

PROCEDURE:

Noise levels were taken with a B&K 2203 noise level meter at a distance of 6 feet and at a distance where the noise level was reduced to 90 dBA.

RESULTS:

See attached data sheets.

CONCLUSIONS/RECOMMENDATIONS:

Hearing protection is needed near several tools and machines in the various shops in the plant.

Kirk E. Martin

Kirk E. Martin

UNION CARBIDE CORPORATION
Industrial Hygiene Department — Texas City, Texas

SOUND LEVEL SURVEY
February 1980

Bldg. ~~209~~ Machine Shop

Tool or Machine	dBA @ 6 Ft	90 dBA Distance Ft
Sandblast Booth	96	10
Overhead Hoist SE Shed	96*	20 *taken directly
Overhead Hoist SW Shed	<90	-- under hoist
Band Saw, Metal	101	30 cutting 1/2 in steel
Metalizing Booth	Not operating during survey.	

Bldg. 216 Carpenter Shop

Tool or Machine	dBA @ 6 Ft	90 dBA Distance Ft
Chain Saw, Pneumatic	96	20
Band Saw	82	--
Table Saw	96	25
Planer	91	10
Shaper	98	25
Small Radial Saw	94	15
Large Radial Saw	101	30
Outside Radial Saw	108	45

Noise levels vary depending on the wood being sawed and the sharpness of the blades.

Bldg. 62 T&I Shop

Tool or Machine	dBA @ 6 Ft	90 dBA Distance, Ft
Small Impact Wrench	94	10
Large Impact Wrench	103	Throughout the room
Pressure Test Bench	109	Throughout the room

Bldg. 209 Pipe Shop

Tool or Machine	dBA @ 6 Ft	90 dBA Distance, Ft
Cut-off Wheel	96	25
Pipe Threader*	109	75

* 6" cast iron pipe was being threaded. Oil is used while threading all pipe except cast iron, which is threaded infrequently.

Bldg. 215 Structural Shop

Tool or Machine	dBA @ 6 Ft	90 dBA Distance Ft	
Hand Grinder, Pneumatic	102	20	
Hand Sander, Pneumatic	93	10	
Carbor Arc Welder	112	60	
Acetylene Torch, Large Tip	102	25	
Air Drill	<90	3	used to expand tubes in tube bundle

APPENDIX L

UC 149-2

UNION CARBIDE INTERNAL CORRESPONDENCE

P. O. BOX 471, TEXAS CITY, TEXAS 77590

September 10, 1980

To: Mr. M. D. Lindsey

Subject: Fertile Female Protection Requirements

1. FINDINGS:

I have investigated the problem of lead/Fluorocarbon 22 exposure among fertile females who are members of the Contract Services janitorial group. I find that we are currently in violation of the Texas City Plant Fetal Protection Policy in the case of fertile female contract janitors who do work in the Paint and Sandblast Shops. I have also found that we are in violation whenever female Maintenance Engineers enter these areas. We are not in violation of regulations in the Refrigeration Shop since exposure levels are sufficiently low so as not to cause a problem in this area. It should be noted that the Lead Shop is also out of bounds, although no females currently work there.

2. RECOMMENDATIONS:

As a result of the above findings, the following recommendations seem appropiate:

a). Immediate action be taken to restrict fertile females among the Contract Services janitorial group from working in the Lead and Paint Shops and the sandblast area.

b) Action be taken to insure that fertile female Carbide employees are also restricted from these areas.

Don Tippett

D. D. TIPPETT

DDT/lf
Enclosures

APPENDIX M

OIL LUBRICATED COMPRESSORS
SUPPLYING BREATHING AIR

OBJECTIVE: To operate all stationary and portable oil lubricated air compressors used to supply breathing air in accordance with applicable OSHA Standards.

ACTION PLAN

1. Identify all oil lubricated compressors that are used to supply breathing air.
   Responsibility: S. S. Murphree.

2. Identify all oil lubricated compressors that are equipped with high temperature shut downs/alarms.
   Responsibility: S. S. Murphree.

3. Establish interim program for Industrial Hygiene to routinely test for carbon monoxide per OSHA Standards.
   Responsibility: H. K. Decker.

4. Install continuous carbon monoxide monitoring system for all oil lubricated compressors used to supply breathing air.
   Responsibility: D. D. Tippett

5. Establish procedure to ensure that breathing air supplied by oil lubricated compressors is continuously monitored for carbon monoxide per OSHA Standards.
   Responsibility: W. C. Hill/D. D. Tippett

6. Establish procedure for verifying proper operation of air compressor high temperature shutdown and carbon monoxide alarm systems.
   Responsibility: W. M. Tyler.

APPENDIX N

MARINE TERMINAL MAINTENANCE WORKFORCE UTILIZATION STUDY

Union Carbide Corporation
Texas City, Texas

Donald D. Tippett
January 1981

N

EXECUTIVE SUMMARY

This is a study evaluating the maintenance operation at the Marine Terminal with particular emphasis on manpower utilization. Data for this analysis was gathered during the period October-December, 1980 in two principal ways – work sampling and personal interviews and observations.

While the overall maintenance operation at the Marine Terminal was found to be very sound, the study discovered the following areas of concern:

1) Percent of time spent working and observing/sampling is too low.
2) Percent of time spent resting and waiting for instructions/ transportation is too high.
3) The large physical area of the facility, large number of crafts and craftsmen, and considerable contractor activity severely hamper the supervisor's ability to monitor and direct the work of his many craftsmen.

After considering a number of alternatives, the study recommends the following:

1) Assign a non-exempt coordinator to the Marine Terminal Maintenance Group to assist the supervisor in planning, scheduling, and coordinating. This should increase percent of time spent working by 6.75%, and allow for the reduction of one in the workforce.
2) Provide an additional pickup truck for use by a pair of pipefitters who will be a "hotshot" team. This move would free other vehicles for use in a variety of ways and tend to ease the transportation crunch. It would also allow a reduction of

at least one pipefitter from the Marine Terminal Group and increase percent working by 7.7%.

3) Encourage the taking of morning and afternoon work breaks on or near the work site to cut down the large amounts of time currently being spent waiting for and traveling to and from the present work break location. This would result in an increase in working time of 6% and allow a reduction of one craftsman from the workforce.

In summary, the proposed changes should increase percent working from the present 26.93% to about 47%. While this would suggest that five craftsmen should be removed from the workforce, a reduction of only three is recommended at this time for a number of non-quantitative reasons.

Finally, it is recommended that a follow-up study be conducted four to six months after recommended changes are initiated in order to insure they are having the desired effects.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

I. INTRODUCTION

This report presents the methods, findings, conclusions, and recommendations from a maintenance workforce utilization study which was conducted at the Marine Terminal of the Union Carbide Texas City Plant. The study was conducted during the months of October - December 1980.

Purpose of the Study

The purpose of this study is to evaluate the maintenance operation at the Marine Terminal with particular emphasis on manpower utilization. Based on the facts discovered, conclusions are drawn and recommendations are made for the improved utilization of maintenance resources at this important facility. A more detailed listing of the study objective and standards is included as ENCLOSURE A.

Background

The Texas City Marine Terminal is one of Union Carbide's major distribution points for products and raw materials going to and from both the Texas City Plant and other Carbide locations. Each month the terminal loads some 19 tankers, 90 barges, and hundreds of railroad tank cars and tank trucks. The Marine Terminal is a sprawling facility which covers some 425 acres and contains 125 tanks (See ENCLOSURE B). It includes a dredged turning basin with two large docks for tankers/large seagoing barges and six smaller barge docks where cleaning, loading, unloading, and maintenance are accomplished. The terminal complex also includes Nineteen Dock, with 25 tanks, which is another dock area some two miles north of the main terminal.

The Marine Terminal maintenance group has responsibility for both

planned and unscheduled maintenance at the main facility and Nineteen Dock. It also is responsible for a considerable number of pipelines which run from these two facilities to the main plant.

Due to the large maintenance workload and limited availability of resources, it was decided to conduct a study of the Marine Terminal maintenance operation with an objective of suggesting ways to better utilize the men, equipment, and material available. This study was begun in October 1980 and completed in January 1981.

Report Structure

Following this brief introduction is Section II, which describes the methods/techniques used to conduct the study. Section III is a detailed presentation and interpretation of the findings. Results of the work sampling study are presented along with material obtained from personal interviews and observations. Section IV seeks to draw logical conclusions and make suggestions for improved utilization of available resources at this facility.

II. METHODOLOGY

Data for this analysis was gathered in two principle ways – work sampling and personal interviews and observations. The work sampling study supplied the data which follows. The interviews and observations were employed to gain a better perspective of the maintenance operations at the Marine Terminal than would be provided by the quantitative approach alone.

The work sampling study was conducted during the straight day schedule when approximately 31 craftsmen and a supervisor compose the Marine Terminal Maintenance Force. The eight and one-half hour day (including lunch) was divided into 34 fifteen minute periods. Once each day the supervisor sampled the craftsmen during a randomly selected time period. The capture of these data over the course of 30 sampling days permitted profiles of manpower utilization to be constructed with proper statistical significance.

The recording and analysis of the data was carried out using a format and computer program developed by Bonner & Moore Associates, Inc. and purchased by Carbide in 1971. This format was modified to fit the requirements of the Marine Terminal Study. The data analysis program was run on the company's IBM 370 Computer.

In order to obtain a detailed profile of manpower utilization, some 58 activities typical of maintenance craftsmen were identified. These activities were divided into six categories – working, traveling, planning/leading, waiting, lost time and company policy. A detailed description of the various activities and categories is included as ENCLOSURE C.

During the randomly selected daily 15 minute sampling period, the

supervisor recorded the observed activity of each assigned craftsman and the craft to which he belonged (See Table 4 for craft listing). Based on these data the computer program yielded a detailed breakdown of manpower utilization (See Figure 2, and Tables 1 through 5). Along with percent of time spent in each activity, an activity cost was calculated based on the 1980 sold service rate of $27.50/hour.

The interviews/observations were conducted during three day-long visits to the Marine Terminal during October and November along with numerous shorter visits and discussions. An attempt was made to view all the facilities and equipment and speak with as many of the principals as possible.

III. PRESENTATION AND INTERPRETATION OF FINDINGS

The results of the workforce utilization study conducted October to December 1980, at the Carbide Texas City Marine Terminal, are presented in this section.

The Findings

During the work sampling phase of the study, a total of 873 observations were taken. These observations form the basis for the data displayed in the figures and tables that follow. This information is referenced throughout the remainder of this report.

Following is a brief description of the information presented in Tables 1 through 5 and Figures 1 and 2:

Table

1 - Percent of time spent in each of the six major categories is displayed along with the accuracy for the 95% confidence limits and the cost/day for each category.

2 - A detailed listing of percent time spent for each of the 58 activities and six categories is presented. Also shown, for comparison purposes, are the results of the 1971 Union Carbide Maintenance Study and a 40 plant petro-chemical industry average complied by Bonner & Moore.

3 - This table gives a breakdown by craft of time spent in each major category.

4 - ENCLOSURE B shows the Marine Terminal Layout divided into six areas. Table 4 is a breakdown of percent of time working in each of these areas by craft.

TABLE 1

DISTRIBUTION OF TIME BY MAJOR CATEGORY
(without supervisor)

RANK	MAJOR CATEGORY	TIME ENGAGED AND COST*			
		Percent**	Accuracy****	Hours/Day	Cost/Day
1	Working	26.93	± 3.32	2.29	$1588
4	Traveling	15.99	± 2.75	1.36	942
6	Planning/Leading	4.63	± 1.51	.39	273
3	Waiting	20.43	± 3.02	1.73	1199
5	Lost Time	10.38	± 2.85	.88	612
2	Plant Policy	21.74	± 3.09	1.85	935***
	Total	100		8.5	$5549

*Based on 30 men at $27.50/hour, less $1051/day for absentees. Absence rate for all reasons averaged 15%.
**Based on 713 observations not including supervisor or absentees.
***Cost does not include unpaid lunch break.
****95% Level of Confidence

Note: For the purposes of this report an "absentee" is defined as a craftsman who is not at work for any reason (example: sickness, vacation, bank day, etc).

TABLE 2

DISTRIBUTION OF TIME BY ACTIVITY/COMPARISON WITH OTHER STUDIES

	1980 Marine Terminal Study	40 Plant Industry Average	1971 UCC Maintenance Study
WORKING			
Tools in hand Zone 1	4.77		
Tools in hand Zone 2	2.81		
Tools in hand Zone 3	6.45		
Tools in hand Zone 4	4.49		
Tools in hand Zone 5	.42		
Tools in hand Zone 6	1.54		
Tools in hand Zone 7	0		
	20.48	38.9	46.0
Layout/Measurements	1.4	2.3	1.9
Helping	.84	4.7	2.5
Housekeeping	.42	3.1	1.8
Safety Precautions	.7	.5	.3
Receiving Instruct	3.09	2.6	2.3
Total working . . .	26.93	53.6	54.8
WAITING FOR			
Instructions	6.59	1.6	1.1
Operations	1.82	1.2	1.1
Mobile Unit	0	.3	.3
Safety Inspection/Permit/ Safety Equip this craft	1.12	.5	.5
Other Crafts	2.1	1.4	2.0
Tools	0	.1	.3
Materials	.28	.7	.5
Transportation	8.42	1.0	.7
Total Waiting For . . .	20.34	6.8	6.5
TRAVELING			
Between Jobs	9.82	4.2	5.0
For Materials/Area	.84	1.7	2.4
For Matls/Warehouse	.56	1.0	.4
For Tools/Area,out of Area, Toolroom	1.54	1.5	1.7
To/from Rest	1.4	1.3	.7
To/from Lunch	1.82	2.3	1.4
To/from Showers	0	.3	.6
Total Traveling . . .	15.99	14.0	12.2
LOST TIME			
Unassigned	.28	.8	.8
Personal	.42	.6	.3
Missing in Plant	7.29	--	.5
Late Start	.84	.3	.6
Early Quit	.42	.8	.9
Idle in Field	.98	1.5	2.9
Idle in Shop	.14	.1	1.2
Total Lost Time . . .	10.38	5.4	7.2
PLANNING/LEADING			
Coordinating/Planning	.56	.9	6.4
Paperwork	.56	.8	1.8
Observing/Sampling	0	.3	.7
Checking Drawings	.56	.9	1.1
Checking Instruction	1.68	.2	.8
Checking Schedule	.14	.1	.1
Checking Safe Precaut	.14	.2	.2
Checking Materials	.56	.7	.6
Checking Tools	.14	.1	.1
Checking Equipment	.28	.4	.4
Check Mobile Units	0	.1	
Total Planning/Leading	4.63	4.7	12.2
PLANT POLICY			
Training Class	.98	.8	0
Medical/Phys Exam	.42	.1	.1
Medical/First Aid	.42	.1	.1
Lunch	7.99	6.5	4.2
Coke/Rest	11.92	5.0	1.9
Showers/Locker	0	.6	.2
Clocking in/out	0	.2	0
Safety Meetings	0	.9	.6
Total Plant Policy . . .	21.74	15.1	7.1

TABLE 3

RESULTS BY CRAFT FOR MAJOR CATEGORIES

CRAFT	WORKING	PLANNING/LEADING	WAITING	TRAVELING	LOST TIME	PLANT POLICY
Carpenter	17.0	1.9	34.0	20.8	3.8	22.6
Electrician	25.5	7.3	20	21.8	3.6	21.8
Equipment Operator	26.9	0	23.1	23.1	3.8	23.1
Instrument Repairman	16.7	8.3	20.8	16.7	12.5	25.0
Insulator	33.6	5.9	13.4	18.5	5.0	23.5
Leadman	13.8	24.1	6.9	37.9	0	17.2
Machinist	44.0	0	22.0	2.0	12.0	20.0
Oiler	4.5	0	0	4.5	59.1	31.8
Pipefitter	25.6	4.0	26.1	12.6	10.6	21.1
Rigger	31.7	6.7	16.7	20	5.0	20
T&I Mechanic	23.7	0	16.9	8.5	25.4	25.4
MEAN: All Crafts	26.9	4.6	20.3	16.0	10.4	21.7

TABLE 4

WORK DISTRIBUTION BY ZONE (%)

CRAFT	I	II	III	IV	V	VI
Instrument Repairman	50					50
Electrician	8.3	8.3	16.6	50.2	-	16.6
Pipefitter	25	15.6	46.8	3.12	3.12	6.25
Machinist	50	10	-	40	-	-
Rigger	27.7	16.7	-	33.3	5.6	16.7
Carpenter	14.3	14.3	-	28.5	-	42.8
Insulator	14.7	17.5	64.9	2.8	-	-
Equipment Operat	19.9	19.9	-	60.2	-	-
T&I Mechanic	20	20	20	30	10	-
All Shifts/Crafts	23.4	13.66	31.7	29.95	1.95	7.3
Rank	2	4	1	3	6	5

TABLE 5

IMPROVEMENT POTENTIAL

MAJOR ACTIVITY	STUDY RESULTS PERCENT	STUDY RESULTS HOURS/DAY	POTENTIAL IMPROVEMENT* PERCENT	POTENTIAL IMPROVEMENT* HOURS/DAY	HOURS CHANGED	CHANGE IN COST DAILY**
Working	26.93	2.29	53.6	4.56	+2.27	+1480.00
Traveling	15.99	1.36	14.0	1.19	- .17	- 110.43
Planning/Leading	4.63	.39	4.7	.39	-	-
Waiting	20.34	1.73	6.8	.58	-1.15	- 741.29
Lost Time	10.38	.88	5.4	.48	- .41	- 260.36
Plant Policy	21.73	1.85	15.1	1.29	- .56	- 367.93
	100.0 %	8.50	100.0 %	8.50	0	0

* Based on 40 plant industry study

**Based on 26 men @ $27.50/hr.

FIGURE 1

MARINE TERMINAL MAINTENANCE ASSETS

A. Personnel (average assigned)*

Supervisor	- 1		
Craftsmen:	Carpenters	2	
	Electricians	2	
	Equipment Operator	1	
	Instrument Repairman	1	
	Insulators	6	
	Machinists	2	
	Oiler	1	
	Pipefitters	11	(includes 1 leadman)
	Riggers	2	
	T&I Mechanic	3	
		31	

Contract Laborers: various, assigned to specific tasks

B. Transportation

Pickup #38 - shared by 6 insulators and 2 carpenters.
Pickup #48 - assigned to supervisor, but used by riggers majority of time.
Pickup #60 - assigned to 3 T&I mechanics on trial basis.
Van #67 - assigned to pipefitter leadman/pipefitters.
Gas Cart #G9 - assigned to 2 electricians
Electric Cart #E1 - assigned to instrument repairman.

C. Communication

4 Pagers - rigger, instrumentman, T&I mechanic, supervisor.
5 Two-way radios - supervisor, equipment operator, electrician, fitter leadman, contract leadman.

*Absentee rate was 15% during the study; thus only about 26 craftsmen were actually on the job each day on the average.

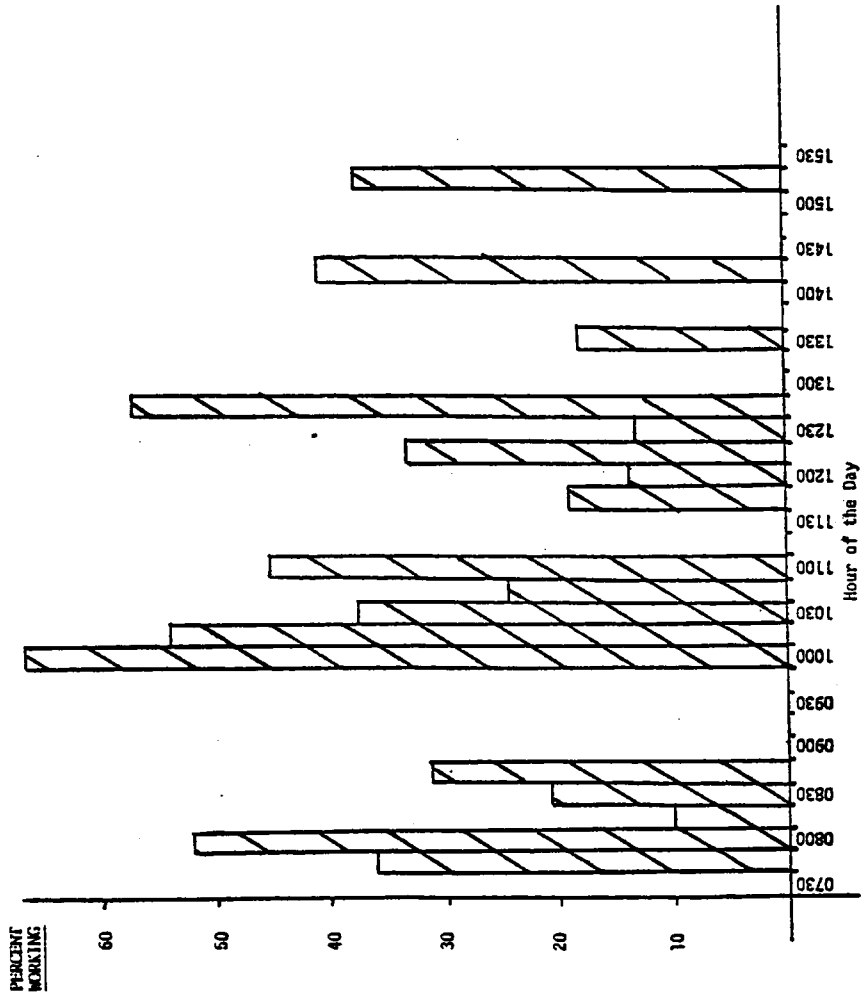


FIGURE 2 Percent Working vs. Hour of the Day

5 - Improvement potential is shown for each of the major categories, as compared to the 40 plant average.

Figure

1 - Presents a listing of the personnel, transportation, and communication assets typically available to the Marine Terminal Maintenance Force.

2 - This figure shows a bar chart of percent working vs. hour of the day. Some periods were not covered because they did not appear in the random number list.

Other findings of a more general nature follow. These observations were made during visits to the Marine Terminal and discussions with the maintenance personnel.

The Marine Terminal Maintenance Supervisor and the Area III Superintendent were enthusiastic about this study and were extremely co-operative and supportive in every way. In general, craftsmen were found to possess high morale, and a spirit of comraderie seemed to exist among the Marine Terminal Maintenance Force that is not normally found in the main plant. It is not unusual to see craftsmen help each other to accomplish some important task and there is an interest in getting the job done in a craftsman-like manner. A congenial relationship exists between maintenance and production/operation personnel although some of the usual friction exists from time to time.

The composition of the maintenance force at the Marine Terminal is shown in Figure 1. Including the pipefitter leadman, the number of craftsmen from the various crafts is 31 (actually 29 craftsmen and 2 apprentices). This is high compared with the average of about 17 craftsmen assigned to

the typical supervisor in the main plant.

The Marine Terminal Maintenance Supervisor must direct the activities of 10 different crafts as compared to the three or four crafts dealt with by the typical in-plant supervisor. It should also be noted that the roster of the Marine Terminal Maintenance Force is relatively fixed – the same craftsmen work there for a long period of time. As a result of this and the physical separation from the main plant, the Marine Terminal Maintenance Supervisor has assumed a greater share of the supervisory load from the various craft supervisors than would normally be the case. Finally, a significant amount of the supervisor's time is spent setting up and monitoring the work of the several contractors who work almost continuously at the Marine Terminal.

The pace on a typical day for the Marine Terminal Maintenance Supervisor is extremely hectic. The usual situation is for the phone to be constantly ringing, the pager and radio to be blaring, and many people to be coming and going. It often requires great effort on the supervisor's part just to stay up with the flow of information. It is extremely difficult for the supervisor to find the time for detailed planning, personnel matters, and routine paperwork.

The bulk of the maintenance force is based in a portable building at the southwestern corner of the Marine Terminal adjacent to the main gate (refer to ENCLOSURE B). This is where all of the personnel take their lunch. It should also be noted that a new maintenance building is being constructed on this site. The machinists are based in Zone I at Building 301 while the T&I mechanics are based at Building 303, also in Zone I. These two crafts take their 9:00 a.m. and 2:00 p.m. breaks at these locations. All others leave their jobs and take their morning and afternoon

breaks at the main maintenance building by the gate. In terms of work done in each Zone, Appendix B shows that the majority of the work is done in Zones I, III, and IV.

The supervisor estimates that 45% to 50% of his load is unscheduled work which he receives either personally from operations personnel or over the radio. The other half of the workload has a varying amount of leadtime built in. Much uncertainty still exists in these jobs since availability of the equipment to be repaired is highly variable. Also, due to the many demands on the supervisor's time, a less than optimum amount of planning and scheduling is done. Virtually no RM work is done by this group.

Transportation appears to be in short supply. Pickup #48 which is assigned to the supervisor is normally being used by various craftsmen out of necessity to get the job done. As a result, the supervisor seldom has transportation available to check on his men who are scattered over the 425 acre terminal. There are five pairs of pipefitters who are constantly moving from job to job. This requirement plus the practice of bringing most craftsmen back to the maintenance building for lunch and breaks virtually reduces the pipefitter leadman in Van #67 to a taxi driver.

As noted in Figure 1, pickup #38 is shared by the insulators and carpenters. The carpenters seem to be getting the worst of this arrangement since, as Table 3 shows, their waiting time is very high (34%). Also noteworthy in Table 3 is the 26% waiting time of the pipefitters which is significant since the pipefitters compose about a third of the workforce.

Bicycles are not practical for the most part because they cannot carry enough tools and equipment. The gas and electric buggies have limited capacities and cannot be used in Zones VI and VII.

In general, the Marine Terminal is a large area to cover. The supervisor is based in a relatively remote corner while the bulk of the work takes place elsewhere. Most of the time, work requirements obligate the supervisor to assign his vehicle to his craftsmen. The result is that he is often physically isolated from the jobs and people he is supervising.

Interpretation

In the interpretation and analysis which follow, the general thrust will be to seek methods to increase the percentage of the workday which a craftsman spends engaged in "working" activities (Table 2). While it must be acknowledged that various activities in each of the other categories are necessary and often desirable, it is principally for the performance of "working" activities that a company hires its workforce in the first place.

Working: The percent of time spent working was found to be 26.93% (refer to Table 2). The 40 plant comparison study indicates that a working figure in the neighborhood of 45%-55% is not unreasonable for a typical petro-chemical installation. This high comparison study working figure should not be overrated, however, since the quality of the data tends to suffer as the scope of the study widens. The percent working figures typically become inflated as the study's quality control goes down. Still, a percent working figure of 45-50 percent is not an unreasonable expectation for the Marine Terminal operation. Therefore, a reasonable goal would be to increase time working by 18-23 percent. It would then naturally follow that a manpower reduction in the neighborhood of 3-6 people would be possible without lowering the service level provided to the customer.

The distribution of time within the working category appears reasonable. The obvious need seems to be to increase the percentage of time spent "Tools in Hand" and thus the entire category. The analysis of the other categories which follows will therefore seek to identify those activities which should be pared down so that "Tools in Hand" can be raised.

In the matter of where the work is being done, Table 4 indicates that Zones I, III, and IV contain the bulk of the work (See ENCLOSURE B). This is reasonable since these are the areas where major dock facilities are located. It should be noted that the break/lunch location is far removed from the center of this activity.

As depicted in Figure 2, the percent working vs. hour of the day is about what would be expected. Relatively high levels of working appear at the beginning of the day and after each rest break and lunch. These levels trail off as the next break or the end of the day approaches.

To sum up, the work sampling study reveals a relatively low percentage of time spent in the working category. About 73 cents of Carbide's labor dollar are being spent for activities other than working. An 18-23 percent increase in time spent working appears to be a reasonable goal. Increased efficiency in utilizing manpower resources would suggest a corresponding reduction in total manpower requirements.

Traveling: The percentage of time spent traveling by Marine Terminal craftsmen is only slightly above the average. This seems a reasonable result considering the size of the facility and the relatively large distances that often must be traveled between jobs. The delivery system from the main plant helps to hold down the traveling for tools and materials activities. Overall, this category seems to be close to

the optimum value.

Planning/Leading: For the most part, this category also seems to have reasonable values compared to the average although it is well below the 1971 UCC study value. The zero value for observing/sampling is interesting to note. This may be related to the supervisor's usual lack of transportation and could reflect his difficulty in covering the large area.

Plant Policy: The most salient feature in this category is the high value, 11.92, of the break activities which drives the entire category well above the industry average. Work sampling indicates about one hour per day is being spent for this activity. This is 30 minutes more than should be spent on breaks according to current policy. This extra 30 minutes reduces time available for working by .6 percent and costs Carbide $350 per day for nonproductive activities.

The breaks are too long due to the current procedure which involves gathering most of the craftsmen up from their various jobs at 9:00 a.m. and 2:00 p.m. and transporting them to the maintenance building. Following the break, they are redeposited at their job sites.

Cessation of this wasteful procedure, and restablishment of the 15 minute work break would greatly increase the efficiency of manpower utilization and allow a commensurate reduction in the Marine Terminal workforce of about one and one-half craftsmen. Further, taking work breaks at or near the work site would result in greater availability of transportation assets for more productive uses.

Lost Time: By far the most obvious feature of this category is the 7.29 percent value titled "Missing in the Plant." Such a notation was made for an individual when he was known to be at work but could not be

located by the supervisor during his allotted 15 minute sampling period. This value undoubtedly contributes to the low working figure since it is likely that many of the "lost" individuals were indeed working when they could not be found. This situation does tend to illustrate once again the extent of the area to be covered by the supervisor and the difficulty in keeping in touch with the activities of his 31 craftsmen.

Waiting For: Other than the working category, the waiting category seems most in need of attention. The work sampling study indicates Marine Terminal maintenance craftsmen are spending just over 20 percent of each day waiting for something. This is far above the figures arrived at in the comparison studies.

Nearly eight and one-half cents of every maintenance dollar are being spent for craftsmen who are waiting for transportation to the job, from one job to another, to lunch, breaks, etc. Even allowing for the large area involved, this value seems quite excessive.

Waiting for instructions is another very high value. This again may be partially explained by the size of the facility and the somewhat limited transportation assets of the supervisor. It also reflects the above average number of people the supervisor must monitor and the rapid pace of activities which often exists.

Waiting for safety permit, etc., is also quite high. Hazardous work permits are written by the Day Production Supervisor who is based in Building 310 but may be found anywhere on the facility. Once the permit is signed, there is often a delay waiting for the various provisions to be accomplished before maintenance work can begin.

If the waiting for transportation and waiting for instruction times could be reduced by half (from a total of 15.01 to 7.51), approximately

37.5 minutes of wasted time could be recovered. This amounts to 7.3 percent of the work day and represents the efforts of 1.9 craftsmen.

In concluding this discussion of waiting, it should be noted that waiting for tools and materials times are much below average. This again speaks well for the delivery system from the plant to the Marine Terminal.

While it is interesting to examine Table 3 which shows percentage of time spent in each major category by craft, taken individually, the statistical significance for each craft is relatively low due to the number of observations. However, the statistical significance of all the crafts taken together is quite good (See Table 1) and its message is very clear that working time needs to be increased. As Table 5 shows, great improvement can and should be made in the working category. This should come about by decreasing waiting time, lost time, and plant policy time.

IV. CONCLUSIONS AND RECOMMENDATIONS

This section will begin with a listing of the problems/areas of concern which the foregoing study has identified. Next, several alternative solutions will be listed. Finally a prioritized set of recommended actions will be presented.

Summary of Problem Areas

The following is a list of the major areas of concern identified by the work sampling study:

1) The percent of time spent in the "working" category is too low.
2) Observing/sampling is too low.
3) Coke/Rest is too high.
4) Missing in the plant is high.
5) Waiting for instructions and transportation are too high.

Other more general problems include:

6) Difficulties due to large physical area of Marine Terminal.
7) Large number of crafts and craftsmen with which the supervisor must deal.
8) The extremely fast pace of activity.
9) Lack of time for supervisor to plan, sample, observe, train, etc.
10) Considerable contractor activity which demands supervisor's time.

Alternatives

In order to address the above problems, increase the percentage of time spent "working", and enhance the general efficiency, safety, and effectiveness of Marine Terminal maintenance operations, the following

alternatives were considered:

1) Create two maintenance sub-areas at the Marine Terminal with two supervisors assigned.
2) Provide the supervisor with a non-exempt "coordinator" to assist with scheduling and free the supervisor for keeping in closer touch with his craftsmen and their jobs.
3) Create a "bus service" with a laborer driving a van in a perpetual circuit or in an on-call status, in order to address the transportation problem.
4) Promote the idea of taking rest breaks on or near the work site to cut travel and waiting time.
5) Assign one or more additional maintenance vehicles to the Marine Terminal to reduce the waiting and transportation problems.

Recommendations

While each of the above alternatives has some merit, the following recommended steps are considered to have the best potential for solving the problems identified by this study (listed in suggested order of priority):

° Recommendation 1 - Assign a non-exempt coordinator to the Marine Terminal maintenance group. His function would be to assist the supervisor in planning, scheduling, and coordinating maintenance activities. If this were done, the following benefits could be expected:

a) Increase "working" time by reducing "waiting for instructions" time by at least one-half (3.25% of available time).
b) Reduce workforce by one pipefitter (chosen due to high

percentage of waiting time fitters currently exhibit.

In addition to the 3.25 percent contribution to "working" from less "waiting for instructions", the phantom "missing in the plant" activity should be reduced by at least one-half (3.5%) as a result of the supervisor's better opportunity to keep track of his men.

Most importantly, the presence of a coordinator would allow the supervisor to visit the work sites/craftsmen around his area much more regularly. It is felt the supervisor's increased presence alone would tend to increase "working" significantly. By being in closer touch with his men, the supervisor could monitor more closely the safety aspects of work practices and procedures and utilize his resources more efficiently. Finally, the fast pace of activity which often exists could be more readily and efficiently dealt with if the supervisor had the assistance of a coordinator.

° Recommendation 2 - Provide an additional pickup truck for the Marine Terminal maintenance group. This truck would be assigned to two pipefitters who would become the "hotshot fitters." These fitters would handle the barrage of short duration fitter jobs which characterize a typical day. The balance of the fitters would be assigned to longer duration jobs. If this step was taken, the following benefits would result:

a) "Waiting for transportation" would be reduced by at least one-half (4.2%).

b) The workforce could be reduced by at least one more pipefitter. This is particularly cost effective considering the annual cost of a pickup ($10,295) as compared with the cost of a craftsman (in excess of $40,000).

c) Additionally, the supervisor's resultant increased mobility

would tend to further reduce the "missing in the plant" category another 3.5%.

With an additional truck, Van #67 could then be made available for other jobs besides hauling fitters. This would make the pipefitter leadman available for other duties as well. A prime use for Van #67 would be to transport riggers whenever possible in order to free the supervisor's truck for the supervisor's use. Van #67 could also be used to supplement pickup #38 in transporting the carpenters and insulators.

The supervisor must keep close control over all of his vehicle assets to insure efficient utilization. He should guard against situations where one group assumes "ownership" of a particular vehicle to the exclusion of others who may need it more.

° Recommendation 3 - In accordance with maintenance policy, morning and afternoon work breaks should be taken at or as close to the job site as possible. Tremendous amounts of time are being wasted in traveling back and forth for these breaks, to say nothing of the transportation assets tied up in this activity. The problem can only worsen when the new maintenance facility is completed. If problems with washup/hygiene exist, perhaps a number of remote break sites can be established. In any case, the traveling from and to the front gate three times a day (twice for breaks, once for lunch) needs to be reduced. If spent time on breaks was reduced by one-half from the current 60 minute to 30 minutes per day, the following benefits could be expected:

a) "Working" time should increase by about 6%.

b) The workforce could be cut by at least one craftsman.

Benefit Summary

Recommendation	Manpower Effects (Conservative Estimate)	Increase in "Working"
1	+1-1=0	3.25 + 3.5 = 6.75%
2	-1	4.2 + 3.5 = 7.7%
3	-1	6.0%
	-2 (Net)	20.45%+26.93=new percent working of 47.38%

While it would logically follow that a 20 percent increase in efficiency would produce a .2 (26)* = 5 person decrease in the workforce, it is recommended that the workforce only be cut by 3 (2 net) at this time. As the changes are implemented, consideration can be given to making further reductions. Too many changes too quickly might tend to be detrimental to the positive attitude the established organization at the Marine Terminal currently displays. Making more gradual, deliberate manpower cuts would also serve to lessen the negative attitude of other plant personnel toward future studies. Besides, some of the potential non-quantitative benefits to be gained, particularly from Recommendation 1, should be weighed along with the quantitative rewards. If this is done

* 26 is used instead of 31 to allow for the 15% (5 person) constant absentee rate. It should also be noted that 7% of the 20.45% potential increase in working comes from the misleading "missing in the plant" category. Assuming those missing craftsmen were actually working, the real incrase in working would be from 34% to 47% or a 13% increase. This would suggest a .13 (26) = 3 person decrease in the workforce is appropriate

it is felt that implementation of the recommendation package will result in a better maintenance operation at the Marine Terminal with less cost to Carbide.

Any study such as this is not a complete entity by itself. Study and evaluation of maintenance activities must be an ongoing program if long term improvements are expected. Therefore, it is recommended that, after installation of some or all of the recommended changes, a followup study should be done four to six months later. If the changes are having the anticipated effects, further personnel cuts and other adjustments can be made as necessary. If not, new recommendation should be formulated.

In conclusion, it should be strongly noted that the Marine Terminal Maintenance Organization is a very fine group headed by an extremely capable supervisor. But, as in any study of its type, this report has necessarily focused on the problem areas where improvement potential is greatest. This approach should not be allowed to overshadow the many laudable aspects of the Marine Terminal Maintenance Organization as it stands today.

ENCLOSURE A

MARINE TERMINAL MAINTENANCE STUDY

OBJECTIVE:

Study the maintenance operation at the Marine Terminal and, based on the facts discovered, formulate recommendations for improving the utilization of maintenance resources at this important facility.

STANDARDS:

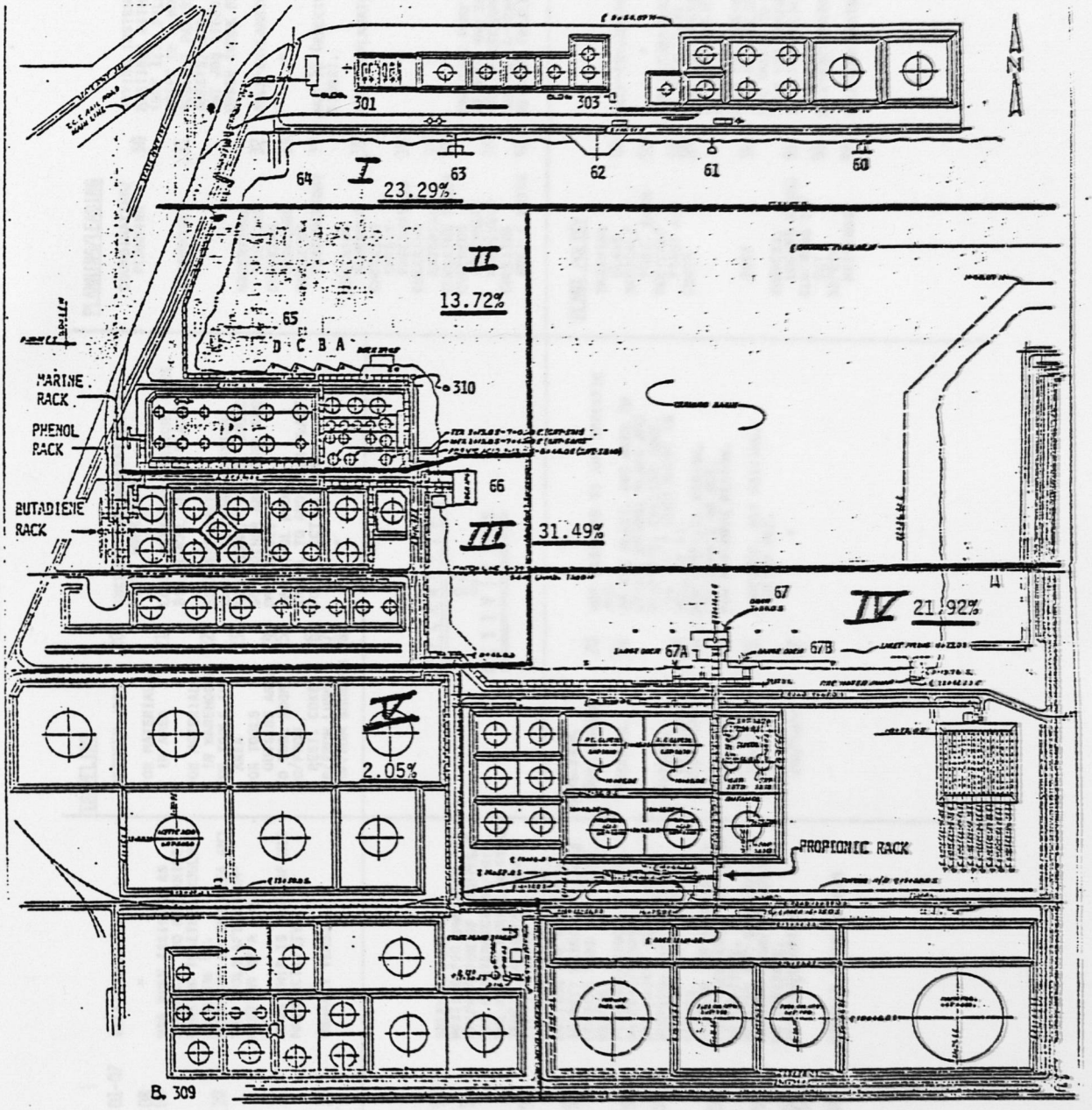
1. Supervisors involved are committed to the project.
2. Hourly employees are informed as to objectives of study.
3. Investigator is familiar with basic maintenance operations at MT.
4. A grasp of current utilization of man-hours available is obtained.
5. Comparisons are made between the MT maintenance operation and those at the main Carbide plant and other comparable petrochemical activities.
6. Locations where work is most concentrated within the MT are identified.
7. Data is analyzed for trends, areas of further investigation, and alternative solutions.
8. Recommendations are formulated from the alternatives suggested in 7.
9. Report is written and presented.

DDT

9/25/80

ENCLOSURE B

PERCENTAGE OF WORKING TIME PER ZONE



Zone VI is Dock 19 area: 7.52%
Zone VII is pipeline to plant: negligible

WORKING

TOOLS IN HAND	01-07	SELF-EXPLANATORY
LAYOUT/ MEASUREMENTS	08	"
HELPING	09	USE WHEN ASSIGNED AS HELPER. TWO MECHANICS WORKING TOGETHER WOULD EACH USE 01.
HOUSEKEEPING	10	CLEANING UP THE AREA AND THE TOOLS AFTER COMPLETION OF A JOB.
SAFETY PRECAUTIONS	11	WHEN THIS IS PART OF HIS MAIN ACTIVITY.
RECEIVING INSTRUCTIONS	12	USUALLY VERBAL.

TRAVELING

BETWEEN JOBS	20	INCLUDE TRANSPORTATION TO FIRST WORK SITE.
FOR MATERIALS IN AREA	21	LOCAL DELIVERY STATION, FREE BIN, LOCAL HIDING PLACE.
FOR MATERIALS IN WAREHOUSE	22	SELF-EXPLANATORY
FOR TOOLS IN AREA	23	LOCAL DELIVERY STATION, TOOL ROOM, PRIVATE SOURCE.
FOR TOOLS OUTSIDE AREA	24	SOME OTHER AREA TOOL ROOM OR SOURCE.
TO TOOL ROOM	25	MAIN TOOL ROOM.
TO/FROM REST, COKE	26	TRAVEL TO AND FROM PLANT POLICY ACTIVITIES.
TO/FROM LUNCH	27	"
TO/FROM SHOWERS	28	"

PLANNING/LEADING

COORDINATING/ PLANNING	30	GIVING INSTRUCTIONS, MEETINGS WITH THE BOSS (NOT 12), FILLING OUT JOB STEPS ON A WORK ORDER.
PAPERWORK	31	ROUTINE PAPERWORK, TIME SHEETS, ETC. NOT FILLING OUT JOB STEPS ON A WORK ORDER (WORK PLANNING).
OBSERVING/ SAMPLING	32	SELF-EXPLANATORY
CHECKING DRAWINGS	33	"
CHECKING INSTRUCTIONS	34	NOT 12 (RECEIVING INSTRUCTIONS).
CHECKING SCHEDULE	35	SELF-EXPLANATORY
CHECKING SAFETY PRECAUTIONS	36	"
CHECKING MATERIALS	37	"
CHECKING TOOLS	38	"
CHECKING EQUIPMENT READINESS	39	CAN THAT PUMP BE RELEASED AT SUCH AND SUCH A TIME FOR MAINTENANCE WORK?
CHECKING MOBILE UNITS	40	TRUCKS, A-FRAMES, FORK LIFTS, WELDING TRAILER, ETC.

WAITING

FOR INSTRUCTIONS	50	SELF-EXPLANATORY
FOR OPERATIONS	51	WAITING FOR SHUTDOWN AND PREPARATION OF EQUIPMENT FOR MAINTENANCE BEFORE THE REPAIR WORK CAN START.
FOR MOBILE UNITS	52	TRUCKS, A-FRAME, FORK LIFTS, CHERRY PICKER, WELDING TRAILER, ETC.
FOR SAFETY INSPECTIONS	53	WAITING FOR SAFETY TO INSPECT BLINDING BEFORE OPENING LINE FOR VALVE REPAIR.
FOR SAFETY PERMITS	54	FIRE (WELDING), ENTRY, OR FIRE/ENTRY.
FOR SAFETY EQUIPMENT	55	GAS MASKS, FOAM TRUCK, BLOWERS, LOW-VOLTAGE LIGHTS, COVER GOGGLES, GLOVES.
FOR THIS CRAFT	56	WAITING FOR SOMEBODY IN THIS SAME GROUP TO BEGIN OR CONTINUE.
FOR OTHER CRAFT	57	WAITING FOR SOMEBODY IN ANOTHER GROUP TO BEGIN OR CONTINUE.
FOR TOOLS	58	SELF-EXPLANATORY
FOR MATERIALS	59	"
FOR TRANSPORTATION	60	USUALLY BETWEEN JOBS

EXPLANATION OF ACTIVITIES

LOST TIME

UNASSIGNED	70	NOT ASSIGNED TO ANY SPECIFIC JOB
PERSONAL	71	IN THE PLANT, BUT GONE TO CREDIT UNION; PLANS AND BENEFITS; CALLING HOME.
MISSING IN PLANT	73	YOU DON'T KNOW WHERE IN HELL HE IS.
LATE START	74	FOR WHATEVER REASON, LEGITIMATE OR NOT.
EARLY QUIT	75	FOR WHATEVER REASON.
IDLE ON JOB/FIELD	76	ASSIGNED, NOT WAITING, GOOFING OFF.
IDLE ON JOB/SHOP	77	"

PLANT POLICY

TRAINING CLASS	90	SELF-EXPLANATORY
MEDICAL/ PHYS. EXAM	91	"
MEDICAL/ FIRST AID	92	FOR EITHER EMERGENCY OR SICK LEAVE.
LUNCH	93	ONLY FOR PERIOD AS STATED IN PLANT POLICY 27 FOR TRAVEL.
REST	94	ONLY FOR PERIOD AS STATED IN PLANT POLICY. USE 26 FOR TRAVEL TO AND FROM.
SHOWERS, LOCKER ROOMS	95	ONLY FOR PERIOD AS STATED IN PLANT POLICY.
CLOCKING IN/ OUT	96	SELF-EXPLANATORY.
SAFETY MEETINGS	97	SELF-EXPLANATORY.

APPENDIX O

PRODUCTIVITY IMPROVEMENTS GOALS
AND OTHER TYPES OF REARRANGEMENT PROJECTS

	ROUTING:	NAME	APPR.	DATE
1	AREA MAINT. ENGINEER	J. Keedy		
2	DEPT. HEAD—OPER. / IMT.	L.E. Calvert		6/23/81
3	DEPT. HEAD—MAINTENANCE	L. A. Smith		6/23/81
4	MAINT. PIG COORDINATOR	L. O. Pell		6/23/81
5	ASSISTANT PLANT MGR.	T. O. Blum		7/9/81
6	ASSISTANT PLANT MGR.	J. S. Knight		
7	PLANT CONTROLLER	J. E. Quin		
8	ENGINEERING			
9	Maint.	K. Horn		7/13/81
10	PIG Coord	C. L. Walton		
11				

FOR DEPARTMENT HEAD

IS ENGINEERING REQUIRED? ☐ YES ☑ NO

IF YES, ROUTE THRU ENGR.

FOR ASSISTANT PLANT MGR.

APPR. FOR ENGR.

PRIORITY

FOR PLANT ENGINEERING MGR.

ACCEPTED _____ DATE _____

PROJ. ENGR. _____

PROJ. NO. ASS'D _____

☐ PIG
☐ SAFETY
☐ POLLUTION CONTROL-WATER
☐ POLLUTION CONTROL-AIR

FOR PLANT CONTROLLER

PIG PROJECT NO. 16758

NON-PIG PROJ. NO. 7-13-81

"09" CHARGE 16

ACCEPTED _____ DATE _____

FOR PIG COORDINATOR

ACCEPTED _____ DATE _____

O C R NR D EC P PNZ

☐ QUALITY IMPROVEMENT
☐ CUSTOMER SERV./ NEW PROD.
☐ ENERGY CONSERVATION
☐ OTHER _____

BENEFITTING SYSTEM NO. _____ SYSTEM NAME Marine Terminal DIV. S&I RESPONSIBILITY H.Augustus/Durdin EXPECTED IMPLEM. 2 QTR 1981

STATEMENT OF PROJECT (WHAT IS TO BE DONE)	OBJECTIVE OF PROJECT (WHAT IT WILL ACCOMPLISH)
Marine Terminal Productivity Improvement	Reduce 8,320 manhours Maintenance requirements at Marine Terminal
BLDG. NO. _____	

COST DATA		EST COST	ACTUAL COST
CAPITAL(930)	$		
EXPENSE (09) (SAMPLE NO. _____)	$		

SUGGESTERS (PIG PROJECTS ONLY)	SUGGESTER'S DEPARTMENT	SUGGESTER CLASS (CIRCLE ONE)
F. C. Phinney		EX XXXXXXXXXX
M. E. Durdin		EX XXXXXXXXXX
H. J. Augustus		EX XXXXXXXXXX

SAVINGS DATA—FOR PHASE I PIG PROJECTS ONLY

EST. SAVS. ACT. SAVS.

RECURRING $ ~~224,420.00~~ 230,620.00 _____

NON-RECUR $ _____ _____

ESTIMATED DURATION OF RECURRING SAVINGS: 10 YEARS

☐ COST IMPROVEMENT
☐ COST AVOIDANCE

GROSS MARGIN DATA—PHASE 2 PIG PROJECTS ONLY (RECURRING ONLY—ATTACH GROSS MARGIN FORM)

INITIAL EST. $ _____ FINAL EST. _____

EXPLANATION: (ON PIG PROJECTS, SHOW PLANNED, DELIBERATE CHANGE AND SAVINGS CALCULATIONS)

A manpower utilization study was completed at the Marine Terminal in late 1980/ early 1981. The recommendations included adding one pickup truck and a non-exempt Coordinator to improve Maintenance efficiency. The Coordinator would free the supervisor to supervise his employees and the pickup truck would allow him the ability to move around the terminal.

In exchange for the truck and Coordinator, 8,320 manhours of Maintenance labor would be eliminated.

8320 manhours (Maint. Labor) X $31/hr (Sold service rate) = $257,920.00 Savings − $31,200 (Coordinator) = $226,720.00

$226,720.00 − $2,300 (Cost vehicle/yr) = $224,420.00 Recurring Savings.

SIGNED H A Smith DATE 6-23-81

IF CLOSING NOTICE, MAKE FINAL COMMENTS HERE (IF NEEDED, MAKE ATTACHMENT)

COPY 1 INITIATION NOTICE (RETAIN COPY 2 FOR FUTURE CLOSING NOTICE)

COPY 2 ☐ CLOSING NOTICE ☐ AFTER-THE-FACT PIG CLAIM (DISCARD COPY 1)

CT-1706-4 REV. 2-82

APPENDIX P

UNION CARBIDE CORPORATION
P. O. BOX 471 • TEXAS CITY, TEXAS 77590

July 13, 1981

Dr. M. J. Fox, Jr.
Professor of Industrial Engineering
Department of Industrial Engineering
Texas A & M University
College Station, Texas 77843

Reference: D. D. Tippett Internship

Dear Dr. Fox:

As you know, Don terminated his internship and employment with Union Carbide on May 15, 1981. The internship was an unqualified success. Don achieved the goals outlined in his Final Set of Objectives and made significant and measurable contributions to Carbide's business objectives.

Through scheduled orientations and specific job assignments, Don was able to observe and interface with all of the major line and staff departments. These included: (a) Plant Managers Group, (b) Employee Relations, (c) Environmental Protection, (d) Maintenance, (e) Shift Organization, (f) Plant Engineering, (g) Distribution, and (h) Operations. In conjunction with a work assignment, Don spent a week in West Virginia visiting various Carbide functions. He has achieved an indepth understanding of the individual plant departments and how they function together to achieve the corporate objectives.

Don took advantage of every opportunity to develop his interpersonal and management skills. He achieved significant growth in the area over the course of his internship, and was always an eager and articulate participant in our weekly meetings held to discuss specific work assignments, future goals, and management philosophies. Don learned and used the techniques of the Union Carbide Management System (UCMS). Especially noteworthy is his ability to clearly define project objectives and standards. These skills coupled with his drive and ability to achieve results through others account for the high performance level achieved during his internship.

The primary emphasis of the internship was on learning by doing "real and productive work." This, I believe, is best exemplified by Don's Marine Terminal Maintenance Work Force Utilization Study. This study will be the basis for implementing changes in maintenance organization and work practices at the Marine Terminal and is expected to achieve $224,420 per year savings. The improvements achieved through implementing these

recommendations demonstrate Don's ability to assimilate the economic, social, regulatory, labor relation, and technical issues of a relatively broad scoped objective.

In summary, I believe Don has fully achieved all of the goals outlined in his Final Set of Objectives and has demonstrated superior skills as a responsible and technically competent practicing engineer.

I look forward to serving on Don's graduate committee for the final defense of his internship report.

Very truly yours,

M. D. Lindsay

MDL/jf

cc: Mr. J. Rowland, UCC
Mr. D. D. Tippett

Vita

Donald Dwight Tippett
3803 Courtney Circle
Bryan, Texas 77801

Birthplace: South Charleston, West Virginia

Birthdate: August 22, 1947

Parents: Virgil Dwight and Betty Jean Tippett

Family: Married with two children

Education:

B.S., Naval Science
United States Naval Academy, 1969

M. Eng., Industrial Engineering
Texas A&M University, 1979

Experience:

July 1981 - Present
Lecturer, Industrial Engineering Department
Texas A&M University

July 1980 - May 1981
Engineer, (Doctor of Engineering Internship)
Union Carbide Corporation
Texas City, Texas

January 1981 - May 1981
Instructor (adjunct)
Natural Science and Mathematics Division
College of the Mainland
Texas City, Texas

September 1979 - May 1980
Graduate Assistant (Teaching)
Industrial Engineering Department
Texas A&M University

June 1969 - October 1979
Officer, United States Navy
(Active Duty)

The typist for this report was Sally B. Tippett