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MANUFACTURING TECHNOLOGY
FOR
SHIPBUILDING

SHIPBUILDING TECHNOLOGY TRANSFER

U.S. DEPARTMENT OF TRANSPORTATION
MARITIME ADMINISTRATION

in cooperation with
Avondale Shipyards, Inc.
New Orleans, Louisiana

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PRODUCTION PUNNING AND Scheduling AGENDA

First Day - May 18;1982

07:30 - 08:00	Coffee
08:00 - 08:30	Overview and Background
	O: Gatlin
08:30 - 10:00	Hull Planning and Scheduling
	C. Starkenburg
10:00 - 10:15	Coffee
10:15 - 11:45	Details of Hull Planning
	D. Smith
11:45 - 13:00	Lunch
13:00 - 14:30	Outfit.Planning and Scheduling
	C. Starkenburg
14:30 - 14:45	Break
14:45 - 16:15	Details of Outfit Planning
	G. Grimsley

Second Day - May 19, 1982

07:30 - 08:00	Coffee
08:00 - 09:00	Engineering Interface
	T. Doussan
09:00 - 09:30	Mold Loft and Production Engineering Interface
	G. Blaxichard
09:30 - 10:00	Material Control Interface
	F. Logue
10:00 - 10:15	Coffee
10:15 - 11:00	Accuracy Control Interface
	J. Taylor
	W. Weidman
11:00 - 12:00	Questions and Answers
12:00 - 13:00	Lunch
13:00 -	Shipyard Tour

BACKGROUND AND INTRODUCTION
PRODUCTION PLANNING AND SCHEDULING
AVONDALE SHIPYARDS, INC.

Prepared By: O. H. GATLIN

BACKGROUND AND INTRODUCTION

I. INTRODUCTION

MarAd, over the past several years, sponsored a series of studies on the level of technology in U.S. shipyards and on the possible transfer of Japanese technology. In-fiscal year 1980, MarAd and Avondale cooperated on a "Technical Evaluation of Avondale's Production Operations and Organization, the Development of a Long Range Facilities Plan, and the Integration of Both," under Contract No. MA-8O-DOC-O1O17. The technical evaluation of Avondale's Production Operations and Organization was performed by Ishikawajima-Harima Heavy Industries (IHI). In this study, Avondale concluded that they could significantly improve their productivity by using the IHI technology. But, there are so many areas that could be affected - many of which are outside the shipyard control - that Avondale could not implement all of the recommended changes at one time.

In order to improve productivity the most with the least amount of disruption, Avondale proposed to implement four of the IHI systems recommended in the Technical Evaluation. They are:

- Accuracy Control
- Production Planning .
- Computer Application
- Design Engineering for Zone Outfitting with Procurement Specifications.

This effort was to be a demonstration intended not only for the benefit of Avondale, but of all U.S. shipyards. Avondale was required to work closely with MarAd and the U.S. shipbuilding community to insure adequate dissemination of all information.

II. OBJECTIVES

The objectives were to decrease the time between the contract date and ship delivery and to increase productivity and reduce cost.

The following specific objectives arose out of the Technology Evaluation:

implement the IHI system of accuracy control at Avondale;

implement the IHI system of production planning at Avondale;

implement the IHI system of computer application it Avondale;

implement the IHI system of design engineering with procurement specifications at Avondale.

Each of the four systems were broad and extensive. In order to implement the systems, the following action was taken:

A) We selected the specific elements within each of the four systems which realize the most significant improvement in productivity with the least amount of disruption during the integration period.

B) We determined to what extent the selected elements must be tailored for adoption for Avondale and for use as an Americanized version of Japanese technology.

C) We determined what elements of the four systems are measurable and that a comparison can be made between the method previously being used and the method finally adopted.

We will tell you the organization adjustment problems encountered and how they were overcome.

Presentations will be made as follows:

- Mr. Chuck Starkenburg, Hull Planning and Scheduling, Outfitting Planning and Scheduling;
- Mr. Donald Sours, Details of Hull Planning;
- Mr. Greer Grimsley, Planning and Scheduling;
- Mr. Tom Doussan, Design Engineering Interface for Production Planning and Scheduling Presentation;
- Mr. Eugene Blanchard, Mold Loft and Production Engineering;
- Mr. Frank Logue, Material Control;
- Mr. Walter Weidman, Accuracy Control as Interface of Production Planning, and Distortions of Units;
- Mr. Jim Taylor, Accuracy Control in the Shipfitting Department.

The subject of this seminar is on the zone construction approach to Production Planning and Scheduling. An agenda of the seminar is included in the handbook. For future planning purposes, all the seminars we plan to hold are scheduled as follows:

- Production Planning & Scheduling - + May 18-19, 1982

  Design Engineering for Outfitting - July 21-22, 1982

- Computer Applications - September 8-9, 1982

- Productivity Control Lifting
  Accuracy Control & Line Heating - November 3-4, 1982

Each seminar is organized to cover in-depth the primary subject - example: Production Planning and Scheduling. Additionally, we will present the influence or interface and effects of Production Planning and Scheduling to the other departments or subject areas.

This may not be the best approach; however, we feel it is suitable to demonstrate that implementing this technology requires that all departments of a company must work as a team and re-align their thinking in order to succeed.

HULL PLANNING AND SCHEDULING

HULL PLANNING AND SCHEDULING
AVONDALE SHIPYRDS, INC.

Prepared By: C. J. STARKENBURG

HULL
PLANNING AND SCHEDULING

I. INTRODUCTION AND BROAD APPROACH

The history of Japanese technology transfer to American shipyards has been adequately covered in many previous seminar discussions and, so, will not be discussed further here.

In this session, which is one of four different seminars, we will be focusing on hull and outfitting production planning and scheduling at Avondale Shipyards, Inc.

Our subject for the next two days will be a presentation of the planning and scheduling functions being performed at Avondale as a result of implementing and applying those principles learned and assimilated from IHI. These methods were introduced by the National Shipbuilding Research Program of the Maritime Administration through the Shipbuilding Production Committee of SNAME.

A) GENERAL APPROACH

The general approach taken to absorb the merits of the technology transfer from IHI is simply shown in the illustrated Graph No. 1 HL.

Over the course of several contracts since 1980, varying degrees of the IHI technology have been implemented and applied.

Shown in Graph No. 2 HL is the percentage of application that was given to each contract in the Main Plant.

The bar chart is based on the approximate number of people that were actively engaged in Engineering and Production given to implementing the technology as a percentage of the total probable work force on the contract at that time.

You will notice on the Exxon contract that approximately 90% of the probable work force will be actively engaged during the construction period and from design to delivery on all three ships.

The term “work force” includes Engineering.

B) GENERAL HULL PLANNING AND SCHEDULING

Before the advent of the new shipbuilding technology, hull planning and scheduling was very conventional, low profile and resulted in many impromptu planning and scheduling changes made in the field during the production process. These changes were necessitated only because the original Plan was not in great enough detail, nor was the logic of product work breakdown" used to any great extent.

Under these circumstances, top management had to rely on the scheduling and planning made by the work force during the many "fire drill" situations which arose.

The authority to allow the individual work forces to make these changes was, therefore, surrendered by management out of a necessity to keep the production of steel moving, regardless of the inefficiencies along the way.

This surrender was only due to a lack of any other specific program available that could, with precise logic and vision, produce each piece in a predictable and, at the same time, in a reliably scheduled effort. We began our efforts by analyzing how much of a percentage, mold loft and cutting, assembly and erection, each represented in the total hull construction. The results of this breakdown are shown here in Graph No. 3 HL.

The next IHI study at Avondale was a comparison of steel breakdown production, using a base of 7,000 short tons per month which was comparable to one of their shipyards. This is shown in Graph No. 4 HL. You will notice that the main assemblies have been divided into several categories and we will discuss this is a few minutes.

The first question to be answered was, "Is there enough steel production real estate at Avondale in which to build the various categories and sub categories of modular structures, using the IHI methods of product work breakdown?"

A study was made to identify those categories of main assembly blocks or units used to construct an average product carrier or container vessel. This categorization is shown clearly in Graph No. 5 HL and Graph No. 6 HL.

Please note that the five different categories are all grouped more or less by problem and by shape.

We then took the estimated category percentages by weight per month in tons for each category. This was targeted for a reasonable total monthly production at ASI of approximately 8,000 tons. This breakdown is shown in Graph No. 7 HL.

Next was a determination of square meters in work area required to produce the necessary tonnage for each category. If we refer back to Graph No.4 HL, this graph shows the square meter area used in the Kure Shipyard in Japan to produce the tonnage of each category based on their 7,000 tons each month. As you can see, productivity varies with each category.

We then assumed that American production was one half that being produced at Kure, Japan. Graph No. 8 HL shows that the existing Avondale work areas or platens have sufficient square meters available to produce 8,000 tons of steel per month.

On this basis, we felt reasonably secure that whatever technological hull planning and scheduling principles we would wish to adopt could be done without a great expenditure of capital funds for real estate.

Our next step began with the total overall general requirements necessary for a meaningful and realistic approach to the entire planning and scheduling process. Obviously, hull planning and scheduling is only one part of many integrated parts and efforts from beginning to end.

Our basic approach to hull planning and scheduling begins before contract by the use of a document called:

> "Job Description At Each Stage In New Hull And Outfitting Engineering Procedure At A.S.I."

Graph No. 9 HL shows the overall effort in a very simple format. You will find this document in more detail printed in seven separate sections throughout your handout.

All the items listed to the left of the contract stage are required to be finally resolved prior to the signing of the contract.

At contract signing, a meeting is held to insure that all this information is available for further processing.

A brief walk-through of this portion of the document will perhaps highlight the necessity for it. Graph No. 10 HL Section No. 1, Graph No. 11 HL Section No. 2, and Graph No. 12 HL Section No. 3 show in more detail the many items involved.

The marketing stage definitions are fairly well detailed and are really the key pieces of information necessary for all of the subsequent stages.

Contract specifications, along with the ship's proportions and lines of course, are essential.

The general arrangement of hull and machinery, along with superstructure and quarters arrangement, should be well defined.

The midship sections, scantling sections, and preliminary shell expansion definition are also made available.

Cargo system diagrams and supporting ancillary diagrams should also be known.

Engine room and related other piping diagrams are also fairly well resolved for system sizes, etc.

As you can also see by the list, numerous calculations and other technical data should be established at this time.

The procurement sepcifications must be in the stage of resolution by contract date. We had some problem with this early on, particularly with the inert gas system.

Other data is, of course, listed below and will be covered later in the seminar:

- initial regulatory body review;
- preliminary unit definition;
- identification of the construction method;
- establish outfitting zones for purchasing;
- study and preliminary assignment of package units, on unit and on board.

We refer again now to Graph No. 9 HL where we find that one month after contract the second meeting, or "go" meeting, is held with Engineering, Planning and top management to insure that the preparation stage and finished design drawings are ready to start the key plan stage. A more detailed discussion of Engineering's role in hull and outfit planning and scheduling will be discussed in the second half of the seminar tomorrow, under integration of hull and outfit engineering.

Four months following the "go" meeting, a third meeting identified as the "K" meeting (or key plan stage) is held to insure that approvals have been obtained from regulatory bodies and the owner, along with the completion of the key plans in hull, mid cargo section, the engine room and superstructure. A pallet schedule is issued at this time on all outfitting material for on-unit and on-board work. The pallet system will be discussed in a later session.

Four months after the “K” meeting, hull drawings are issued to the Mold Loft to start their unit control manuals. A meeting is held at this time, called a “ML” (Mold Loft) meeting, to insure to top management that this schedule is being followed.

Parts programming, templates, numerical control tapes, outfitting drawings, jig instructions are delivered to Production starting three months later.

This particular engineering hull and outfit schedule was not used on the A.P.L. Container Ship contract due to the entry of the technology system too late after the A.P.L. contract was signed; however, many of the other IHI methods were incorporated into A.P.L. as we will eventually see.

Comparing the time used from contract to, drawing releases, and drawing releases to production (mold loft), and from this release date to keel laying, then from keel laying to launch, some improvements become evident. This is illustrated by Graph No. 13 HL.

The longer period, in the case of the A.P.L. contract, between issue of hull drawings and launch resulted from a design change from steam to diesel propulsion.

As of today, the hull drawings for the Exxon contract have been delivered to Production on schedule, and future performance still looks good.

The eight months between drawing issue (end of month number 9) and keel laying (end of month number 17) are divided into the following activities:

- Mold Loft production of the work plan - 3 months
- Issue of work orders and assembly of material - 1 month
- Fabrication, sub assembly and assembly of units - 4 months

C) PROCESSES AND FUNCTIONS OF HULL PLANNING AND SCHEDULING

The word "unit" will be used frequently during this presentation. Please note at this point that "unit" corresponds to the IHI term "block."

To keep productivity high, primary planning and scheduling should be developed beforehand for the following stages:

- material procurement
- fabrication
- sub assembly
- assembly
- erection

The work in these stages should be executed in accordance with planning and scheduling instructions. These instructions should be sub-divided into each group that has the same nature of work and should be the bible of hull construction. In other words, the plan and the schedule should drive the work and not allow the work to drive the plan or the schedule.

The functions of hull construction relate to each other and flow in a sequence as shown in Graph No. 14 HL.

The basic process for hull planning is:

- how to divide a hull into units to meet the best requirements of the erection sequence;
- how to assemble each unit into something with high productivity and quality, using a product work breakdown grouping.

The basic planning for unit sequence and unit erection is made by Avondale, using these IHI methods and by considering the following:

- determine the first unit to be put down (as a rule this is generally selected to be the engine room units to allow complicated outfitting to commence at an early stage);
- capacity of the cranes, both in assembly and erection;

the area facilities in the assembly yard, making sure deformation during assembly does not occur due to the size being too large;

maintaining the accuracy of the unit when turning for position welding;

- the fitting and welding lengths of each unit which will determine their length of stay at each construction stage;

consideration of on-unit outfitting;

the size of the unit which should be determined and adjusted with the outfitting. schedule so that the merits of both hull construction and on-unit outfitting can be achieved.

The first hull document made is the “Preliminary Unit Definition," Graph No. 15 HL.

A portion of this plan is shown here and a full size complete plan is shown in your handout book.

This unit breakdown is made from hull scantling contract drawings and is developed prior to the “contract” meeting illustrated in Graph No. 16 HL Section No. 4.

Between the “contract” meeting and the “go” meeting is a period of one month we call the preparation stage. Most important here are the:

- faired lines by frame and station,

- basic unit arrangement,

- drawing issue schedule,

sea chest design,

- preliminary milestone schedule,

- labor and material estimate.

Some of these items are extremely essential for further development breakdown of the final unit arrangement documents in the “key plan stage.”

Between the “go” meeting and the “K” meeting, there is a time frame of four months.

This period is called the "key plan stage" and is shown in Graph No. 17 HL Section No. 5.

The key-plans developed during this stage are basically done in conjunction with the three main zones of the vessel:

- cargo block and fore body - Zone “D”,

  engine spaces and aft construction - Zone “M”,

  superstructure - Zone “A”.

Please note that they are grouped slightly different in this illustration due to the sequence of design priorities.

Also during this period, 70% to 75% of the required steel is requisitioned and the number of steel plates that have to be furnaced are resolved by the Mold Loft. This 70% to 75% of initial steel order generally consists of rectangular shaped shell, bulkhead, and deck plating.

The final unit breakdown and arrangement is completed in this period by the “K” meeting.

Every effort is made at this time to standardize as many units as possible in the area of the flat midbody.

All master butts in the midbody are held to approximately 8" forward of the frames wherever feasible ,in order to achieve the largest standard midbody unit length. In the case of Exxon Product Carriers, the midbody unit length is 48 feet. Plate edge seams are generally held above and parrellel to the various decks and flats, where possible, in order to. prevent crossing the flat or deck. This makes fitting and welding easier to perform.

An order of sequence in unit erection is then established, using the same hull document in Graph No. 15 HL and entering the sequence unit numbers on this document. This sequence is then charted out on an erection sequence master diagram.

Incidentally, please note on Graph No. 18 HL that the ship has also been divided into three (3) major zones and twenty-four (24) sub zones. This, also, is established prior to the “contract” meeting. The details of these zones and sub zones will be discussed during the portion of the seminar that deals with outfitting later in the program this afternoon.

The erection sequence master diagram shown here in Graph No. 19 HL illustrates how much advantage or disadvantage we shall have in unit erection from repetitive performance. For example, in this graph after initial keel laying of Units Nos. 1, 2, 3, 4, and 5, there are two more centerline innerbottom units to be layed two weeks apart, after which the outboard innerboard units are laid approximately every one week up to week No. 5, then every two weeks to week No. 9, then skipping two weeks, two more are laid, followed by two additional units the next week, skip a week, then one more, etc.

In Graph No. 20 HL, we find a more evenly distributed grouping of units that fall into a more regular cadence of erection. This provides us with a greater advantage to utilize the same people and the same equipment in predetermined and production line type of erection sequences.

You will note that a similar cadence occurs with longitudinal bulkheads, transverse bulkheads, deck sections, and side shells. This, then, would be the ultimate erection sequence and should be used, if at all possible. This type cadence also allows a maximum efficient movement of personnel, from ship-to-ship in multi-vessel construction, performing the same jobs.

Once we have decided on the erection sequence, the schedule is made and everything in hull and outfitting is reflected from this hull erection schedule.

D) PRELIMINARY UNIT ASSEMBLY PLANNING IS NOW ACCOMPLISHED BY UTILIZING THE KEY PLANS FROM ENGINEERING DESIGN SECTION AND IS PERFORMED BETWEEN THE “K” MEETING AND THE “ML” MEETING (SEE GRAPH NO. 21 HL SECTION NO. 6).

This sub unit breakdown planning is developed by the lead hull production planner in charge, giving every consideration to the following:

- hull unit categories

- fitting sequence

- fitting jigs (pin & fixed), facilities, etc.

  welding processes

  sub-assembly and assembly areas

The next step taken by the lead hull planner is the division of the ship’s units into hull shape categories. Graph No. 22 HL shows the nature of these categories, the shapes of the categories and the source from which each category derives its fabricated pieces and sub-assemblies. These categories become the keystone for establishing the process lane method of hull construction.

These six categories are further divided into subassemblies, partial sub-assemblies, and pieces.

Using this as a basis, the lead hull planner then starts writing his construction method instructions in great detail assigning partial sub-assemblies, sub-assemblies, and main assemblies to the specific manufacturing process lanes as generally depicted by Graphs Nos. 23 HL, 24 HL, 25 HL, 26 HL.

The above planning produces a document called "The Unit Breakdown Summary Sheet," Graph No. 27 HL. Shown in the graph is a partial write-up of Unit No. 36 (a deck section) and the routing and work instructions for processing the unit from start of construction to blast and paint (a full size example of this sheet is included in your handout).

This unit breakdown summary sheet will be explained in greater detail later in the seminar under "Details Of Hull Planning."

This document has considered in its development the following:

classification of parts (partial sub-assemblies, sub-assemblies, assemblies, pieces, etc.),

- lines and type of weld connections,

- beveling of welded edges,

extra stock for adjustment,

- provisions for accuracy control,

- pre-outfitting and blast and painting.

Rationalization and standardization of the work packages in this manner improves construction productivity by doing basically the same type work, in the same place, with the same people, using the same tools, and encouraging new and better methods through repetitive operations.

The unit breakdown summary sheets for each unit become the work instructions to hull engineers and draftsmen to make the detailed unit-by-unit yard plans which are sent to the Mold Loft with a unit parts list. Graph 27 KHL Section No. 7 shows the breakdown of the various stages between the "ML" meeting and keel laying. This shows the time frames previously mentioned of three (3) months for Mold Loft issue of the first UCM book, one (1) month for work orders, and four (4) months for fabrication and assembly.

With the yard plans and unit parts list, the Mold Loft then creates a work instruction booklet for each unit called a "Unit Control Manual," a sample of which is shown in Graph No. 28 HL.

The unit control manual is so printed by drawings and stages that it can be easily divided and distributed to each work group in each of the stages of process lane construction on a need-to-know basis.

This unit control manual shall be discussed in detail during the second day portion of our seminar.

E) THE UNIT BREAKDOWN SUMMARY SHEETS HAVE NOW CREATED THE "PRODUCT WORK BREAKDOWN" TO FIT INTO THE STAGES AND SUB-STAGES OF THE PROCESS LANE TYPE OF CONSTRUCTION.

For each of these sub-stages, at each lane and at each stage, controls are assigned to shop planners. The shop planners must control the daily schedule unit by unit, looking ahead approximately six to eight weeks. This monitoring of the short term schedule is based on the long term schedule developed by the Production Planning Department. These schedules are loaded to the platen foremen on a weekly basis.

In the long term schedule there are certain allowances for certain unpredictable adjustments. You can identify these as “work queue” periods and/or storage time.

Graph No. 29 HL shows a section of long term schedule for pre-fabrication, sub-assembly and pre-outfit.

These schedules will be discussed in greater detail later in this seminar.

Thus, the unit sub-assembly and assembly process progresses on schedule up to and including erection, each stage of which becomes one section of what we call the hull construction method.

F) THE ASSEMBLY STAGE IS THE FINAL HULL CONSTRUCTION STAGE BEFORE THE ERECTION OF THE UNIT.

The functions of this stage consist of the assembly of sub-units from other process lanes and panel lines into larger and complete hull units.

As previously mentioned, the grouping of these unit assemblies is by category and is dependent on the following:

the supporting facilities of the area (flat jigs for flat units - fixed and pin jigs for curved units);

the staying time in process (short time or long time) of fitting lengths, welding lengths, pre-outfitting, etc.

The long term schedule for assembly, pre-outfit, blast and paint, storage and erection is shown in Graph No. 30 HL.

Sub-schedules at this stage are made for each assembly area we call process lanes for main assembly.

The assembly step sequences, welding lengths for each step, crane hours, etc. can be graphed and determined before hand. A sample of this type of data and the time frames used is shown in Graph No. 31 HL.

This is the basic scheduling network that is typically used for all parts from cutting to erection.

This mechanism will also be described later in the seminar.

Up until now, no mention has been made of the significance of an item very important to hull and outfit planning and scheduling. That item is the coatings applied to the various parts of the steel from start to finish during hull assembly construction.

Planning and scheduling the coating system is just as much of the total hull picture as scheduling the hull and outfitting stages.

The purpose of planning and scheduling the paint system is to accomplish as much surface preparation and undercoating as possible during hull construction and prior to the vessel being erected.

Zone painting methods will vary depending on many factors, such as:

shipyard space for unit storage,

capacity of cranes,

construction methods.

A ratio of the work volume before launching and after launching depends on whether the units are assembled on the ground and finished painted before erection or finish painted after erection.

The following Graph No. 32 HL shows the advantages of finished painting prior to erection.

Unit construction and unit painting before launch:

before launch : 70% to 80%

after launch : 20% to 3070

Panel construction and panel painting before launch:

before launch : 45% to 50%

after launch : 50% to 55%

These percentage achievements seem to make for suitable and appropriate conditions for safe work and high productivity once the vessel has been launched.

When coatings are less than these percentages, productivity onboard should be expected to be lower and quality not to the optimum.

The expense of equipment on-board also increases, due to more blowers, scaffolds, etc. Paint coatings are very greatly intermingled with the hull construction picture. It is only briefly mentioned here to highlight its importance in hull and outfit planning and scheduling. There is now a separate program being prepared by SPC Panel 023-1 on this subject.

G) THE ERECTION STAGE IS THE FINAL STAGE OF HULL CONSTRUCTION WORK. ITS SCHEDULING IS THE KEY TO ALL THE OTHER preceding. STEPS .

Defaults at this stage can affect the ship's launch data and delivery; therefore, special attention should be paid at this time to safety.

The work sequence of the erection stage is that of joining hull units together performed for each tank or zone according to the erection schedule.

It is at this time that the units lose their individual identity and start to become part of the zone.

The erection stage is divided by sequences into a series of follow-on scheduled sub-stages shown here in Graph No. 33 HL.

These sequences are listed and scheduled for each tank, zone, and sub-zone and are generally performed by the same grouping of personnel per stage: a shipwright crew - a rough fitting crew - a finish fitting crew - a welding crew - an inspection crew - a testing crew - and a painting crew.

The dates of unit erection are determined by the hull erection schedule, previously shown in Graph No. 30 HL.

Fitting manhours and welding lengths are obtained by control charts similar to Graph No. 34 HL. With this data, the sub-schedules are made which tell us the predetermined amount of time needed to perform the fitting, welding, and other sub-stages for each unit, each tank, and each zone.

The execution of the erection sub-stage work, tank by tank and zone by zone, should be completed with no work remaining. Unfinished work negatively influences the total shipbuilding process; it slows down the progress of productivity and of pre-outfitting.

This influence is especially detrimental in engine room, boiler room, and cargo oil pump rooms.

Enough cannot be said about this subject of unfinished work.

To show some example of the cost disaster of unfinished work, an example was taken from one particular ship of a contract and is shown in Graph No. 35 HL.

Thus, for every ton left to be finished after launch, the cost is more than doubled. The costly delays to other crafts are, of course, not shown here but they become perhaps the most serious.

The progress and productivity of each tank and each zone completion will be checked at Avondale by the erection shop planners. This will include the progress of each trade by utilizing their particular parameter of gauging progress, such as feet of fitting, length of welding, weight of pipe, numbers of pipe pieces, square footage of paint, and so on.

H) <u>THE ERECTION STAGE PROGRESS DEPENDS TO A LARGE DEGREE ON THE ACCURACY CONTROL MEASURE TAKEN BY THE PRECEDING SUB-ASSEMBLY AND ASSEMBLY PROGRESSES.</u>

Accuracy control problems at the erection stage are mainly classified into two cases:

the accuracy of the finished condition at the completion of main assembly;

- deformed conditions occurring due to heating in the erection process such as welding, fairing, etc.

The first case at ASI is being approached by improving accuracy procedures in the sub-assembly and assembly areas. This was initiated by forming a knowledgeable team, headed up by a qualified engineer and called the "Accuracy Control Group."

This team, under IHI, has developed various procedures to improve accuracy through all the processes up to erection.

The results of the team have been very successful in improving the final accurate dimensions on the units being erected on the APL contract. This has made a significant improvement in the amount of time used by a burner in fitting a unit in the erection stage.

For example, we will refer to Graph No. 30 HL. This graph first gives us what the significance of the burning ratio means.

A very meaningful reduction has taken place at ASI in burning manhours in the erection site as a result of the dimensional and accuracy control program instituted at Avondale Shipyards.

This accuracy control check in the sub-assembly and assembly areas has also eliminated a great deal of deformation of plate edges caused by improper use of plate heads and welding deformations.

The subject of accuracy control will be further expounded on in the second half of our seminar tomorrow. This presentation today will not cover it in any detail.

In the second case, Avondale has had, over the last year (1981-1982), a six-month staggered program from IHI in the demonstration and teaching of "line heating," shrinking, fairing, and plate bending techniques; This has assisted in our planning and scheduling of hull construction by eliminating some furnacing and, more important, by eliminating many of the fixed steel jigs.

To illustrate the cost associated with the fixed jigs, the following data was taken from one of our past contracts where fixed jigs were used (see Graph No. 37 HL):

Steel - 725 tons @ $400 per ton =	$290,000
Manufacture in M/H 4,420 x 8.15 =	36,023
Fixed Jigs Total Cost =	$326,023

As a result of line heating technology, six (6) pin jigs for formed plate will be utilized at a considerable savings on the Exxon contract now being started. Also, line heating is used to correct plate and structural deformation at the erection site, thereby eliminating the cost of installing strong-backs and the use of excessive fairing of plate edges.

I) THE HULL PLANNING AND SCHEDULING THAT WE ARE REVIEWING DURING THIS SEMINAR IS CONCEPTUALIZED AND FORMED BY THE COMPLETION OF MANY SEQUENTIAL ACTIVITIES.

These activities, as we consider more of their individual details further into the program, all hinge on one strategic item: the scheduled successful delivery of the proper material to the designated manufacturing site.

Material handling and delivery to implement the process lanes concept is of extreme importance. I would like to dwell on this subject for a few minutes because of its tremendous impact to planning and scheduled events.

The basic concept of good plant layout is effective material flow. The objective is to minimize the number and length of routes and eliminate any unnecessary movements such as back-hauls, crosshauls, transfers, etc. Material flow problems can arise because of changes in the design of a process, or may develop because of gradual changes over time that finally manifest themselves in terms of bottlenecks in production, crowded conditions, poor housekeeping, failure to meet schedules, and a high ratio of material handling time to production time.

The material flow analysis, which was performed at Avondale, concentrates on some quantative measure of movement between departments or activities. Since the shipyard layout should be designed to facilitate the flow of the product, we are primarily concerned with the flow of materials. Some of the factors that affect material flow are:

external transportation facilities,

the number of items to be moved,

the number of units to be produced,

material storage locations,

- location of manufacturing service areas.

The development of the charts and diagrams presented in this analysis were generated from information collected during a ten-week period in March, April, and May of 1981. The information was extracted from reports derived by the Material Control Department and mobile crane servicing area. These reports represented actual material movements within the shipyard. The trip and distance information was summarized and is presented here in Graph No. 38 HL. The (from - to) charts were developed representing a measure of the steel material flow between work areas. These (from - to) charts provided
information concerning the number of material handling trips made between centers of activities, the volume of material moved between centers of activities, and the total material handling distances.

Using information developed by the process lanes committee concerning future work locations and working with the present methods, the proposed material flow method and its associated charts and flow diagrams were developed. The proposed flow method was developed by keeping in mind the process lanes concept of eliminating multi-hull cutting and the concept of work site storage queues. The charts of the proposed methods have incorporated present production rates for ease of analysis. Since the process lanes concept will eliminate steel material flow (except outfitting) to the fabrication storage area and direct this material to work site storage queues, proposed charts were developed by mathematically shifting related material from the fabrication storage area to the work site storage queues. The end result is a large reduction in material going to fabrication storage, structural bulk storage and an appropriate increase in material going to the work sites from the plate shop and platens.

As we can see from the Graph No. 39 HL, under the present facility layout and storage method, we move 9,174 pieces of steel material per week of which 60.7% is moved to or from the fabrication storage area. The proposed process lanes method will move 6,571 pieces per week of which 8% will move to or from the fabrication storage area. The reduction of 2,603 pieces per week will be due to the large reduction in double handlding due to eliminating much of the material movement to the fabrication storage area. Thus, a projected reduction of 18.4% in the number of pieces handled per week may be realized by the process lanes concept.

Presently, we make 170.5 trips per week moving an average of 53.8 pieces per trip of which 47.8% is moved to or from the fabrication storage area. The process lanes method will make 145.2 trips per week moving an average of 45.3 pieces per trip of which 6.4% will move to or from the fabrication storage area. Thus, a 14.8% reduction in the number of trips per week will be realized while handling 15.8% less material per trip. If we fill the loads to capacity (assume 53.8% pieces/load is capacity), we will reduce the trips by an additional 15.8% and project a total reduction of 30.6% on the total number trips per week.

The present facility layout has a total steel material movement of 66.6 (in plant) miles per week of which 60% is to and from the fabrication storage area. Under the proposed process lanes method, movement will be 43.4 miles per week of which 13.6% will be to and from the fabrication storage area. A projected reduction of 23.2 miles per week (34.8%) may be realized under the process lanes concept.

There are 177 distinct moves from area to area under the present material flow method. Under the process lanes method, there will be a reduction of these moves by 58 for a total of 119, resulting in a 32.8% decrease in the number of distinct moves.

Thus, evaluating the four areas above, it can be projected that a savings of approximately 30% in the handling of steel material will be realized due to the implementation of the process lanes concept. The appropriate cost savings can be obtained by evaluating the manpower, eqqipment, and energy reductions which will result from a 30% reduction in the handling of steel material. Thus, it has become evident from the analysis, that a major reason for process lanes implementation is the need for the evolution of an ideal material handling and flow system.

J) ORGANIZATION CHANGES DUE TO THE IMPLEMENTATION OF IHI METHODS

Many changes in the engineering planning and production planning organization had to be made in order to plug in much of the IHI technology.

By the same token, some of the IHI technology had to be modified to fit those social and traditional parts of our organization that could not or should not be changed at this time.

1) New functions had to be absorbed by the Mold Loft to implement line heating and the UCM book.

2) A new department was created and called “Operation Services” to handle all the various lifting devices and turning methods as a result of process lanes.

3) The Production Planning Department was reorganized into two divisions - Hull and Outfitting.

4) A modified system of planning hull construction entitled “Unit Breakdown Summary Sheet" was introduced.

5) A completely new system of unit breakdown and manufacturing called "Process Lanes" was introduced.

6) The yard construction, fabrication and assembly platens were all modified to accommodate the process lane concept.

7) A new group of skilled burners has been formed to create a "Line Heating Crew."

8) An accuracy control team of four people under a qualified engineer has been initiated to improve dimensional control.

9) A Production Group called Shop Planners has been formed to re-enforce the process lane concept at the local level.

10) The budgeting system of IHI has been modified to accommodate the concept of process lanes and will continue to develop until it forms the proper integrated system necessary.

11) Computer-oriented engineering, production, and material control programs have been initiated and are presently being evaluated.

Changes still need to be made to bring about a balanced and productive effort:

in Engineering,

in Production,

in Material Control,

in Administration.

Most changes, to be worthwhile, must be done deliberately with much planning, slowly, over a long period of time.

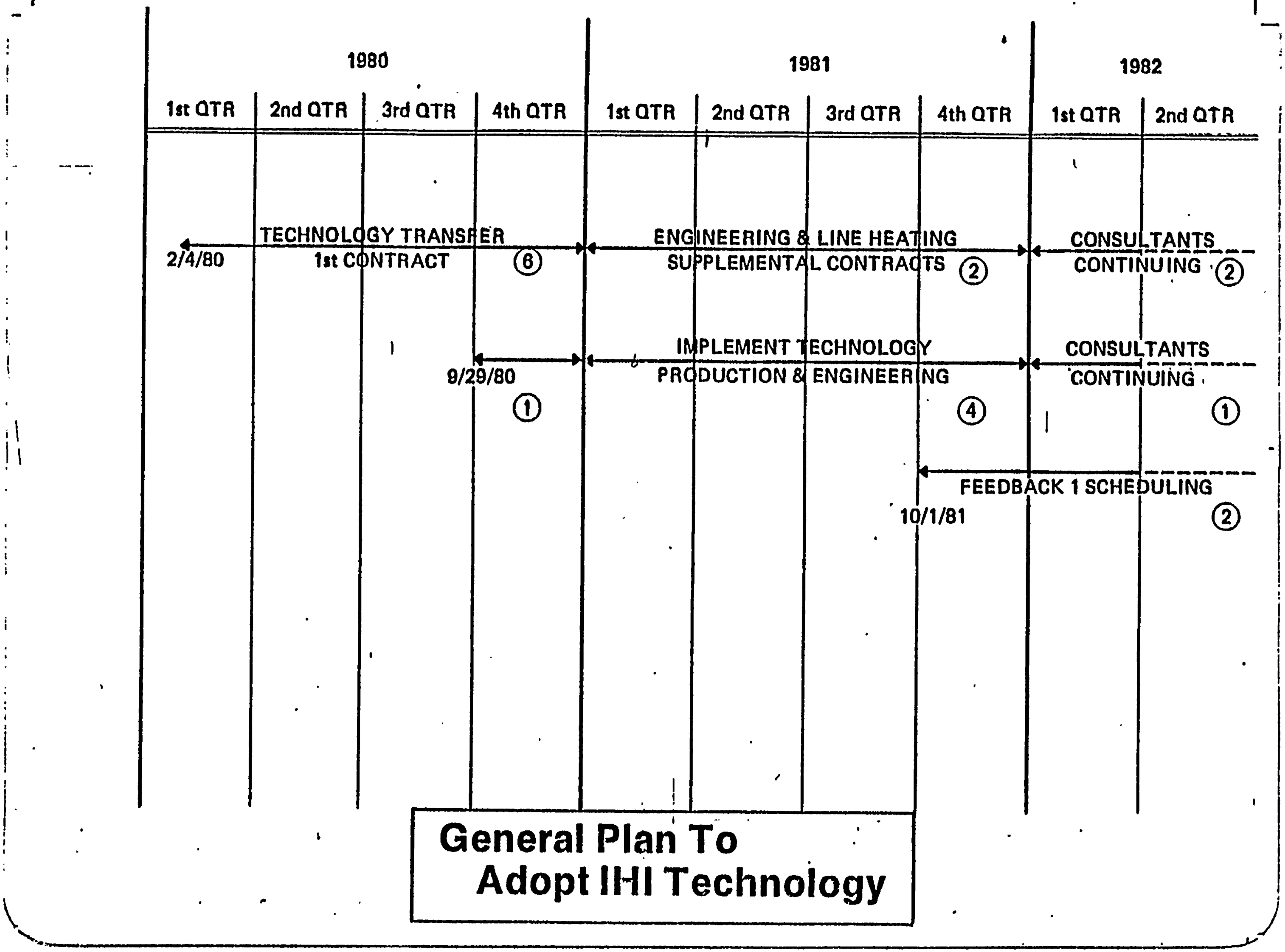
So it is with the changes of methods by any type of organization. There are no simple answers; there never shall be. If we are to get anything like the real productivity in shipbuilding we are all striving to achieve, we must first *realize the problems. Second, we must act with a spirit of consensus and recognize that we all have the same problems. Third, we must acknowledge that the problems can be solved only by using all of the solutions available. Fourth, we must begin by using the solutions that are within our grasp - namely, the implementation of "product work breakdown" technology as demonstrated by the techniques being described. These are really improved upon American techniques that we have allowed to atrophy and the Japanese have recognized them for what they are:*

"Keys to Competitive Survival."

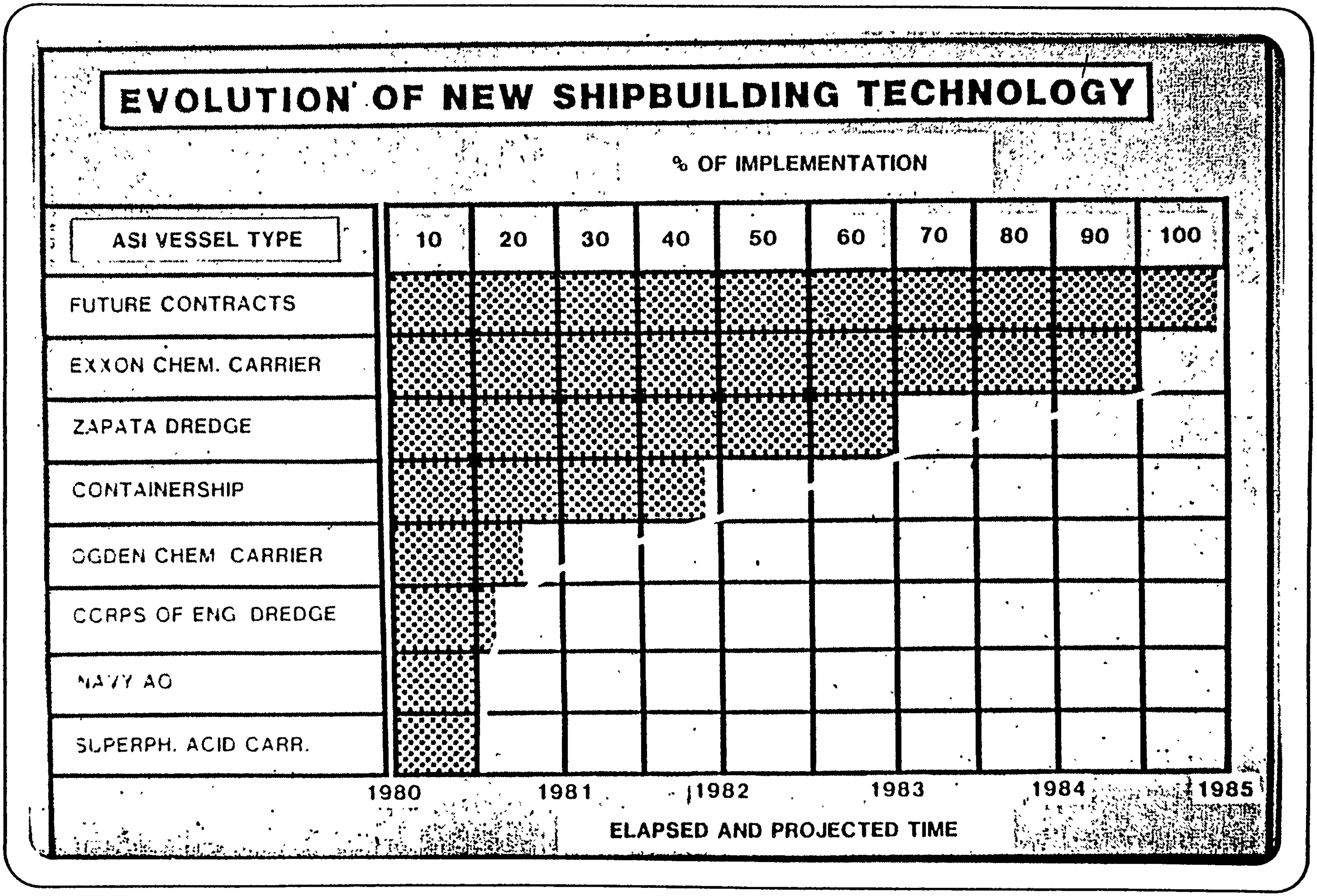
We hope at Avondale they will provide us with the same advantage.

VIEW GRAPHS FOR HULL PLANNING SEMINAR

	TITLE
1-HL	General Plan to Adopt IHI
2-HL	Evolution of New Shipbuilding Technology
3-HL	Hull Construction Breakdown
4-HL	Japanese Tons vs. Area
5-HL	Main Assemblies
6-HL	Sub Assemblies
7-HL	Estimated Category Percentages
8-HL	Avondale Tons vs. Area
9-HL	Hull &-Outfitting Engineering Schedule
10-HL	Marketing Stage - Section #1
11-HL	Marketing Stage - Section #2
12-HL	Marketing Stage - Section #3
13-HL	Engineering Drawing & Building Comp.
14-HL	Functions of Hull Construction
15-HL	Preliminary Unit Definition
16-HL	Contract to "GO" Meeting - Section #4
17-HL	"GO" Meeting to "K" Meeting - Section #5
18-HL	Preliminary Unit Zones
19-HL	Exxon Cadence Rev. 1
20-HL	Exxon Cadence Rev. 2
21-HL	"K" Meeting to "ML" Meeting - Section #6
22-HL	Category of Sub Platens & Assemblies
23-HL	Process Lane Flow for Pre-Fab
24-HL	Process Lanes for Sub-Assemblies
25-HL	Process Lanes for Assembly (Flat Units)
26-HL	Process Lanes for Assembly (Curved Units)
27-HL	Unit Breakdown Summary Sheet
27K-HL	"ML" Meeting to "Keel" - Section #7
28-HL	Unit Control Manual Title Page
29-HL	Pre-Fab and Sub-Assembly Schedule
30-HL	Main Assembly and Erection Schedule
31-HL	Scheduling Mechanism Network
32-HL	Vessel Painting



1-HL GENERAL PLAN TO ADOPT IHI


EVOLUTION OF NEW SHIPBUILDING TECHNOLOGY
% OF IMPLEMENTATION
ASI VESSEL TYPE
10
20
30
40
50
60
70
80
90
100
FUTURE CONTRACTS
EXXON CHEM. CARRIER
ZAPATA DREDGE
CONTAINERSHIP
OGDEN CHEM CARRIER
CORPS OF ENG DREDGE
NAVY AO
SUPERPH. ACID CARR.
1980
1981
1982
1983
1984
1985
ELAPSED AND PROJECTED TIME

HULL CONSTRUCTION BREAKDOWN

AVONDALE SHIPYARDS, INC.

MOLD LOFT & CUTTING	10%
SUB ASSEMBLY & ASSEMBLY	50%
ERECTION	40%

3-HL HULL CONSTRUCTION BREAKDOWN

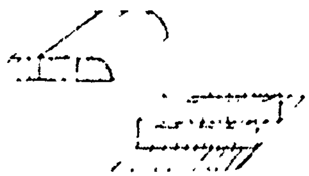
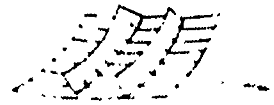
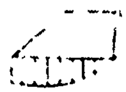
JAPANESE TONS VS AREA FOR BUILDING MAIN ASSEMBLIES

AVONDALE SHIPYARDS, INC.

CATEGORY	UNIT NAME	ASSY WT. TON MONTH	AREA M^2	PRODUCTIVITY OF AREA TON MONTH M^2
PANEL UNIT	MID PART: D. BOTTOM T. BHD. S. SHELL U. DECK	4,060	7,700	0.53
SEMI-PANEL UNIT	A & F PART: DECK, FLAT, T. BHD.	1,314	3,200	0.41
3 DIM. UNIT	A & F PART: D. BOTTOM	450	1,000	0.45
CURVED UNIT	A & F PART: CURVED S. SHELL	1,176	2,700	0.44
ASSEMBLED MONTHLY TONN.	TOTAL:	7,000	14,600	0.48

MAIN ASSEMBLIES

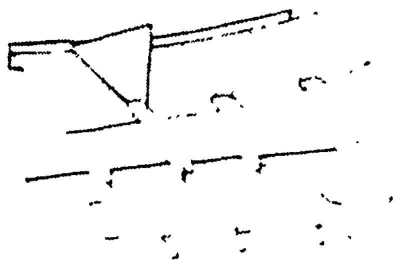
AVONDALE SHIPYARDS, INC.

CATEGORY	UNIT NAME	SHAPE	BAY
NO. 1 FLAT PANEL UNIT	MIDPART: DOUBLE BOTTOM SIDE SHELL LONGITUDINAL BULKHEAD		20
NO. 3 SEMI-FLAT PANEL UNIT	AFT. & FORE PART: DECK, FLAT, TRANSVERSE BHD.		BUILDING WAYS
NO. 2 CURVED UNIT	AFT. & FORE PART: SIDE SHELL		17
NO. 5 3 DIM. UNIT	AFT. & FORE PART: INNERBOTTOM		14
NO. 4 AFT. & FORE END UNIT	BOW CONSTRUCTION STERN CONSTRUCTION CANTED CONSTRUCTION		BUILDING WAYS

5-HL MAIN ASSEMBLIES

SUB-ASSEMBLIES

AVONDALE SHIPYARDS, INC.

CATEGORY	SUB UNITS	PLATEN
ORDINARY SUB 	FLOOR & GIRDER OF INNERBOTTOM WEB FRAME & GIRDER OF SIDE SHELL WEB FRAME & GIRDER OF DECK WEB FRAME & GIRDER OF LONGITUDINAL BULKHEAD ETC.	23 24
OTHERS	BUILT UP LONGITUDINAL	15
CATEGORY NO. 9	BILGE KEEL RUDDER HAWSE PIPE MAST SEA CHEST BULWARK ETC.	19

ESTIMATED CATEGORY PERCENTAGES

AVONDALE SHIPYARDS, INC.

CATEGORY	%	WT. /MONTH (TONS)
FLAT PANEL UNIT	52.8%	4,224
SEMI-FLAT PANEL UNIT	8.2%	656
CURVED UNIT	14.8%	1,184
3 DIM. UNIT	8.5%	680
A & F END UNIT	9.6%	768
OTHERS	6.0%	480

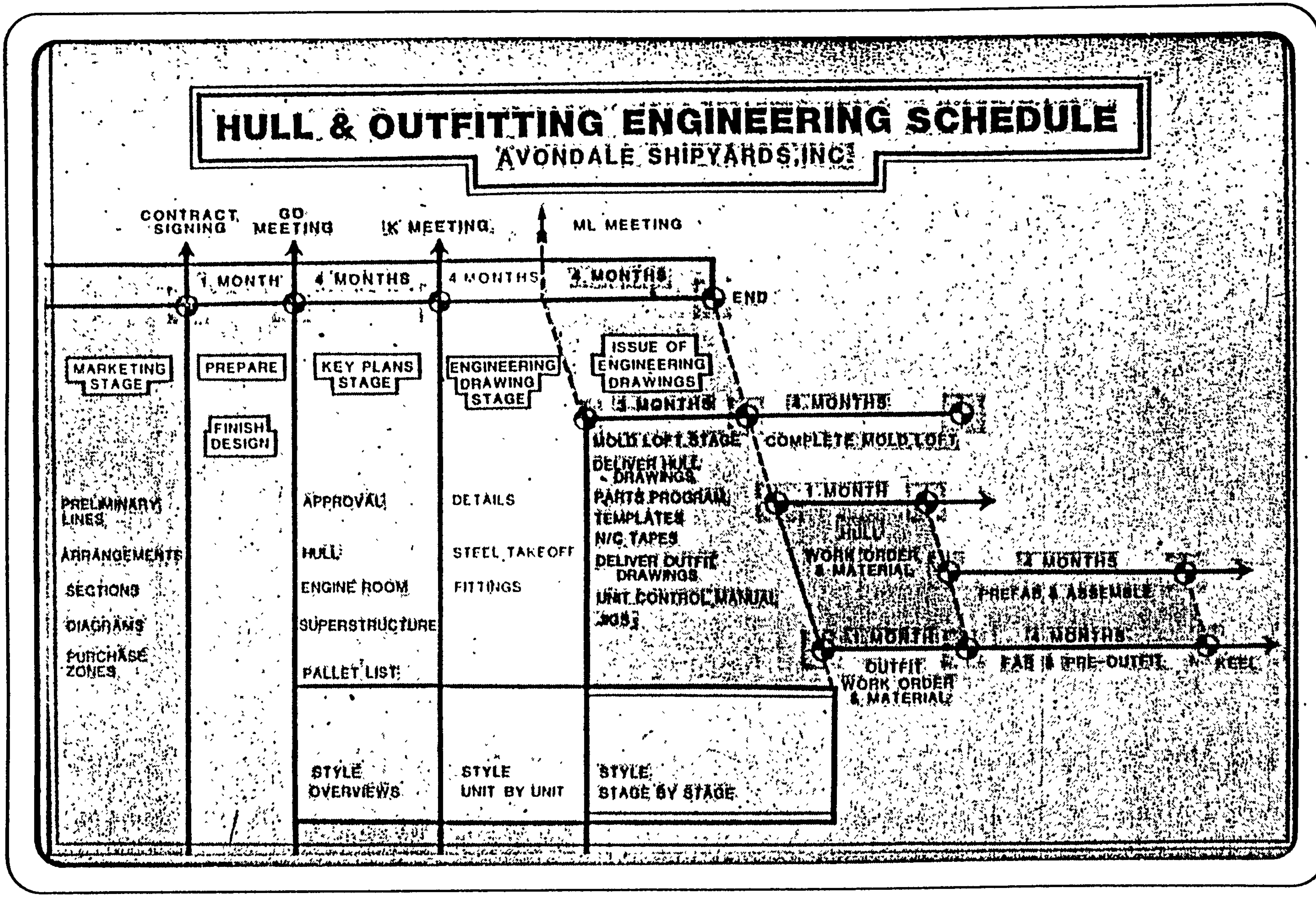
TOTAL AVONDALE PROJECTED MONTHLY TONNAGE - 8,000 TONS MONTH

7-HL ESTIMATED CATEGORY PERCENTAGES

AVONDALE TONS VS AREA FOR BUILDING MAIN ASSEMBLIES

AVONDALE SHIPYARDS, INC.

CATEGORY	ASSWT TON	PRODUCTIVITY OF AREA T. M.M^2	REQD AREA M^2	BAY	EXISTING AREA M^2
FLAT PANEL UNIT	4,224	0.26(0.53)	16,246	20	16,800
SEMI-FLAT PANEL UNIT	656	0.20(0.41)	3,280	WAYS	4,000
3 DIM. UNIT	680	0.23(0.45)	2,960		4,750
A & F PART: DOUBLE BOTTOM				14	
CURVED UNIT	1,184	0.22(0.44)	5,380		4,350
A & F END UNIT	768			UP & LOW WAYS	
OTHERS MASTS - RUDDERS	480			19	3,100



9-HL HULL & OUTFITTING ENGINEERING SCHEDULE

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

MARKETING STAGE DEFINITIONS

(A) – CONTRACT SPECIFICATION

– SHIP PROPORTIONS

– DRAWINGS

LINES

GENERAL ARRANGEMENT OF HULL AND MACHINERY

SUPERSTRUCTURE AND QUARTERS ARRANGEMENTS

MIDSHIP SECTION

SCANTLING SECTIONS

PRELIMINARY SHELL EXPANSION

CARGO OIL SYSTEM DIAGRAM (3)

INERT GAS, DEHUMIDIFICATION AND CARGO VENT DIAGRAMS (3) – 43 TANKS

ENGINE – RELATED AND OTHER PIPING DIAGRAMS

- – DIAG. MAIN ENGINE LUBE OIL SYSTEM
- – DIAG. MAIN ENGINE CYLINDER LUBE OIL SYSTEM
- – DIAG. LUBE OIL FILLINGS, TRANSFER AND PURIFIER SYSTEM
- – DIAG. STERN TUBE LUBE OIL SYSTEM
- – PIPING MATERIAL SCHEDULE
- – DIAG. ENGINE ROOM BILGE & BALLAST SYSTEM
- – DIAG. SEGREGATED BALLAST SYSTEM
- – DIAG. FEED AND CONDENSATE SYSTEM
- – DIAG. FIREMAIN – ENGINE ROOM
- – DIAG. FIREMAIN – ACCOMMODATIONS
- – DIAG. FIREMAIN AND FOAM SYSTEM – MAIN DECK
- – DIAG. CENTRAL FRESH WATER COOLING SYSTEM
- – DIAG. MAIN ENGINE JACKET WATER COOLING SYSTEM
- – DIAG. MAIN ENGINE PISTON COOLING WATER SYSTEM

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

- DIAG. MAIN SEA WATER COOLING SYSTEM
- DIAG. AUXILIARY SEA WATER COOLING SYSTEM
- DIAG. VENTS, SOUNDING TUBES AND OVERFLOWS
- DIAG. STEAM SYSTEM
- DIAG. SHIP'S SERVICE, STARTING AND CONTROL AIR SYSTEM
- DIAG. FUEL OIL SERVICE SYSTEM
- DIAG. FUEL OIL FILLING, TRANSFER, AND PURIFICATION SYSTEM
- DIAG. DIESEL OIL SYSTEM
- DIAG. FUEL, SLUDGE AND MAIN ENGINE CLEANING SYSTEMS
- DIAG. TANK HEATING COILS

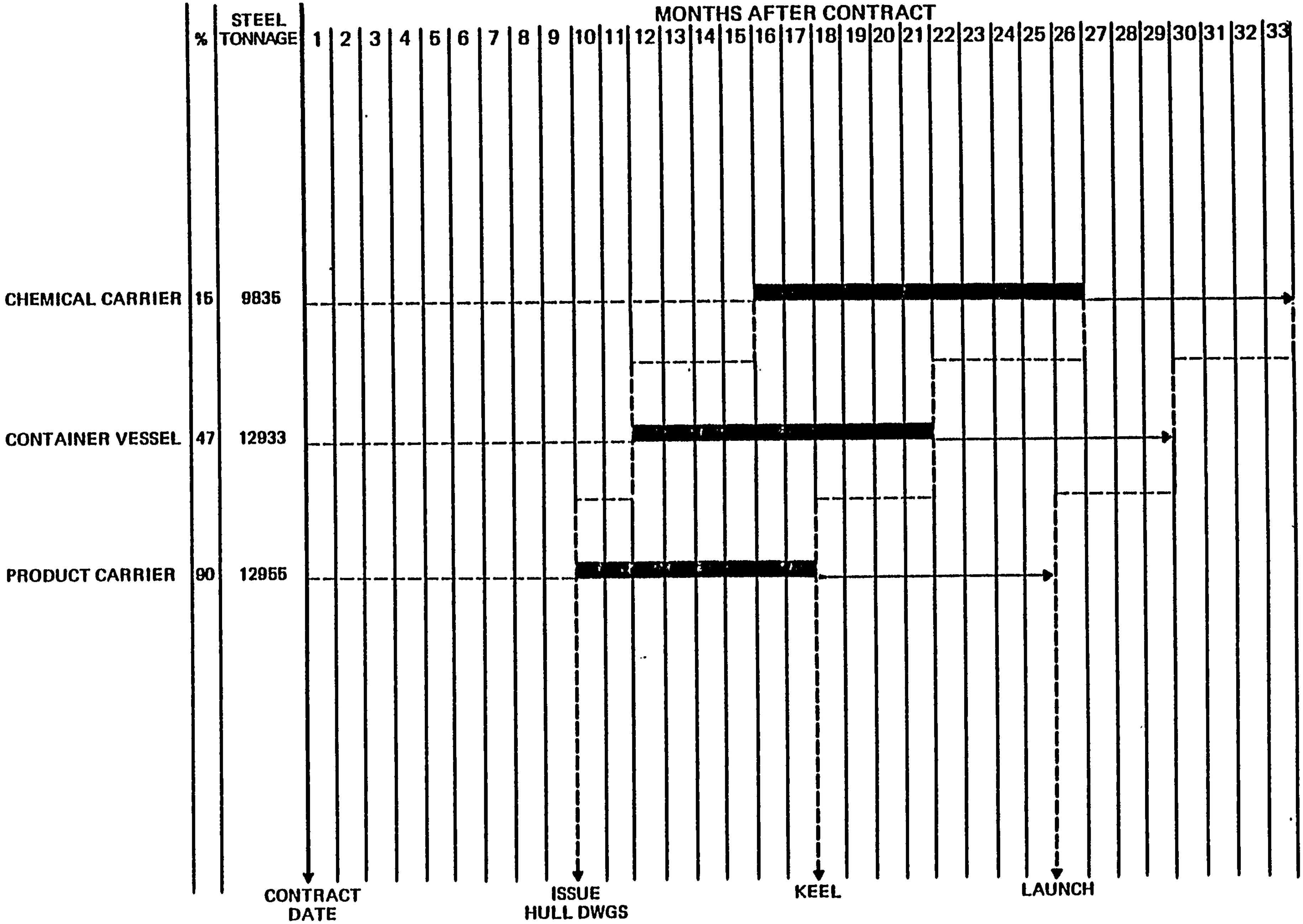
- CALCULATION OR OTHER TECHNICAL DATA
  - WEIGHT ESTIMATE
  - LONGITUDINAL STRENGTH
  - HYDROSTATICS
  - TANK CAPACITIES
  - BONJEANS CURVES
  - INTACT TRIM AND STABILITY DATA
  - LOADING CONDITIONS
  - DAMAGED STABILITY EVALUATION
  - WAKE SURVEY
  - RESISTANCE AND SELF-PROPELLED TESTS
  - ELECTRIC LOAD ANALYSIS
  - ELECTRIC ONE LINE DIAGRAM
  - VENT SYSTEM DEVELOPMENT AND DUCT OPENING

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

CONTRACT

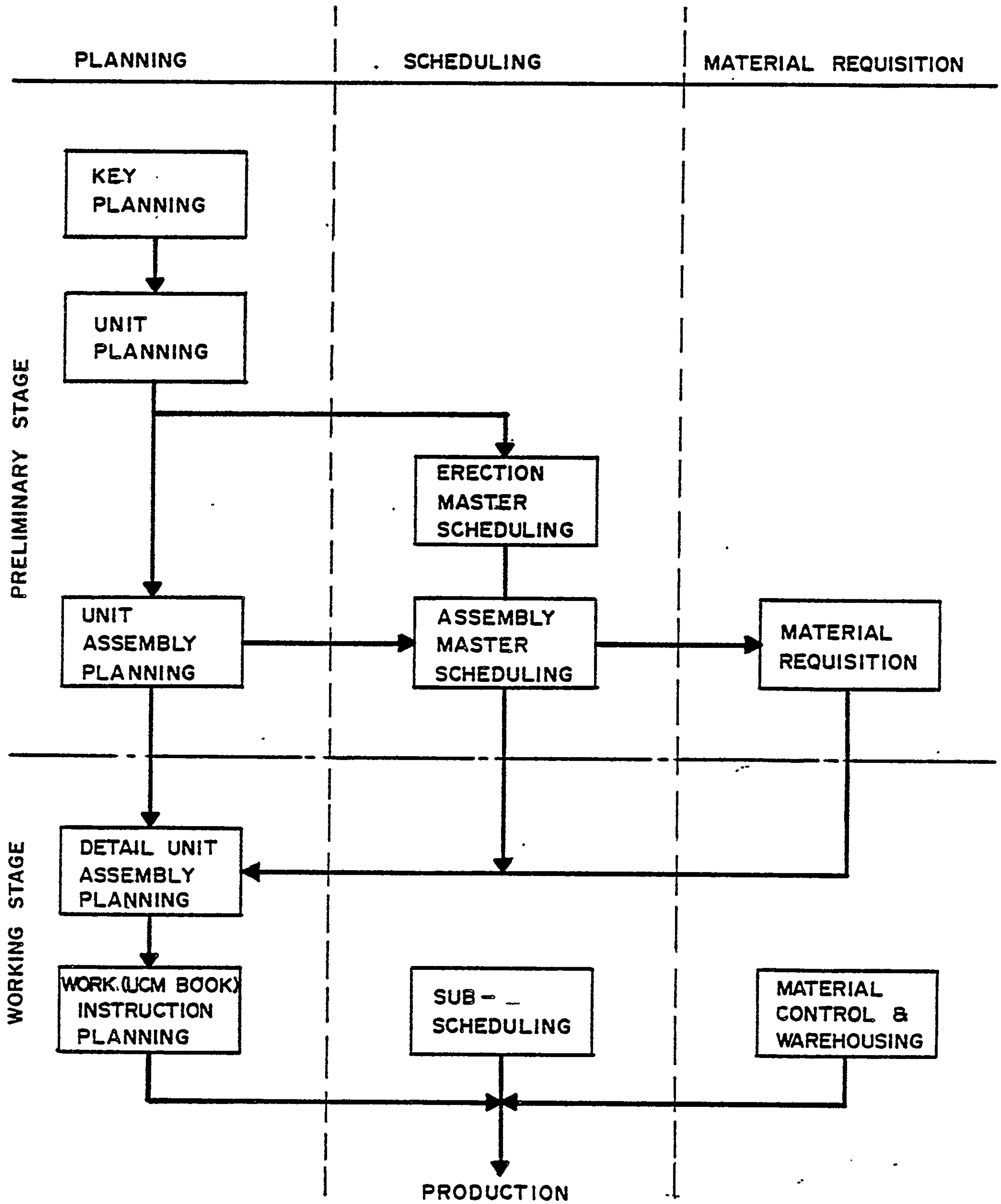
- PROCUREMENT SPECIFICATIONS
  - MAIN PROPULSION ENGINES
  - DIESEL GENERATORS
  - CARGO OIL PUMPS
  - BALLAST PUMPS
  - WASTE HEAT BOILER
  - ANCHOR WINDLASS
  - MOORING WINCHES
  - INERT GAS SYSTEM
  - DEHUMIDIFICATION UNITS
  - LUBE OIL, FUEL OIL, AND DIESEL OIL PURIFIERS
  - PLATE HEAT EXCHANGERS
  - ENGINE ROOM CONSOLE
  - CARGO SYSTEM CONSOLE
  - ELECTRIC MOTORS FOR CARGO PUMP
  - BOW THRUSTER
  - STEERING GEAR
  - BLENDING UNIT
  - AUXILIARY OIL FIRED BOILER
  - FUEL OIL PUMP/ HEATER SETS
- OTHER REQUIRED DATA
  - ✓ INITIAL REGULATORY BODY REVIEW
  - ✓ PRELIMINARY UNIT DEFINITION
  - ✓ IDENTIFICATION OF CONSTRUCTION METHOD
  - ✓ ESTABLISH OUTFITTING ZONES FOR PURCHASING
  - ✓ STUDY AND PRELIMINARY ASSIGN PACKAGE UNITS ON-BOARD AND ON UNIT MATERIAL

ENGINEERING, DRAWING AND BUILDING TIME COMPARISONS

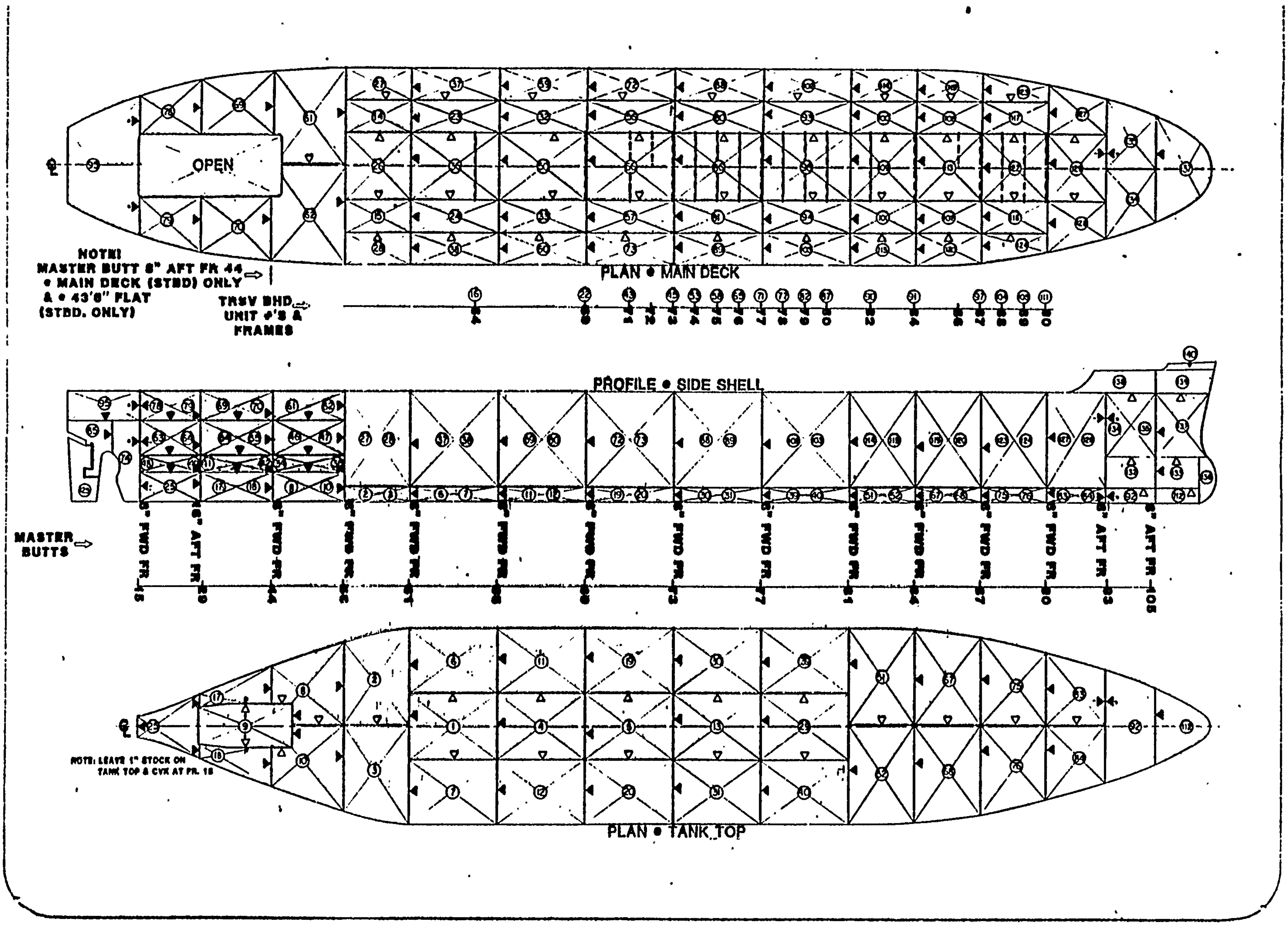


13-HL ENGINEERING DRAWING & BUILDING COMP.

THE FUNCTIONS FOR HULL CONSTRUCTION RELATE TO EACH OTHER AND FLOW IN SEQUENCE.



14-HL FUNCTIONS OF HULL CONSTRUC



15-HL PRELIMINARY UNIT DEFINITION

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

CONTRACT SIGNING

1 MONTH

GO MEETING

PREPARATION STAGE

(B) – FAIRED LINES (BY STATIONS) FAIRED LINES (BY FRAMES)—>

- LABOR AND MATERIAL ESTIMATE
- PURCHASE REQUEST FOR MAJOR ITEMS
- BUDGET
- ADJUSTMENT OF SPECIFICATION AND DRAWINGS
- BASIC UNIT ARRANGEMENT
- DRAWING ISSUE SCHEDULE
- SEA CHEST DESIGN (LOCATIONS AND NOZZEL LOCATIONS)
- OUTFIT PALLET LIST (PRELIMINARY)

3 MONTHS

- PROPELLER DESIGN
- FINALIZED APPLICATION OF PACKAGE UNITS, ON-UNIT AND ON-BOARD INSTALLATION OF MATERIAL
- OUTFIT MILESTONE SCHEDULE REVIEW
- TORSION ANALYSIS
- SHAFTING ARRANGEMENT

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

GO MEETING — 4 MONTHS — K MEETING

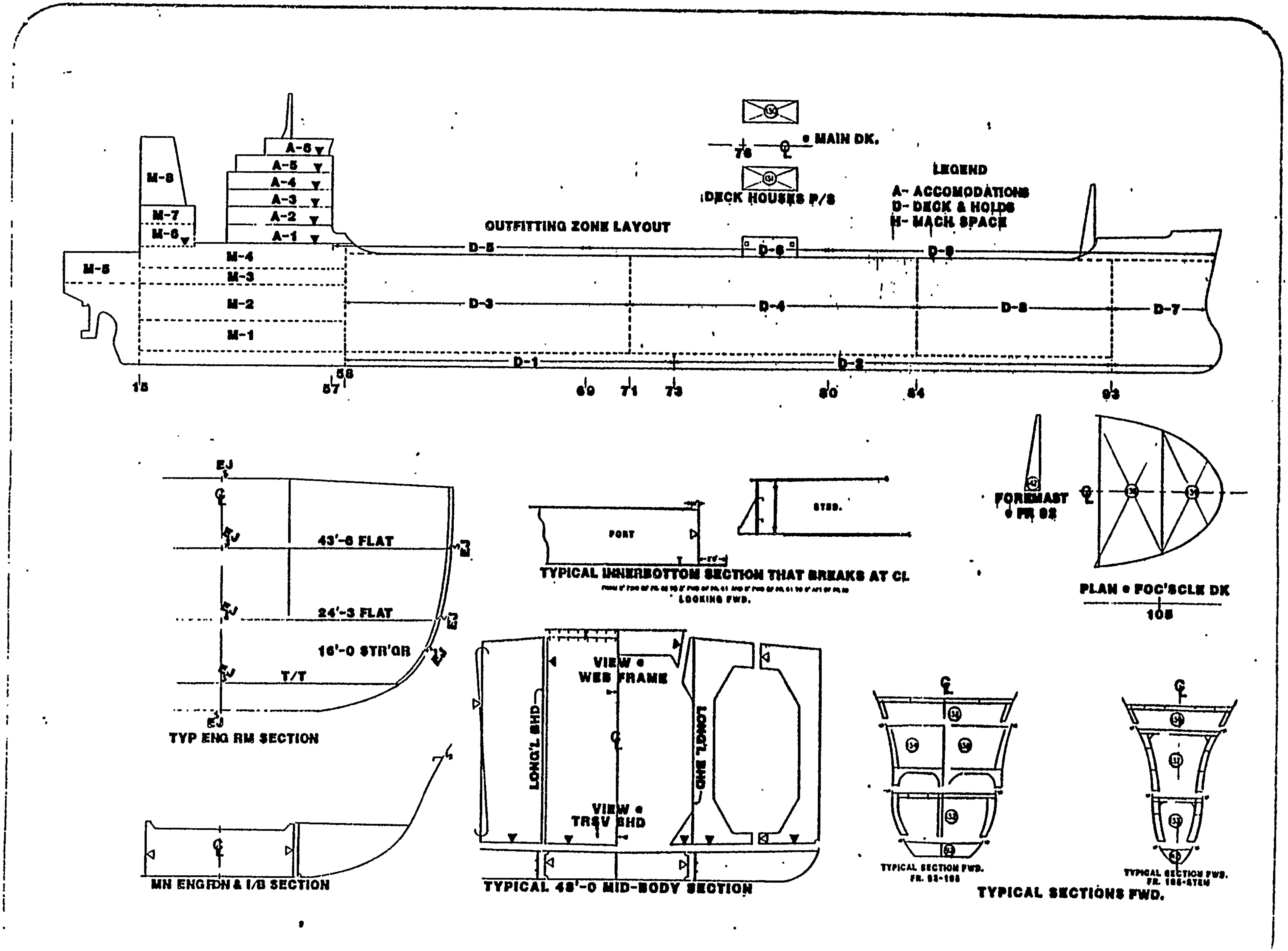
2 MONTHS	1 MONTH	1 MONTH
KEY PLAN CARGO BLOCK	AFT, PEAK AND E. R. SUPERSTRUCTURE	FORE BODY FWD. OF CARGO BLOCK

KEY PLAN STAGE

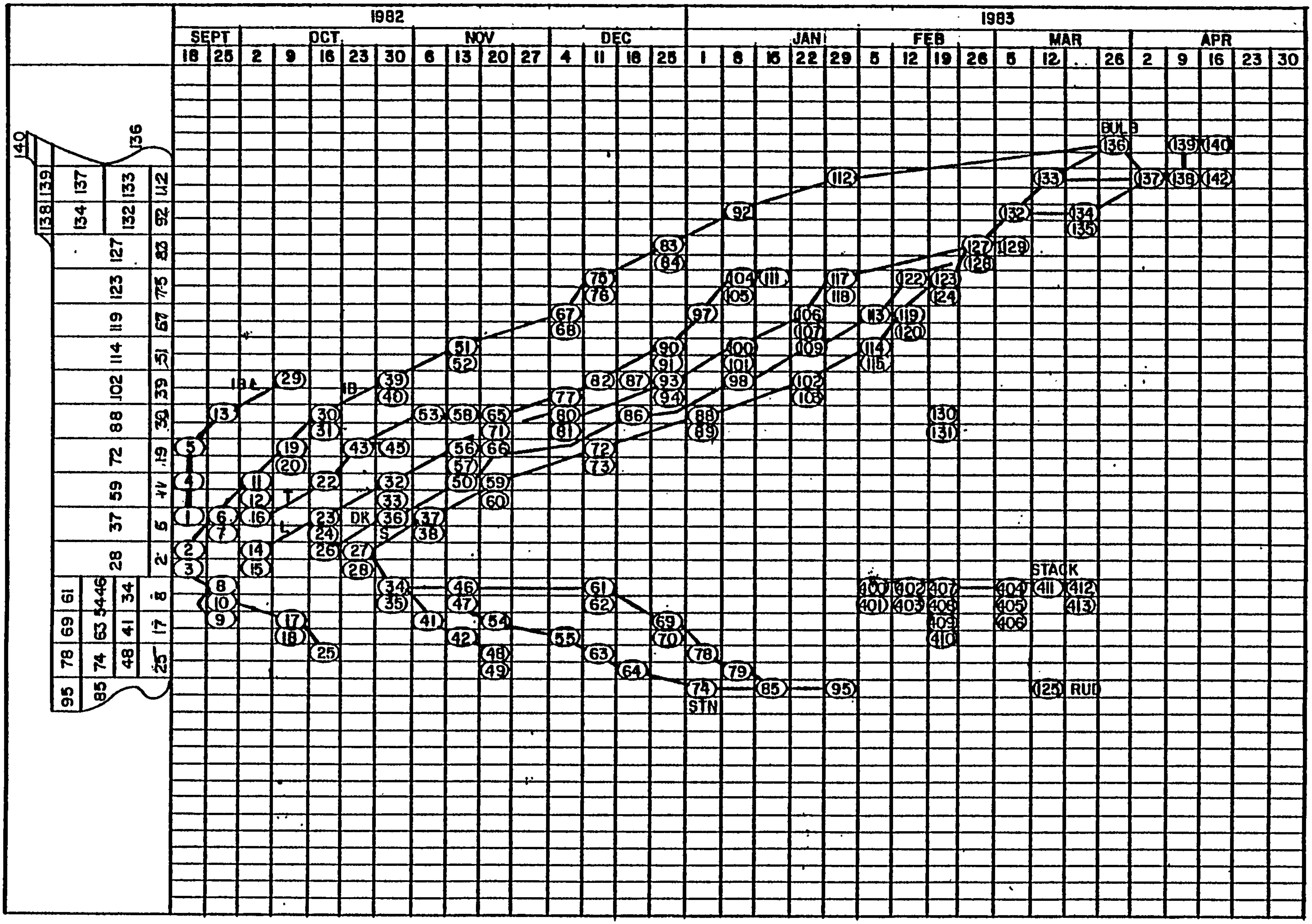
- FRAME BODY PLAN (BASED ON FAIRED LINES)
- SHELL EXPANSION
- FORE CONSTRUCTION
    - DECK, FLAT AND STRINGER
    - ELEVATION (LONGITUDINAL BULKHEAD AND GIRDER)
    - EVERY FRAME SECTION AND TRANSVERSE BULKHEAD
- HOLD PAR CONSTRUCTION
    - DECK AND FLAT
    - ELEVATION
    - EVERY FRAME SECTION AND TRANSVERSE BULKHEAD
- ENGINE ROOM AND AFT CONSTRUCTION
    - DECK AND FLAT
    - ELEVATION
    - EVERYFRAME SECTION AND TRANSVERSE BULKHEAD
- SUPERSTRUCTURE CONSTRUCTION
- SET-UP OF SPADE DATABASE
- APPROVAL OF REGULATORY BODY AND OWNER
- FINAL UNIT ARRANGEMENT AND LIST
- 70%–75% STEEL BILLED-BUY STEEL AS NEEDED
  DETERMINE PLATES TO BE FURNACED BY "K" MEETING
- ISSUE FINAL OUTFIT MILESTONESCHEDULE
- ISSUE FINAL PALLET LIST

STYLE OF DRAWING:

OVERVIEW OF STRUCTURE

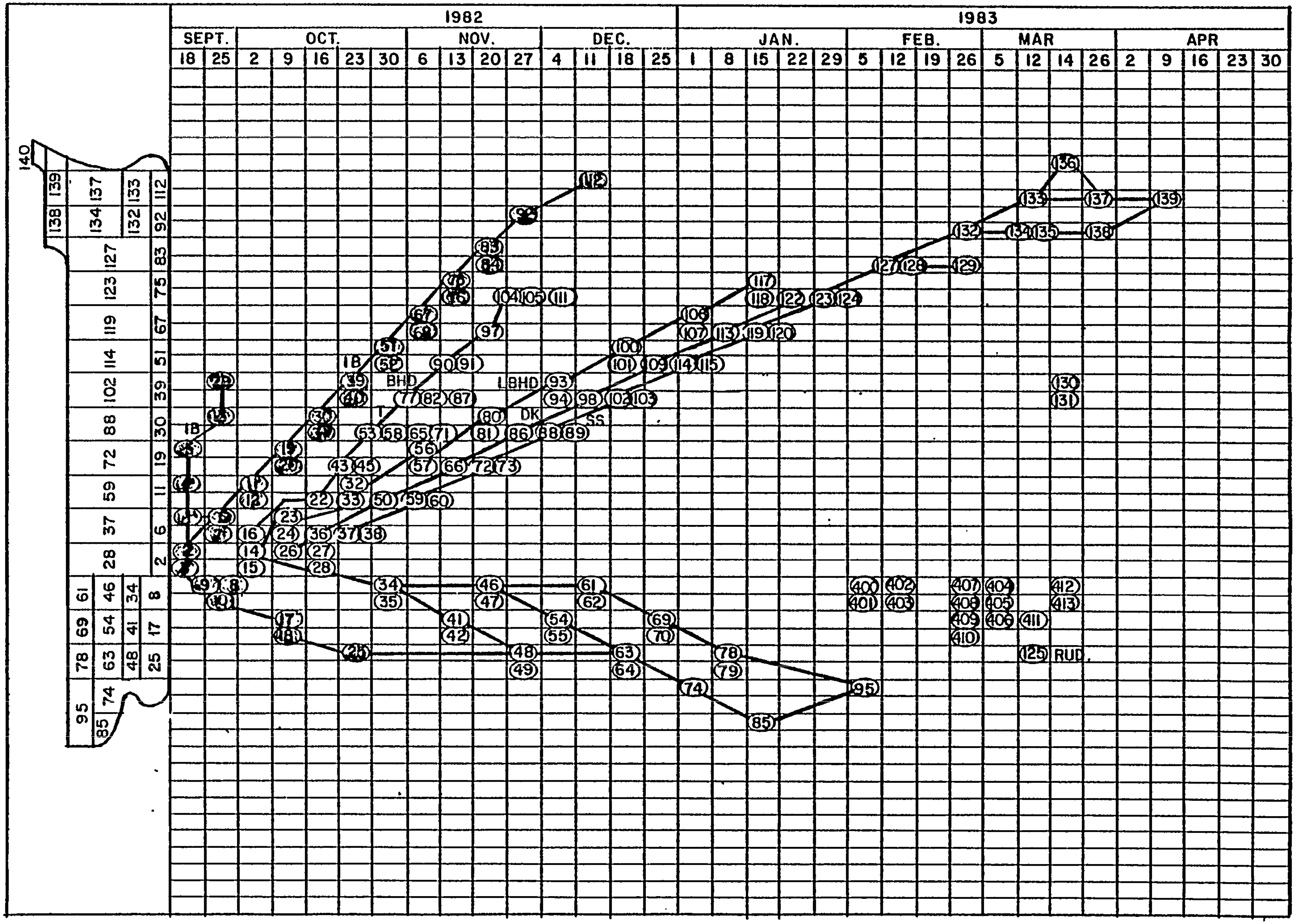

OUTFITTING ZONE LAYOUT
LEGEND
A- ACCOMODATIONS
D- DECK & HOLDS
M- MACH SPACE
@ MAIN DK.
DECK HOUSES P/S
A-6
A-5
A-4
A-3
A-2
A-1
M-8
M-7
M-6
M-5
M-4
M-3
M-2
M-1
D-5
D-6
D-9
D-3
D-4
D-8
D-7
D-1
D-2
TYP ENG RM SECTION
43'-6 FLAT
24'-3 FLAT
16'-0 STR'GR
T/T
EJ
TYPICAL INNERBOTTOM SECTION THAT BREAKS AT CL
LOOKING FWD.
PORT
STBD.
FOREMAST @ FR 92
PLAN @ FOC'SCLE DK
105
VIEW @ WEB FRAME
VIEW @ TRSV BHD
LONG'L BHD
TYPICAL 48'-0 MID-BODY SECTION
MN ENG FDN & I/B SECTION
TYPICAL SECTION FWD.
TYPICAL SECTIONS FWD.

EXXON NO. 1 ERECTION SCHEDULE REV 1



19-HL EXXON CADENCE REV. 1

EXXON NO. 1 ERECTION SCHEDULE



JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

K MEETING

ML MEETING

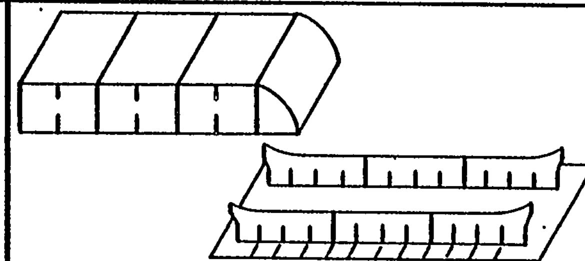
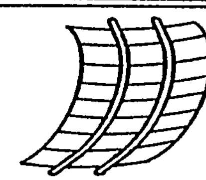
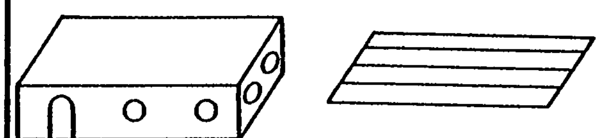
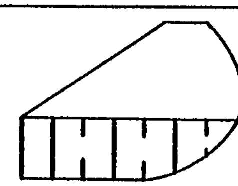
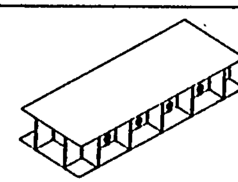
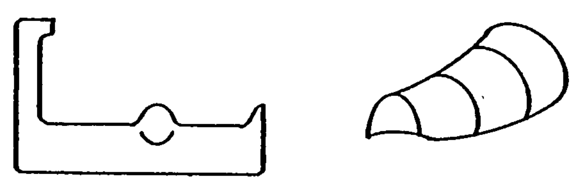
4 MONTHS

ENGINEERING DRAWINGS STAGES

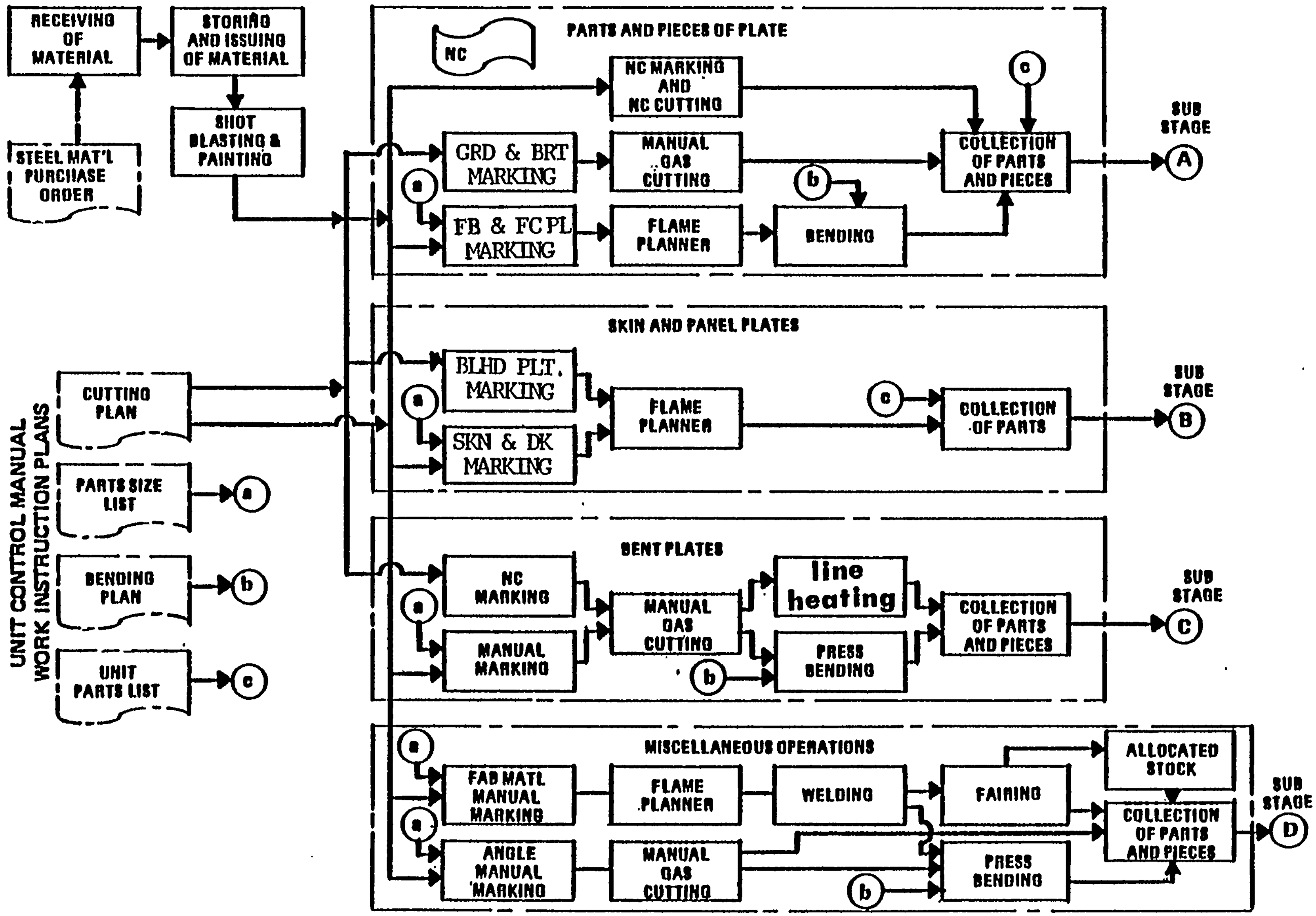
- STRUCTURE DERAILINGS
- PENETRATION CUT-OUT
- PIECE NAME
- STEEL PLATE TAKE-OFF
- UNIT PARTS LIST
- DEFINITION OF EDGE PREPARATION AND EXCESS
- SETUP OF PARTS DATA BASE
- SUB-UNIT BREAKDOWN
- HULL CASTING
- RUDDER SUPPORT SYSTEM AND RUDDER
- CLOSURES (DOOR AND WINDOW LIST)
- ANCHOR HANDLING SYSTEM
- MOORING ARRANGEMENT
- CARGO HANDLING SYSTEM
- SEA CHEST
- CARGO CONTAINMENT
- UNIT OUTFIT DRAWINGS DEVELOPMENT AND PALLET L/M
- START WEEKLY OUTFIT MEETINGS - ENGINEERING AND PRODUCTION ,

STYLE OF DRAWING:

UNITS BY UNITS

CATEGORY	UNIT NAME	PLATEN SUPPLYING FABRICATED PARTS	SHAPE	ASSEMBLY PLATEN
No. 1 FLAT PANEL UNIT	MID PART DOUBLE BOTTOM SIDE SHELL LONG BHDS	23 24		20
No. 2 CURVED SHELL UNITS	AFT & FORE PART SIDE SHELLS	16		17
No. 3 SUPERSTRUCTURE UNITS	DECKS FLATS BULKHEADS HOUSES ETC.	16		8 9 11
No. 4 FORE PEAK AFT PEAK	LARGE AND VERY HEAVY 3 DIMENSION UNITS	16		10 13 307
No. 5 ENGINE ROOM INNER BOTTOMS	LARGE AND HEAVY INTRICATE UNITS	16		14 307
No. 6 SPECIAL UNITS SKEGS RUDDERS ETC.	BULBOUS SHAPES STERN CASTINGS	16		19

PROCESS LANES FOR THE PREFABRICATION STAGE AND WORKING INSTRUCTION PLANS



23-HL PROCESS LANE FLOW FOR PRE-FAB

PROCESS LANES FOR THE SUB-ASSEMBLY STAGE AND WORKING INSTRUCTION PLANS

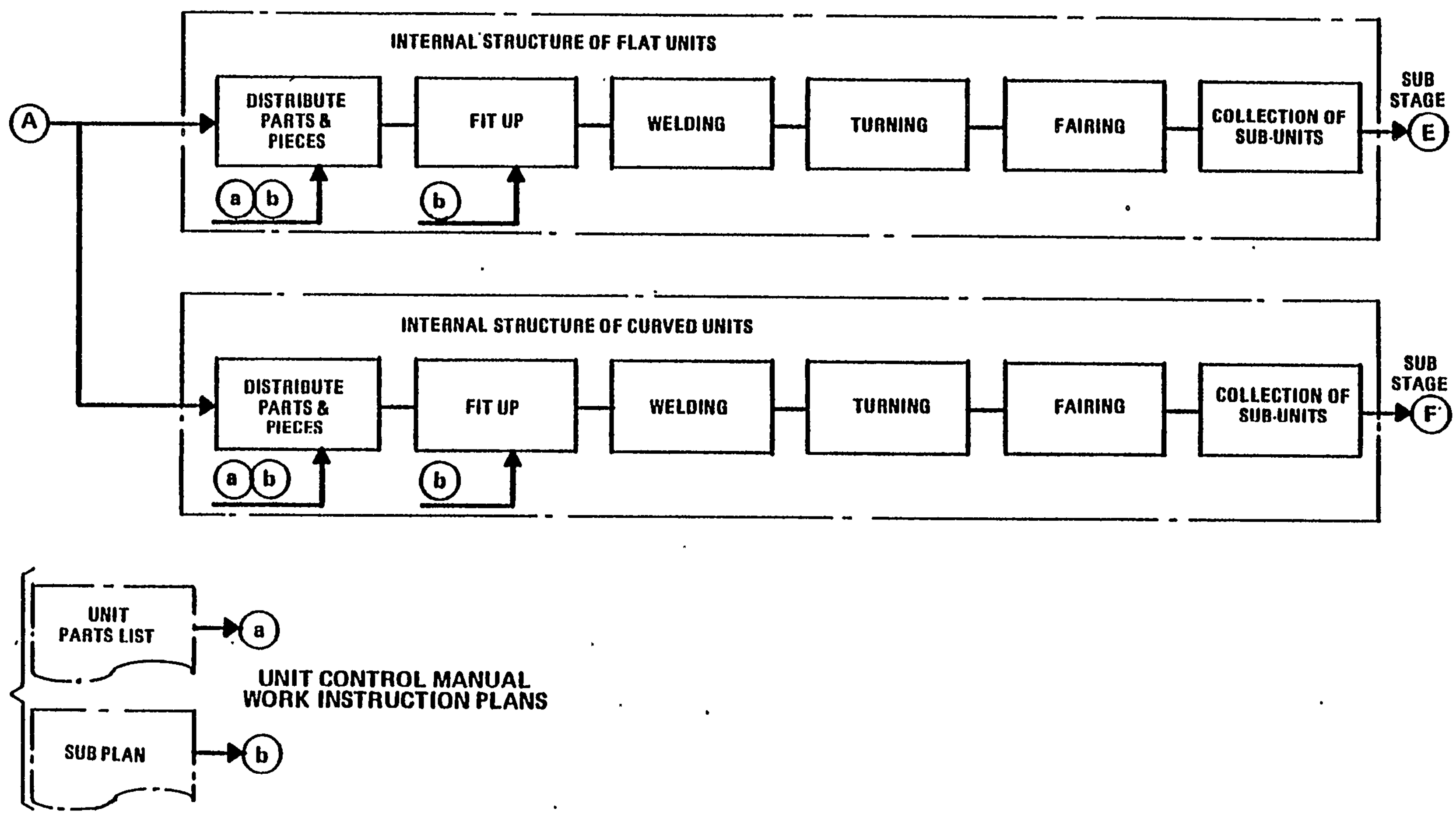
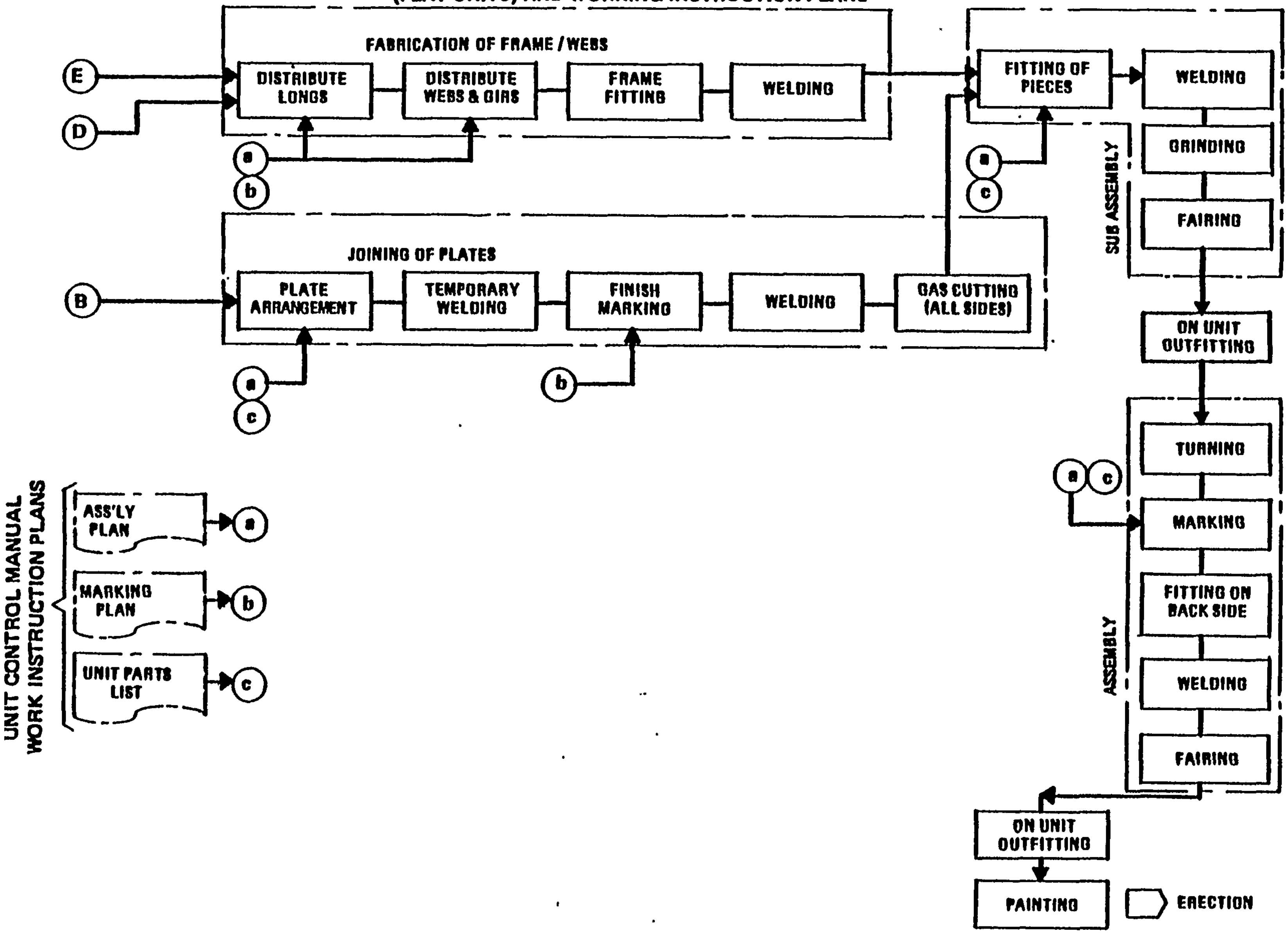
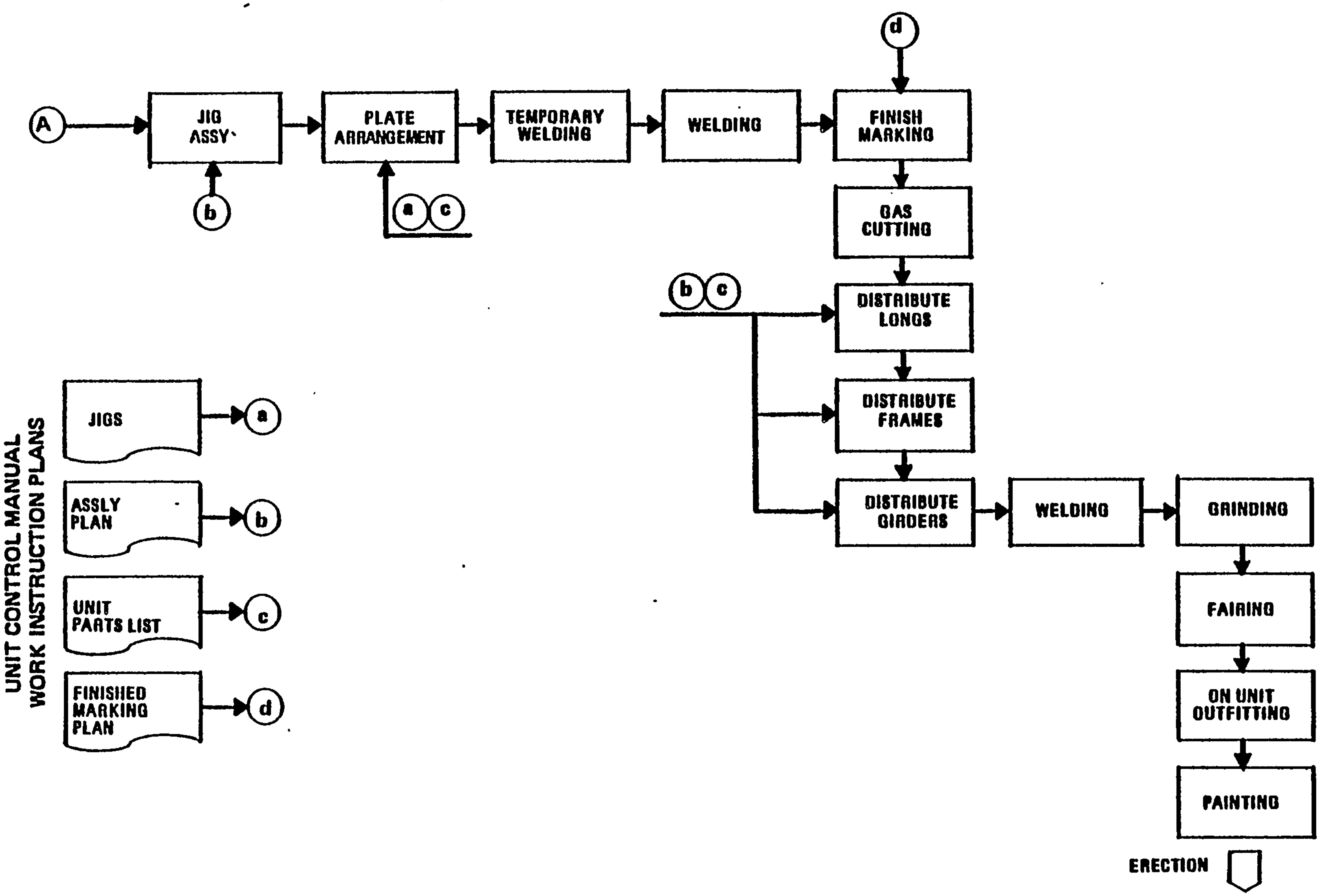


Fig 2-3 PROCESS LANES FOR THE ASSEMBLY STAGE (FLAT UNITS) AND WORKING INSTRUCTION PLANS



25-HL PROCESS LANES FOR ASSEMBLY (FLAT UNITS)

PROCESS LANES FOR THE ASSEMBLY STAGE (CURVED UNITS) AND WORKING INSTRUCTION PLANS



UNIT #36 (CATEGORY #1) WGT. (TONS) 38.0

DATE: 03/03/82 REV. #2

CENTER SECTION OF MAIN DECK FROM 8" FWD. OF FR. 61 to 8" FWD. OF FR. 65

(48'O''x35'8%")

A. PARTIAL SUB UNIT #036-001 -001

WORK CENTER — PLATEN #23

FABRICATE AND PARTIAL SUB ASSEMBLE THE CENTER SECTION OF TRANSV. DK. WEB AT FR. 62, WITH WEB FR. BKTS.

(1) 036-001-002 — WEB FR. 62

(2) 036-001-003 — BKT. ON CL.

(3) 036-001-004 — BKT. 7'1 11¼" OFF CL. PORT

(4) 036-001-005 BKT. 7'11¼" OFF CL. STBD.

B. PARTIAL SUB UNIT #036-001-006

WORK CENTER — PLATEN #23

FABRICATE AND PARTIAL SUB ASSEMBLE THE CENTER SECTION OF TRANSV. DK WEB AT FR, 63, WITH WEB FR. BKTS.

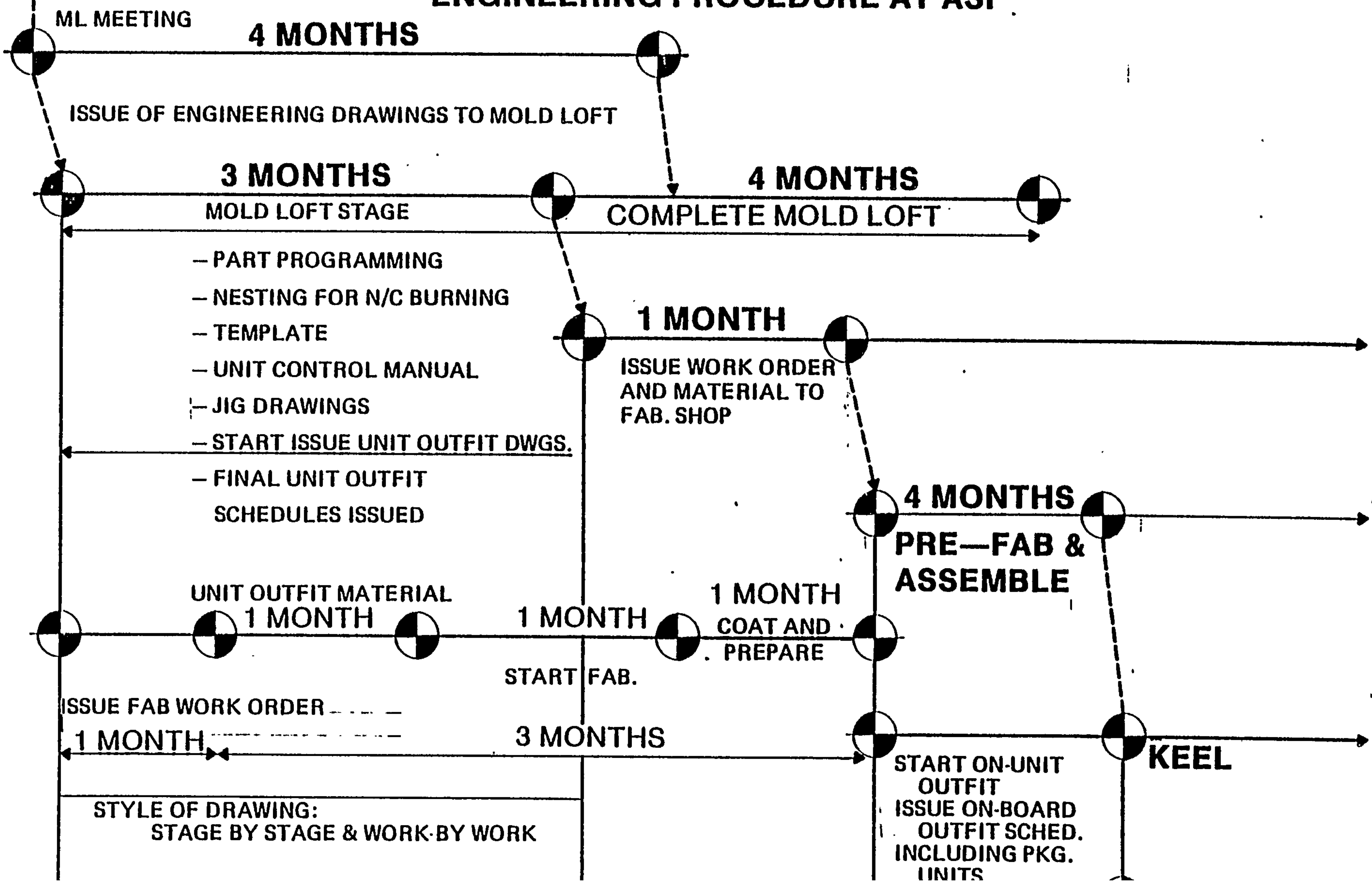
(1) 036-001-007 — WEB FR. 63

(2) 036-001-008 — BKT. ON CL.

(3) 036-001-009 — BKT.7'11¼" OFF CL. PORT

(4) 036-001-010 — BKT. 7'11¼" OFF CL. STBD.

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI



RESERVATIONS

NO	DESCRIPTION

UNIT CONTROL MANUAL

ASI HULL NO	NAME OF VESSEL
2335 (B)	
2336 (H)	
2337 (G)	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

ASI JOB NO C1-15

EXXON

DRAWN BY A. HURLEY DATE 4-14-82

CHECKED BY DATE

APVD

ISSUED

42,000 DWT
MULTI-PRODUCTS CARRIERS

UNIT-18 STBD

DOUBLE BOTTOM WING UNIT FRS. 29-44

SIZE B

CUTTING LIST

REV 1

TITLE SHT 8/8 9/81

28-HL UNIT CONTROL MANUAL TITLE PAGE

LEGEND

- ● PRE FAB
- ⦶ PRE FAB W/JIG REQUIRED
- △ FAB
- ▲ SUB ASSY
- 🄿 PRE-OUTFIT

PRE FAB AND SUB ASSEMBLY SCHEDULE

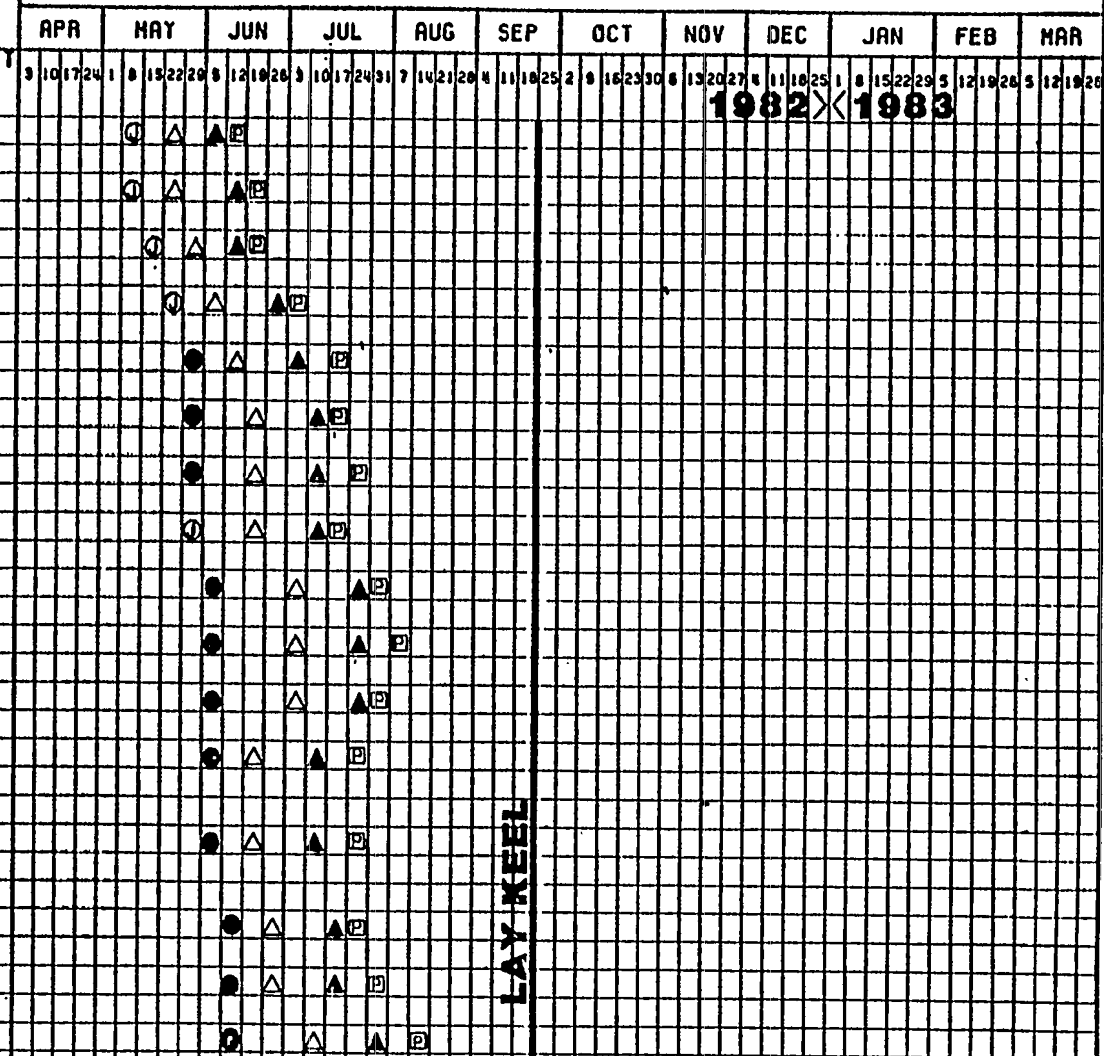
AVONDALE SHIPYARDS INC

ASI JOB NO. C1-015
ASI HULL NO. 2335

EXXON # 1

LAY KEEL 09-14-82
LAUNCH 05-14-83
DELIVERY 10-15-83

ZONE	UNIT	CAT	DESCRIPTION	LOC	FRAME	UNIT WT
M1	06	5	INNERBOTTOM	P	44 - 50	
M1	12	5	INNERBOTTOM	P	20 - 44	
M1	10	5	INNERBOTTOM	S	44 - 50	
M1	18	5	INNERBOTTOM	S	20 - 44	
D1	01	1	INNERBOTTOM	C	61 - 65	
D1	02	1	INNERBOTTOM	P	50 - 61	
D1	03	1	INNERBOTTOM	S	50 - 61	
M5	25	5	INNERBOTTOM	P/S	15 - 20	
D1	06	1	INNERBOTTOM	P	61 - 65	
D1	07	1	INNERBOTTOM	S	61 - 65	
M1	09	4	MAIN ENGINE FDN.	C	20 - 40	
D5	14	1	WING TK. LONG'L. BHD. W/MH. DK.	P	50 - 61	
D5	15	1	WING TK. LONG'L. BHD. W/MH. DK.	S	50 - 61	
D1	04	1	INNERBOTTOM	C	65 - 69	
D1	05	1	INNERBOTTOM	C	69 - 73	
D1	11	1	INNERBOTTOM	P	65 - 69	



MAIN ASSEMBLY AND ERECTION SCHEDULE

AVONDALE SHIPYARDS INC

ASI JOB NO. C1-015
ASI HULL NO. 2335

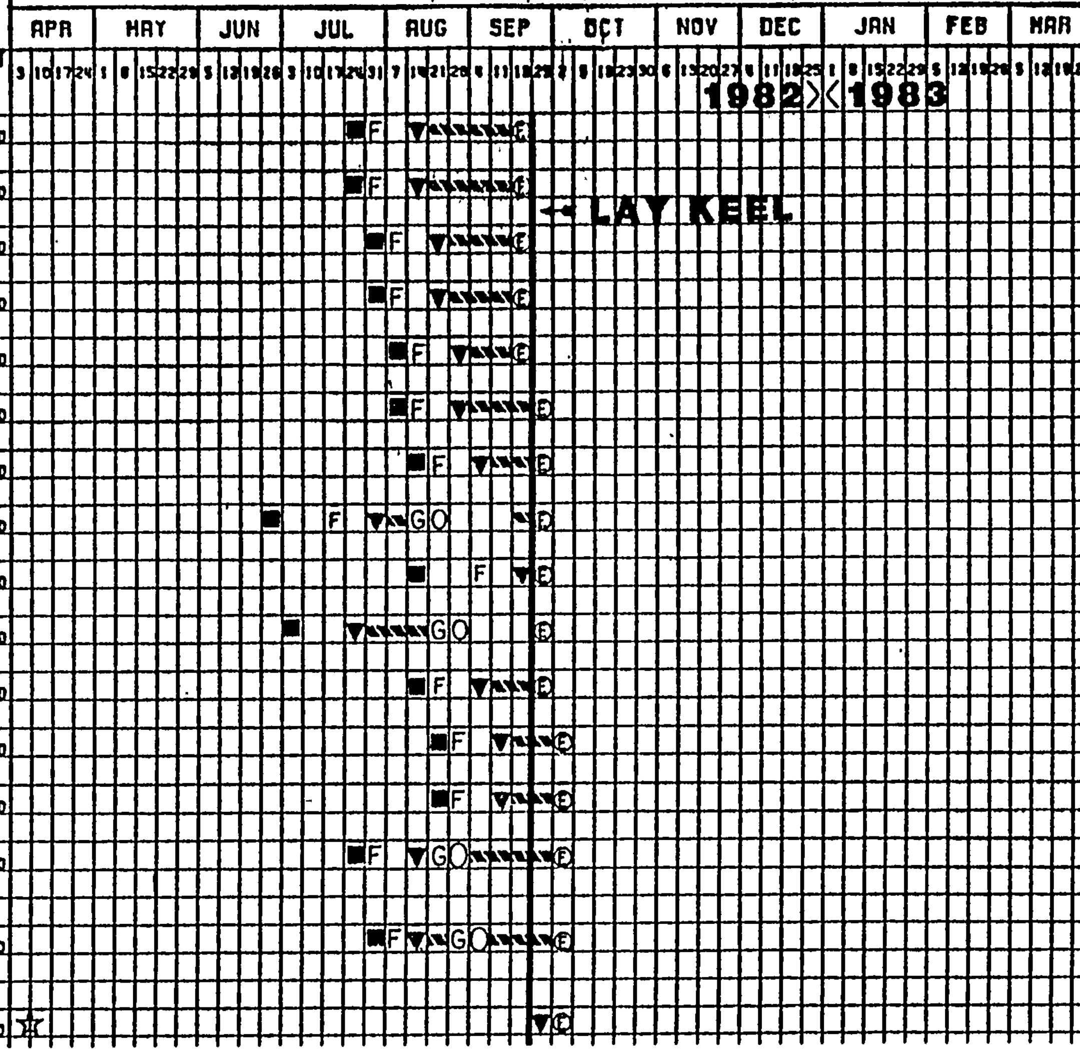
EXXON # 1

LAY KEEL 09-14-82
LAUNCH 05-14-83
DELIVERY 10-15-83

LEGEND

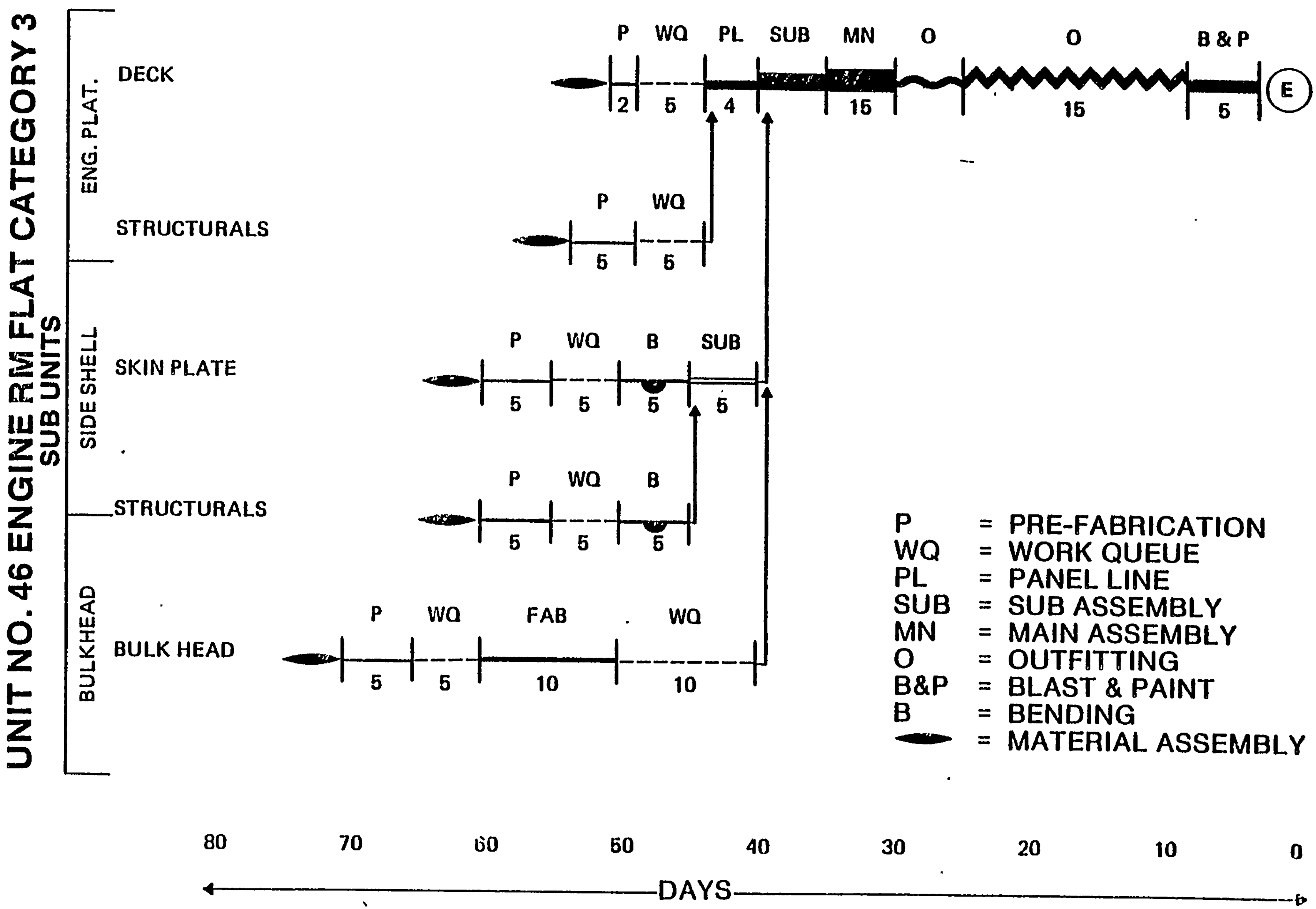
- ■ MN ASSY
- F FINAL ASSY
- ▼ BLAST & PAINT
- G GRAND ASSY
- ▽ FINAL ASSY. & BLAST & PAINT-SAME WEEK
- Ⓖ GRAND ASSY. & OUTFIT
- STORAGE ZONE
- Ⓔ ERECT
- O OUTFIT

ZONE	UNIT	CAT	DESCRIPTION	LOC	FRAME	UNIT WT
01	01	1	INNERBOTTOM	C	61 - 65	88.0
01	02	1	INNERBOTTOM	P	58 - 61	87.0
01	03	1	INNERBOTTOM	S	58 - 61	89.0
01	04	1	INNERBOTTOM	C	65 - 69	98.0
01	05	1	INNERBOTTOM	C	69 - 73	86.0
01	06	1	INNERBOTTOM	P	61 - 65	86.0
01	07	1	INNERBOTTOM	S	61 - 65	100.0
M1	08	5	INNERBOTTOM	P	44 - 58	133.0
M1	09	4	MAIN ENGINE FDN.	C	28 - 43	137.0
M1	10	5	INNERBOTTOM	S	44 - 58	139.0
02	13	1	INNERBOTTOM	C	73 - 77	98.0
01	11	1	INNERBOTTOM	P	65 - 69	101.0
01	12	1	INNERBOTTOM	S	65 - 69	101.0
05	14	1	WING TK. LONG'L BHD. W/MN. DK.	P	58 - 61	85.0
05	15	1	WING TK. LONG'L BHD. W/MN. DK.	S	58 - 61	85.0
03	16	1	TRANSVERSE BHD.	C	64	49.0



30-HL MAIN ASSEMBLY AND ERECTION SCHEDULE

SCHEDULING MECHANISM AND NETWORK



VESSEL PAINTING

PRIOR TO & AFTER LAUNCH

UNIT CONSTRUCTION METHOD

BEFORE LAUNCH	70% TO 80%
AFTER LAUNCH	20% TO 30%

PANEL CONSTRUCTION METHOD

BEFORE LAUNCH	45% TO 50%
AFTER LAUNCH	50% TO 55%

THE SUB-STAGES OF ERECTION

1. UNIT ERECTING
2. SHIPWRIGHTING
3. SCAFFOLD ERECTING
4. MAIN STRUCTURE FITTING
5. MAIN STRUCTURE WELDING
6. SUB STRUCTURE FITTING
7. SUB STRUCTURE WELDING
8. CLEANING
9. INTERNAL VISUAL INSPECTING
10. SCAFFOLD REMOVAL
11. AIR TEST
12. PAINTING (COATED TANKS)
13. WATER TEST
14. COMPLETION

CATEGORY RECAP SHEET

JOB NO. C1-15

CATEGORY | TYPE SUB-ASSEMBLY | REV. 1

UNIT	WT.	WELD. LENG.	SIZE	BLAST PAINT	OUTFIT	ASSY	NO. FIT	NO. WEL	MAN-HOURS	NOTE
LBhd		22800			2	5	4	6	4500	5.1 FT/HR
TBhd		7920			2	5	2	3	2475	3.2 FT/HR
BS		4890			5	10	4	6	2250	4.3 FT/HR
TT		24224			5	10	4	6	9000	2.7 FT/HR
SS		15124			2	5	4	6	2700	5.6 FT/HR
TBhd		5040			2	5	2	3	1575	3.2 FT/HR
TBhd		1670			2	5	2	3	675	2.5 FT/HR
CBhd	378	4560		5	5	10	2	3	2025	2.3 FT/HR
BhdC	210	2256		5	2	5	2	3	675	3.3 FT/HR
UDC	974	3900		5	5	5	2	3	1125	3.5 FT/HR
BhdC		2056			2	5	2	3	900	2.3 FT/HR
SUB TOTAL	1562	94440							27900	2.4 FT/HR

THE TOTAL COMPARATIVE COST OF HULL WORK PRIOR TO LAUNCH AS OPPOSED TO COST OF HULL WORK AFTER LAUNCH

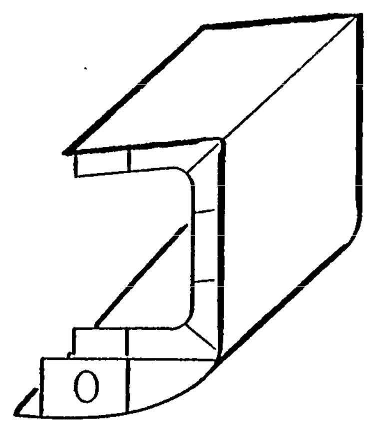
	BEFORE LAUNCH	AFTER LAUNCH
FIT WELD HYDRO CHIP & GRIND	42.6 M/H PER TON	96.3 M/H PER TON

APPROXIMATELY 10% OF THE TOTAL TONNAGE OF THE VESSEL WAS LEFT TO BE FINISHED AFTER LAUNCH AND AMOUNTED TO FITTING - WELDING - CHIPPING - GRINDING - AIR TESTING - WATER TESTING AND INSPECTION.

BURNING RATIO AND IMPROVEMENT FACTORS AT AVONDALE SHIPYARDS AS A RESULT OF IHI ACCURACY CONTROL TECHNIQUES

$$\text{BURNING RATIO} = \frac{\text{TOTAL SEAM AND BUTT LENGTH BURNED BY BURNERS IN THE ERECTION STAGE}}{\text{TOTAL SEAM AND BUTT LENGTH OF SHELL + SKIN PLATE IN THE ERECTION STAGE}}$$

	1980	1981	1982	1983	
IHI BURNING RATIO	15%	15%	15%	15%	
ASI BURNING RATIO	90%	80%	50% End of Year	35% or Less	



COST OF FIXED JIGS COMPARED TO PIN JIGS

STEEL COST-
725 TONS @ 400.00 =$200,000.00

LABOR COST- =$ 36,023.00

TOTAL FIXED JIG COST LIMITED TO SINGEL CONTRACT- =$336,023.00

PIN JIG COST LABOR & MTL CAN BE USED FOR ALL CONTRACTS =$175,000.00

NOTE- DOES NOT CONSIDER UPGRADE TRAINING FOR LINE HEATING BURNERS TO IMPLEMENT THE PIN JIG CONCEPT.

37-HL FIXED JIG COST VS. PIN JIG COSTS

HULL STEEL MATERIAL MOVEMENT COMPARISON BY TRIPS AND DISTANCE

	PRESENT METHOD	PROCESS LANES	DIFFERENCE
Material Handling Distance/week (Miles)	66.6	43.4	23.2
Material Handling Distance To-From Fab. Storage	39.3	5.9	33.4
Percent M. H. Distance To-From Fab. Storage	60.0	13.6	
Trips / week from Plate Shop	42.3	62.3	(20.0)
Trips/week from Platen 18	5.3	11.4	(6.1)
Trips/week from A-Crane Storage	31.3	7.7	23.6
Distinct Moves	177	119	58

GRAPH 40 H

HULL STEEL MATERIAL MOVEMENT COMPARISON BY PIECES

DESCRIPTION	PRESENT METHOD	PROCESS LANES	DIFFERENCE
Pieces/week	9,174	6,571	2,603
Pieces To - From Fabrication Storage	5,564	532	5,032
Percent To - From Fabrication Storage	60.7	8.0	
Trips/week	170.5	145.2	25.3
Pieces/trip	53.8	45.3	8.5
Trips/week To - From Fabrication Storage	81.5	9.3	72.2
Percent To - From Fabrication Storage	47.8	6.4	

DETAILS OF HULL PLANNING AND SCHEDULING

SEMINAR ON HULL SCHEDULING METHODS
AS OUTLINED BY PROCESS LANES PROCEDURES
AVONDALE SHIPYARDS, INC.

Prepared By: DON SOURS

PROCESS LANES PROCEDURES

I. INTRODUCTION

Roughly thirteen (13) months ago, ASI undertook a project to re-direct their hull construction and outfitting methods. With the joint efforts of ASI personnel and consultants from IHI, Japan, a very intense study was conducted and the following methods of module construction were arrived at, through the process lanes method.

The area that needed to be resolved first, which was very evident from the study, was a method to control and handle materials quickly and in the most efficient and economic way. The best way to accomplish this task was through the process lanes method. Process lanes means the categorization and separation of like kinds of work, and the development of work centers specifically designed to efficiently and economically produce that kind of work. Process lanes establish the greatest amount of "learning curve" efficiency by having the same people, at the sme work centers, doing the same type of work every day with a constant organized efficient flow of material.

Process lanes, as defined above, did not exist at ASI. Here, different types of units are assembled at the same location. Assembling different types of units at one location requires the following:

- different types of assembly periods of time,
- different types of assembly platens,
- different types of construction methods.

When units having different characteristics are produced in the same loctions, those obstacles must be overcome. This tends to decrease productivity and accuracy because of the use of different types of material. The establishment of on-site storage becomes very difficult, resulting in increased material handling costs.

When process lanes were established at ASI, there were controls to create detailed process lane schedules based on the volume and quantity of work for each process lane work center, thereby enabling ASI management to determine work center cost and efficiency.

At ASI, shop planners are assigned to work centers for each stage of construction to study and establish detailed work center schedules, collect and monitor actual performance from the work center foreman on a daily basis, and prepare efficiency charts or graphs for management. The charts and graphs will be the controls by which management can determine each work center's cost, progress regarding schedules, and actual manhours per ton versus projected manhours per ton efficiency.

II. UNIT CATEGORIZATION

Process lanes require the units of a vessel to be divided into categories based on the size, shape, weight and method of construction.

You may ask, why would we want to categorize units? To help explain, imagine the following:

- Ford Motor Company produces the Lincoln, using a conveyor assembly line, at one every five minutes. Ford also produces Pintos at the rate of one every minute. Should a Lincoln be put on the conveyor that had been producing Pintos, repercussions would be felt. The Lincoln frame is wider and adjustments must be made to the conveyor. Production would stop for three hours for required alterations, causing 500 workers to be idle. Because engine settings require higher torque tools, workers had to go to the tool room for proper equipment. This would cause units produced to decrease and manhour cost, per unit, to increase.

A similar parallel can be considered in shipbuilding. We have flat units, curved units, large complex three dimensional units, etc. to construct. A Pinto would relate to a category one (1) flat panel unit. A Mercury would relate to a category two (2) curved panel unit. A Lincoln would relate to a category three (3) large three dimensional unit. They each require different assembly jigs and specialized tools. Workers who are familiar with building flat units would not be efficient on curved units. Add material flow problems, and you may understand the need for categorization and the establishment of process lanes for each category of hull unit at Avondale.

Categorization of hull components is required, primarily by the Planning Department and later by shop or work center planners. This will assist them in basic and detailed planning and scheduling, as well as establishing an orderly flow of materials. Categorization also allows us to determine where a component will be constructed, as well as elapsed time in, and control through, the process lanes.

To accomplish this, we have divided the hull units into six basic types.

A) CATEGORY NO. 1, FLAT PANEL UNITS

These units are comprised of panel line components and assembled on a flat surface as the base of a unit. This flat surface could be a deck, innerbottom, bulkhead, or even the shell. This category is comprised of relatively simple units, with short construction time required. Category No. 1 units usually comprise approximately 50% of the total hull weight, across varied type hulls.

With this category containing the largest amount of units to be constructed, we at ASI designated our most productive and largest platen for Category No. 1. This platen is also very suitable because of its relationship with the panel line and the material flow from the fabrication platens. There will be four (4) designated construction stages on this platen as indicated on the layout drawing (see Graph No. DHL-1). They are as follows:

- Sub-Assembly
- Pre-Outfit (in unit)
- Main Assembly
- Final Assembly & Outfitting, Welding & Inspection

The above establishes a specific location at the work center for sub-assembly, pre-outfitting, and main assembly, final assembly.

The establishment of the four (4) construction stages on the platen will allow for the same kind of work to be done by the same people every day in that specific loction where all of the work tools, welding machines, etc. needed for that work are readily available. This concept is the automatize assembly line concept, whereby the work moves to the workers rather than having the workers relocate to the work, requiring the movement of all their special tooling.

The learning curve efficiency that this assembly line concept will bring will provide lower manhour expenditures, resulting in a management choice to decrease the manning at each stage and maintain current schedules, or to contract for more work. This is our equivalent to the Pinto assembly line - fast moving, easy construction units.

B) CATEGORY NO. 2, CURVED SHELL UNITS

These units are assembled on curved shell, knuckled longitudinal bulkhead or innerbottom, in fixed or pin jigs. Examples would be wing tanks or outboard sections of wings assembled on curved shell plating or possible knuckled longitudinal bulkheads. These units are, in general, more complex in construction requiring different construction methods and techniques and more elapsed time in assembly position than the Category No. 1 units. The location for this category is also convenient to the pre-fabrication shop for economical material flow and convenient-to the pre-outfitting area and blast and paint shop.

C) CATEGORY NO. 3, SUPERSTRUCTURE UNITS

Category No. 3 units are the superstructure units, along with engine flats with bulkheads for side shell below.

They consist of many different types of units, such as poop-deck, navigation bridge deck, pilot house, machinery casing, and boat deck. Because Category No. 3 units are generally so large, a significantly large area will be designed for their construction. These units are typically those being built with a deck or a flat as the base of the unit. Such an example is the pilot house. The house top would be used as the base of the unit - fit and weld miscellaneous bulkheads and exterior bulkheads to the base. There may be partial sub-assembly for this type of unit. After the fitting and welding is completed, the unit would be released for the pre-outfitting work and final inspection. Category No. 3 units will stay on the platen longer than most Category No. 1 and No. 2 units because of their outfitting and piece-meal construction. Therefore, a separate process lane is required.

D) CATEGORY NO. 4, LARGE AND HEAVY MODULAR UNITS

Category No. 4 units consist of large and heavy modular units which are difficult to build. Due to close fitting tolerances and some confined areas, they require (along with Category No. 5 units) the most qualified mechanics available. The units are usually piece-meal with limited sub-assembly work. Category No. 4 units are fore and aft peaks, along with some engine room innerbottoms. These units are required to stay on the building platens for a longer period than the Category Nos. 1, 2, 3 types of units. Because of this, a separate process lane is required.

E) <u>CATEGORY NO. 5, MACHINERY SPACE DOUBLE BOTTOM</u>

These units are typically those with the engine room inner-bottom as the base. The assembly period is long, with close fitting tolerance, extensive outfitting, and usually piece-mealed rolled shell plate work.

F) <u>CATEGORY NO. 6, SPECIAL WELDMENTS</u>

These units are specialty items, such as rudders, skegs, anchor pockets, etc. There was no change with this category from current procedures.

III. PLANNING CONTROLS

With the implementation of process lanes, there were numerous planning controls required.

With the implementation of process lanes on future contracts, the Planning Engineering Department will be required to study platen load and schedule, within process lanes guidelines, to insure realistic achievable schedules.

These following guidelines are thus established and should be scheduled with the Planning Department in the proper sequence upon inquiries for new contracts:

A) Determine Present Platen Loading

B) Establish Key Dates

C) Divide Hull into Units and Develop Erection Sequence

D) Categorize Hull Units

E) Weight Calculations by Unit (Rough)

F) Platen Load to Capacity

G) Establish the Erection Schedule

H) Insure Comparability with Key Dates

I) Prepare Ground Assembly Schedule

J) As Detailed Drawings Become Available - Refine Weight Estimates and All Schedules

Summaries of the planning effort required for each of the above guidelines are explained as follows:

A) <u>DETERMINE PRESENT PLATEN LOADING</u>

Study the present and long term loading for contracts in progress. This should be constantly monitored, and the loading for any given week should be immediately available for each platen and all contracts on hand for the period of their durations.

B) <u>ESTABLISH KEY DATES</u>

The Planning Department must establish the possible key events dates (start pre-fabrication. keel. launch, and delivery) as soon as-possible, based on the required delivery date set by the customer and within the overall master (long term) yard schedule. This effort must be rough cut or preliminary for contract bid purposes and then refined upon signing of contract (or-letter of intent).

C) <u>DIVIDE HULL INTO UNITS AND DEVELOP ERECTION SEQUENCE</u>

The unit arrangement drawing must be prepared for purposes of unit dividing and numbering and the development of desired erection sequence.

The list of units, along with basic unit descriptions, should be prepared.

D) <u>CATEGORIZE HULL UNITS</u>

The hull units are to be categorized within the process lanes concept, and a separate list of units should then be prepared within each of the six (6) process lanes categories, along with basic unit descriptions and weight (to be added later). The planning engineer should study the construction method of each unit and determine the proper category in which to place the unit.

E) <u>WEIGHT CALCULATIONS</u>

Weight estimates must be done for each unit in all *Categories* Nos. 1 through 6 for the purpose of proper platen loading on all platens.

F) PLATEN LOAD TO CAPACITY

An example of this at AS I would be Platen No. 20. After thoroughly reviewing the loading of a platen for the period of time of the duration of a contract, based on the established preliminary key events dates, the platen should then be loaded (week by week) to capacity.

In an earlier study conducted by the process lanes committee *to* support the contract, it was established that Production would have to have an average tonnage of 1,000 tons per week to maintain production schedules, with 600 tons per week coming from Platen No. 20, Category No. 1 type units. For the first vessel of the contract, this should be 600 short tons per week. The quantity of units per week, based on their weight, can then be determined and this, then, establishes the number of units per week that will be available for erection during any given week from start to launch from Platen No. 20. The number of units per week, thus established, is now applied *to* the unit erection sequence and the erection schedule can be established.

G) ESTABLISH ERECTION SCHEDULE

Using the sequence of erection developed. and the number of units per week available from Platen No. 20, the erection schedules can be developed. For example, if the first five (5) units to be erected are numbered in sequence #1, 2, 3, 4 and 5, and the unit weights are:

Unit #l = 86.5 tons,
Unit #2 = 125.0 tons,
Unit #3 = 125.0 tons,
Unit #4 = 86.5 tons,
Unit #5 = 86.5 tons,
Total = 509.5 tons;

then Units #l through 5 can be erected in one (1) week, leaving 600 - 509.5 = 90.5 tons (based on 600 tons/week output, Platen No. 20) available for units on another ship.

It is important to note that the quantity of Category No. 1 units per week to be erected (all jobs) cannot exceed this maximum tonnage output per week available from Platen No. 20.

H) INSURE COMPATIBILITY WITH KEY DATES

Review the prepared erection schedule to be sure that all units can be erected in a timely fashion with the rough draft key event dates established and consistent with machinery requirements. Adjustments to platen loading should be made, if required.

I) PREPARE GROUND ASSEMBLY SCHEDULE

The ground assembly, or short term, schedule should be prepared as a two (2) month schedule, updated and issued once a month for all platens.

J) DETAILED DRAWINGS - REFINE SCHEDULES

As detailed drawings are developed and become available, a review of all weight estimates is necessary, and fitting a welding lengths may be used as desired to further refine a update all platen loading schedules.

IV. PROCESS AND EFFICIENCY CONTROL

We currently believe that keeping control of the process lane means maintaining current production level by producing accu-rate products in the planned manhours. This means sending or the planned material to each stage within the required time period. However, in order to maintain and increase our compe titive edge, this line of thought is not enough. Our efforts should be in one of two directions, depending on the company' long term production plans:

- Increase the amount of production per manhour.

- Decrease the manhours per a given production amount.

In order to achieve this goal, various controls are available In the case of material handling, that is, moving material to its appointed location in a timely manner, we have material control, storage control, and transportation control. The tools used in the effort are the unit parts list and the U.C.I (both will be discussed in the Mold Loft presentation). When considering the accuracy of the product, accuracy control is necessary. This includes manufacturing standards, tolerance standard, etc. Standards should be established as part of th production methodology to be used at ASI.

In the case of controlling the amount of production and the number of workers at a work center, a detailed schedule is made for each stage.

The detailed schedule is used, also, for efficiency control by being able to plot actual working status against the planned efficiency. You can also see good and bad efficiency trends developing.

Sample efficiency control charts have been made, using the actual amount of production and consumed manhours in pre-fabrication. This is data from a recent three (3) month period.

Pre-fabricatin is divided into two (2) sections:

- marking and burning,
- bending.

Therefore, the objects for efficiency control are:

- total pre-fabrication efficiency tendency,
- marking and burning efficiency tendency,
- bending efficiency tendency.

Other control charts may be used for sub-divisions of the two (2) main sections.

The basis of initial process scheduling (prior to contract) is the manhours needed for a given amount of production. It is very difficult at this stage to accurately gauge work volume; so, we find a factor which is directly proportionate to manhours and use it instead of work volume.

In the case of pre-fabrication, we use the pre-fabrication weight which is proportionate to the manhours and may vary depending on the type of vessel.

Suppose that the following budget was given to pre-fabrication prior to construction of the vessel:

Hull Steel Weight	14,000 tons	
Marking and Burning	21,500 hrs.	1.5 H/T
Bending	3,000 hrs.	0.2 H/T
Total	24,500 hrs.	1.7 H/T

The expected efficiency is calculated to be 1.7 H/T and the sample control charts (Fig. 1-3) indicate this. The actual manhours consumed on the contract from March through May have been plotted using 1.7 H/T as the guide.

The primary purpose of these charts is to identify bad tendencies, investigate the causes and take appropriate countermeasures. On the other hand, when the efficiency shows good tendencies, investigate its causes also and take appropriate steps to keep them. When using the charts, we see the following:

- Figure 1 and 2
  - April 30: Investigate why the efficiency decreased.
  - May 14 - May 30: Investigate, if not already known, wh the efficiency increased.
- Table 3
  - March 16: It is required to determine why the bending costs were delayed.
  - April 30 - May 30: Check if bending work delayed? Increase bending efficiency? Check job site conditions

It is felt that the efficiency control charts are very useful tools at each production stae, and implementation can be accomplished in the near future by the shop planner/engineer.

V. STAGE PLAN

The processs lanes have primarily addressed four stages of hu construction - pre-fabrication, fabrication, sub-assembly, an main assembly. There are two other areas of hull constructio here at ASI that have been mentioned, but not discussed in detail. They are the panel line and erection, two important work centers. These two operations will remain in their present location and will fit in with our process lanes operatio

Stage plans are documents vital to process lane operations. Stage plans are documents used in IHI shipyards. Avondale's stage plan will be the Unit Control Manual. Our UCM was devel oped in the MoldLoft with other IHI representatives in the pas year. It is produced on CADAM-CRT's based on:

the unit parts list from Engineering;

the unit drawing from Engineering;

the unit summary sheet from Production Planning;

the SPADES hull data base and N.C. parts file which is used to determine what information goes in each stage plan. The planning summary sheet and the Engineering parts list must be written, based on the policies of construction methods, as established by process lanes.

The UCM was made for yard use, to establish feed back and produce an effective document. It contains all the information in our present unit book, plus detailed drawings for each operation of hull construction. It is broken down into six sections: (1) cutting list, (2) partial sub-unit, (3) panel line, (4) sub-assembly, (5) main assembly, and (6) erection.

The UCM, along with material transfer, work orders, and schedules, are necessary for supervision and workers to perform their operations efficiently with uncluttered, detailed information. Worker will be given only the sheets of the UCM that are required to perform his operation for his job site. Shop planners and superintendents will have the complete UCM to aid in production control and planning.

The process lane production system calls for the level loading of work centers, based on their capacity. This is accomplished by the establishment of stage scheduling, produced by shop planners. Their purpose is to ensure proper material flow and develop detailed shop schedules and the capabilities of the work center, as previously discussed. Shop planners also need fitting and welding lengths (now produced in Production Engineering), as well as weights of components (from Steel Control Department), to accomplish his task.

Our committee reviewed the UCM as it relates to process lanes requirements. With only a couple of minor additions, we feel those requirements would be satisfied. The entire plan should be studied from key plan, hull drawings, numerical control, UCM, planning, material and production engineering to further eliminate duplications and to improve the overall operations. (The UCM will be explained in full detail later during the presentation on Mold Loft operations.)

VI. PROCESS LANES EFFECT UPON COST

The process lanes committee, for several months, has been evaluating the process lanes concept and the subsequent effect it will have upon the cost of the steel hull construction of the next contract. After much debate and analysis, the process lanes committee established (see Figure 4) that a cost reduction of 21% in hull manhours was achievable under the propose process lanes concept. The individual percentages which comprise the 21% reduction are shown in Figure 2 and consist of the savings achievable in each area at each stage of construc tion.

To illustrate the manhours savings which will be projected on the next contract for a 21% reduction in hull manhours, we us the actual. manhours per ton cost of the first vessel of the last contract. The vessel cost figures were chosen primarily due to the similarities of the hulls. Also, the contract is recent commercial vessel for which the hull construction has been completed; thus, very little change in skill level and facilities have occurred since construction. Under the proposed process lanes concept of construction, a reduction of 2 in the hull manhour cost will be obtained through the process lanes methods. Thus, a sizeable savings is achievable under the process lanes concept.

As also shown in Figure 4, there are five (5) main areas that are affected by process lane implementation. These areas wil be addressed individually. They are:

A) Area 1. Process Lanes

B) Area 2. Material Flow and Handling

C) Area 3. New Production Methods

D) Area 4. Accuracy Control

E) Area 5. Others

As each area is discussed, items will be listed that are now cost factors that process lanes implementation will affect. There are some items that may belong in more than one area; however, these items will be listed in only one.

A) <u>AREA 1. PROCESS LANES</u>

The implementation of process lanes will allow for the clar ification of material flow with proper flow procedures. This will help overall production efficiency and will promote the improvement of material handling methods. Also, the large reduction in material delays and the establishmer of material queues, which will occur with the process lanes concept, will reduce the idle time of workers waiting on material, resulting in considerable manhour savings in the fabrication and assembly areas.

Schedules will be written and platens loaded, which will permit material and workers to progress sequentially from operation to operation until the product has been constructed and outfitted at the most optimum manufacturing cost. The process lane will allow work functions of individual workers to remain similar. The worker efficiency will increase as the worker becomes more familiar with his work. The line-balancing of each process lane will allow for the calculation of the most economical manpower distribution, thus allowing the evaluation of manpower reductions or allowing for the reduction of the fabrication and assembly time periods by allowing us to specify work areas as progressively related operations with approximately equal times for each operation.

The process lanes concept will allow for the establishment of a stage control system for each production area which will allow area managers to evaluate each area on a regular basis.

This continuous efficiency check will allow the area manager to monitor and control each area for optimum efficiency. Recommendations for the format of the stage control system will be presented in the scheduling portion of this presentation.

B) AREA 2. MATERIAL HANDLING AND FLOW

A projected cost savings of up to 45% in the main storage area can be realized through the implementation of process lanes. Process lanes will eliminate the need to send material from pre-fabrication to storage and then to the work center. Material flow will by-pass general storage and, in most cases, go to smaller work centers' storage queues. The material flow reduction will result in a reduction in the amount of manpower and equipment needed to perform the material handling operation. Also, the eliminated storage area may be developed into a productive area.

Material handling is a major cost to shipyard operations. In many cases, it requires capital that is not working for the production operation; thus, material handling procedures should be established which allow shipyard operations to work efficiency. A material control system should be developed which will insure that shipyard production is not hampered due to the lack of required material or, for that matter, a surplus of material. Material Control personnel should be assigned to specific work areas responsible for the receiving, verification, locational assignment, and the exiting of construction material, and have the responsibility of monitoring work queue buffers so as to expedite any material problems. Material Control personnel should follow procedures developed for obtaining and storing required material such that a minimum cost is expended on the material handling function. Process lanes will allow for the establishment of a hull work pallet system. The palletizing system will greatly reduce the amount of mater ial handling in the fabrication and assembly area. The system will result in less material damage and a large reduction in material loss. Material will be easy to loca and will be grouped in one area, thus reducing the time spent in material search by the field personnel.

C) AREA 3. NEW PRODUCTION METHODS

Process lanes will require the early study of piece nestin by the Engineering Department. Proper nesting plans will allow for greater utilization of steel and improved scrap ratios.

with process lanes, the division of the ship into specific units for process lane production will be required. The Planning Department must divide the units of a ship so tha these units can be adaptable to a particular process lane and can be produced at optimum efficiency. Process lane will require manpower to prepare detailed schedules of all area activities. The cost of these area planners will jus tify itself by the coordination of all shipyard activities from raw material to finished product. These planners wil prepare proper area loading schedules which will assure proper completion times and costs. Recommendations for th use of area planners will be elaborated in Part Two of the presentation, which will cover scheduling.

The process lanes concept will require the elimination of our present multi-hull cutting system and the establishmen of a single hull cutting system. The single hull cutting system will require more cutting time for multi-hull con- tracts. The cost of this extra cuttig time may be offset the savings incurred by not having to recut material due t mistakes or revisions. Also, the single hull cutting syst will allow for a large reduction in cut steel storage. Savings on the investment of previously stored material an the excess of usable estate will help offset the cost of t extra cutting time.

The committee acknowledges the fact that proper accuracy controls must be established for the proper development of process lanes. Thus, with proper accuracy controls, the elimination of the stock on paralleled midbody sections wi allow for the ease of the fitting activities and will resu in a reduction in fitting manhours. A projected savings of 9.5% in erection cost could be realized as a direct result of eliminating stock as hull erection joints. The elimination of scribing, burning, and welding edge preparations, along with the elimination of the double pulling in of sections, will result in considerable savings.

With process lnes, the fairing of distorted plates should be performed by the most economical method available and in the most economical stage of construction. The Accuracy Control Department should issue guidelines on when, where, and how this work is to be performed by field personnel. Process lanes will promote the increased use of pin jigs. However, pin jigs will require precisely curved shell plates. Studies you have seen this morning indicate that the use of pin jigs will reduce the company's expenditures in the fabrication of fixed jigs.

D) AREA 4. ACCURACY CONTROL

Proper accuracy control procedures is one of the most important prerequisites to process lanes development and maintenance. The implementation of proper accuracy controls throughout the shipyard will result in a sizeable savings in fitting manhours in the fabrication, assembly and erection stages of construction. The amount of necessary checks in the shipyard can be drastically reuduced by the introduction of a system of coordinated activities which prevent the manufacture of a product deviating from what is typically expected.

A projected direct labor cost increase of 0.5% at the prefabrication stage is anticipated to establish the dimensional and accuracy control program and the documentation necessary for anticipated cost reduction in fabrication, assembly, and erection stages. A projected savings of up to 6.0% at the assembly stage can be realized as a direct result of accuracy controls in preceding stages.

If pre-fabricated parts and fabricated parts are dimensionally accurate, assembly work should be constructed with appreciable savings. A projected cost savings of up to 13% at the erection stage can be realized through dimensional and accuracy control by the elimination of racked or distorted assemblies, the reduction of internal members having to be left loose for alignment and the subsequent welding of same in erection.

E) AREA 5. OTHERS

The establishment of process lanes will reduce the amount stored material and subsequent lost material and will all for the establishment of material flow procedures. These changes, in conjunction with proper accuracy control, wil reduce the total pre-fabrication, fabrication, and assemb remakes and result in a direct savings of material and mai hours.

If the drawing schedules precede the process lane schedul in all Engineering Sections, the decreased number of draw revisions and subsequent UCM revisions will greatly reduc the cost due to remakes. Also, the standardization of working pieces, such as lifting lugs and padeyes as controlled stock items, will greatly reduce the cost of material and manpower to produce these items.

Thus, a projected savings of 4.0% in the pre-fabrication, fabrication, and assembly stages is anticipated in the co of remakes due to the elimination of multi-ship burning, anticipated decreases in drawing or unit book revisions, establishment of material flow procedures, and the standa ization of working pieces.

With the establishment of process lanes, there will be an initial creation of specialized platens for the manufacturing of different types of ship units with little or no future platen modification; thus, platen modification cost will be reduced. Also, since process lanes will require detailed schedules of all area activities, it will assure proper completion dates and may allow for a reduction in night shift personnel.

Thus, after investigating the five (5) areas mentioned, the committee concluded that improvement in work efficiency will evident throughout all stages of ship construction. Conclusions show that upon the establishment of the process lanes concept at Avondale Shipyards, with all the necessary Supporting functions, that there will be a 21% reduction in hull manhours cost and subsequent increases in platen productivity

With the development of the process lanes method, the prepari of the unit breakdown to the lowest level of construction was greatly defined. In order to properly identify the lowest level of fabrication, the Hull Production Planning Department had to completely re-vamp their unit breakdown procedures and unit, sub-unit, and partial sub-unit numbering. Using the ne methods of construction, the lead hull planner then prepares the unit breakdown summary sheets. This is a detailed unit breakdown from fabrication through erection. At the present time, the key drawings are used by the hull planner to prepare the unit summary sheet. Once this document is finished, it is forwarded to the Hull Engineering Section where the hull drawings are prepared for each unit. Upon completion of the hull drawings, a copy of each unit drawing, along with the unit summary sheets and unit parts list, are forwarded to the Mold Loft.

When these documents are received by the Mold Loft, the Unit Control Manual is then prepared. These are the actual working drawings that-will be issued to the production trades. (This will be explained in full detail during the Mold Loft presentation.)

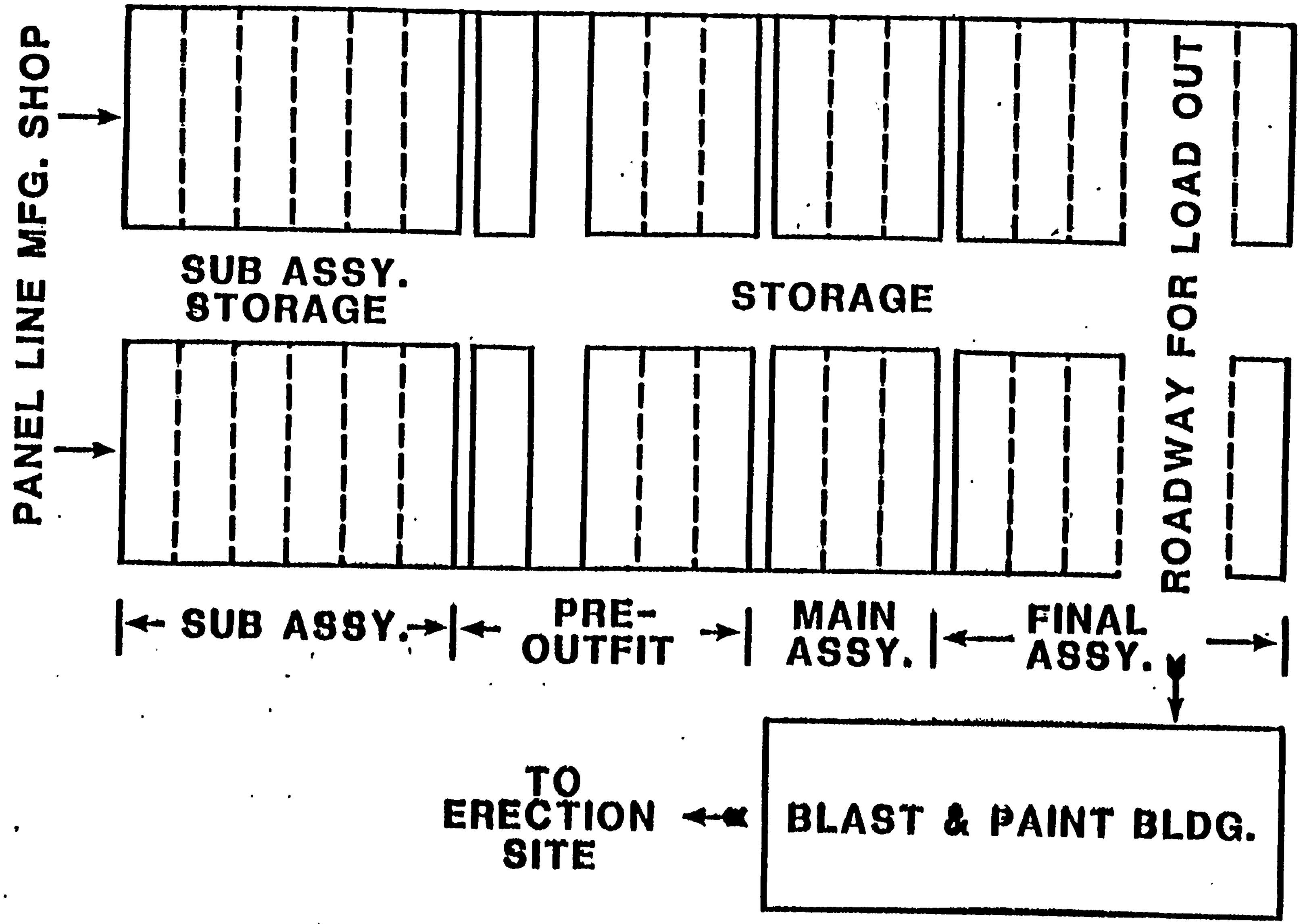
VII. CONCLUSION

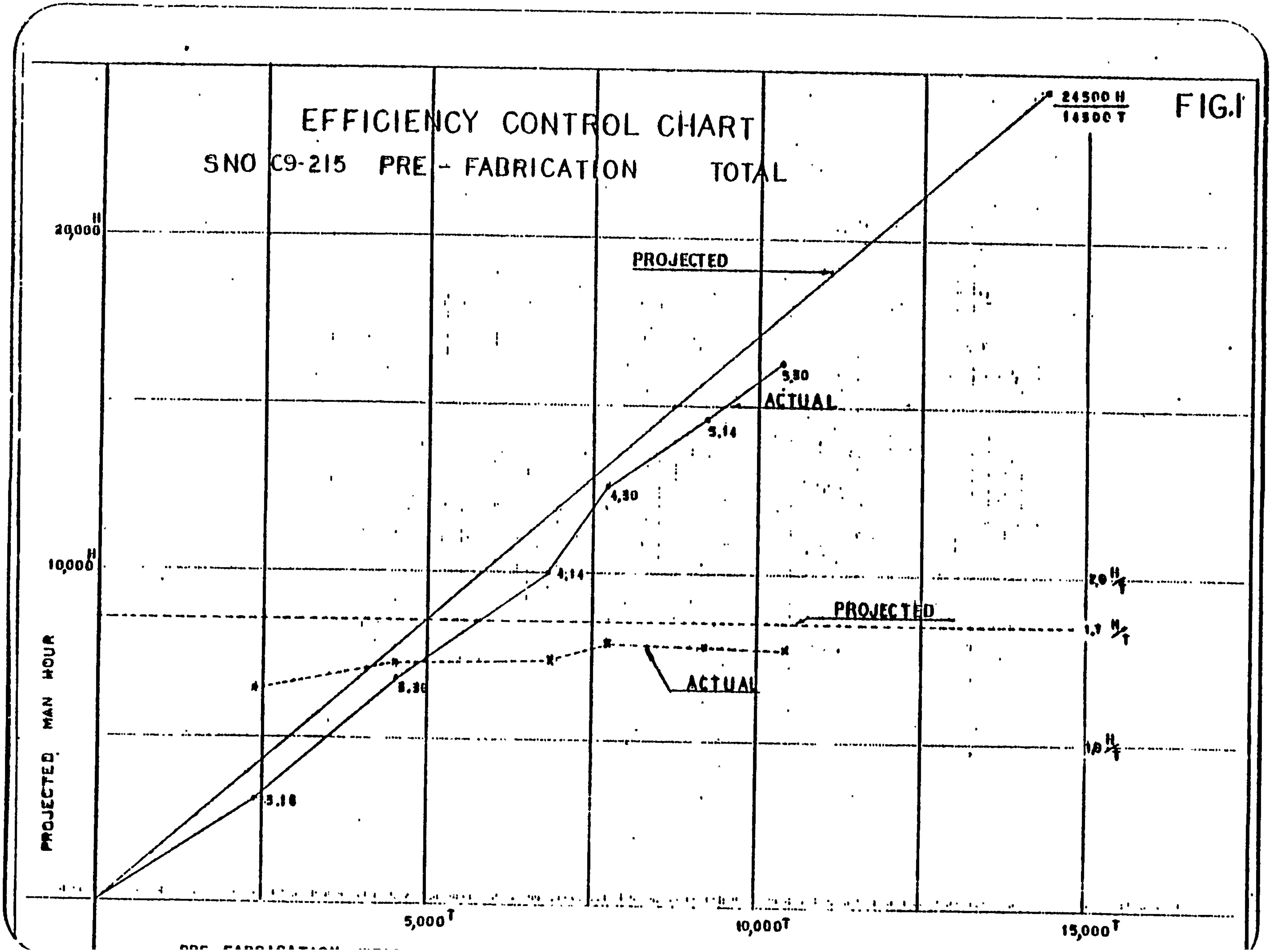
Gentlemen, I would like to take this opportunity to thank you for your attention and patience. Today, I briefly touched on the hull planning procedures at Avondale Shipyards. There were numerous changes brought about by the process lanes method. I would like to leave you with this phrase.

> It is easy to state required changes and to justify change. It is more difficult to bring about changes.

Many organizations resist change, sometimes quite unconsciously, perhaps because of insecurity. Health organizations welcome and actively encourage change when it is related to sensible, long term strategy. In particular, the organization should see itself evolving to embrace the relevant development in ship and production technology. This careful evolution should be seen as a function of the organization.

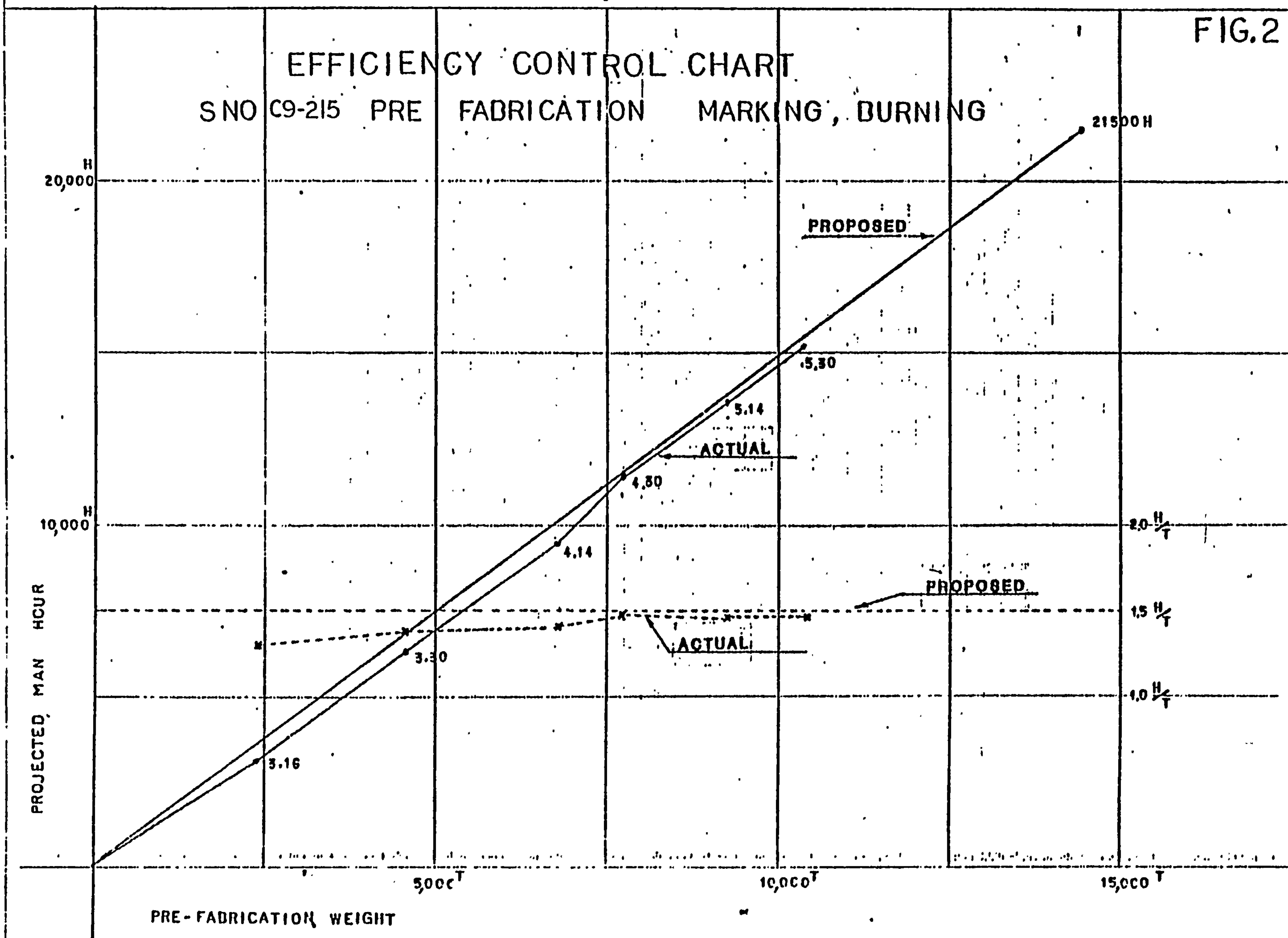
PROCESS LANE LAYOUT FOR CATEGORY 1 HULL UNITS





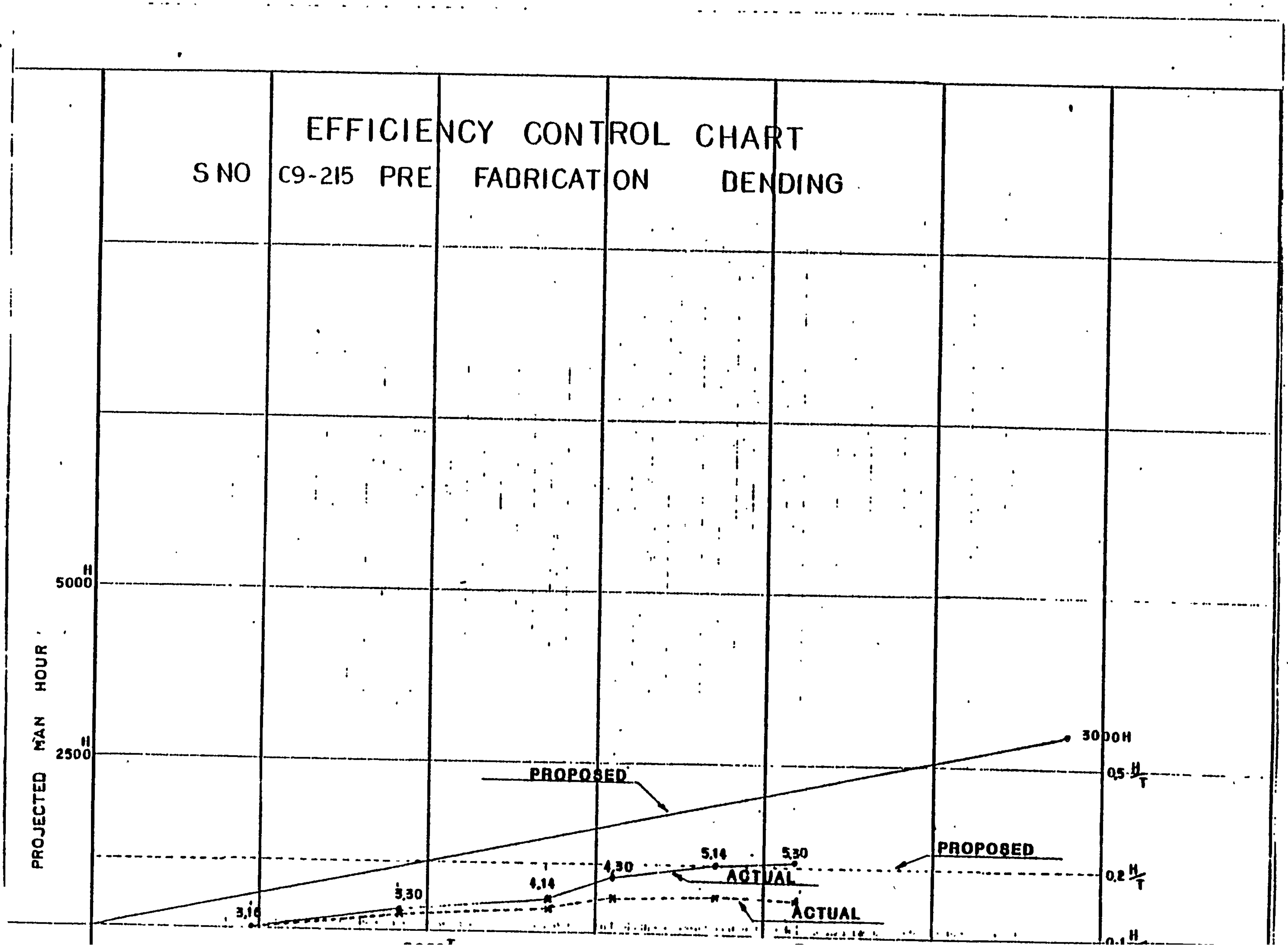
EFFICIENCY CONTROL CHART
SNO C9-215 PRE - FABRICATION TOTAL
24500 H
14500 T
20,000 H
PROJECTED
5.30
ACTUAL
5.14
4.30
10,000 H
4.14
2.0 H/T
PROJECTED
1.7 H/T
ACTUAL
3.30
1.0 H/T
3.18
PROJECTED MAN HOUR
5,000 T
10,000 T
15,000 T

FIG.I



EFFICIENCY CONTROL CHART
S NO C9-215 PRE FABRICATION MARKING, BURNING
21500 H
20,000 H
PROPOSED
5.30
5.14
ACTUAL
4.30
10,000 H
2.0 H/T
4.14
PROPOSED
1.5 H/T
ACTUAL
3.30
1.0 H/T
3.16
PROJECTED MAN HOUR
5,000 T
10,000 T
15,000 T
PRE-FABRICATION WEIGHT

FIG. 2


EFFICIENCY CONTROL CHART
S NO C9-215 PRE FADRICATION DENDING
PROJECTED MAN HOUR
5000H
2500H
3000H
PROPOSED
PROPOSED
ACTUAL
ACTUAL
0.5 H/T
0.2 H/T
3,16
3,30
4,14
4,30
5,14
5,30

COST BREAKDOWN BY HULL GROUP

COST CENTER		PERCENTAGE OF MANHOURS PER TON
PRE-FAB		8.25%
FABRICATION		20 .46%
ASSEMBLY		24.26%
ERECTION		47. 03%
TOTAL		100.00%

COST SAVINGS OF PROCESS LANE METHOD VERSUS CURRENT METHOD

COST CENTER	CURRENT METHOD		PROCESS LANES METHOD	
		% OF M/H-TON	SAVINGS	% OF H/A-TON
PRE-FAB		8.2577	.12% LESS =	8.13%
FABRICATION		20.46%	3.45% LESS =	17.01%
ASSEMBLY		24.26%	5.48% LESS =	18.78%
ERECTION		47.03%	11.77% LESS =	35.26%
TOTAL		100.00%	20.82% LESS =	79.18%

PROCESS LANE SAVINGS BREAKDOWN

CATEGORY	PRE-FAB	FABRICATION	ASSEMBLY	ERECTION	STORAGE
PROCESS LANES	1%	5.5%	4%	1%	
MATERIAL FLOW	1%	3%	1.5%	.5%	F-1 47%
NEW PRODUCT-ION METHODS	1.5%	5%	4%	C-1 9.5%	
ACCURACY CONTROL	A-1 -.5%	1%	D-1 6%	E-1 13%	
OTHERS	B-1 4%	B-2 4%	B-3 4%	1%	
TOTALS	7%	18.5%	19.577	25%	47%

FIGURE NO. 4

SEMINAR ON ZONE OUTFITTING
OUTFITTING PLANNING AND SCHEDULING
AVONDALE SHIPYARDS, INC.

Prepared By: G. B. GRIMSLEY

ZONE OUTFITTING
PLANNING AND SCHEDULING

I. INTRODUCTION

A) THE ZONE OUTFITTING METHOD

The conventional method of outfitting used in the past at ASI was designed on drawings that were concerned with whole systems and system functions. The outfitting material was installed, for the most part, after erection of the hull units and after completion of the hull work, by system.

Performing the outfitting in this manner is an extremely costly operation because of the number of people and the amount of material required to be in the same area, at the same time, in order to complete the work according to schedule. These conditions result in poor labor cost returns because of the condition. The scaffolding costs are also very high because of the access needed to do the work. Additionally, safety records are poor because of the crowded, confined working conditions. The conventional method is also a vastly complicated operation, due to its being concerned with whole systems, some of which could cover almost the entire length of the ship.

We, in Outfit Planning, recognized some good time ago that there must be a better way to do the outfitting. We made an effort to "pre-outfit" the hull units on the Ogden contract, the Occidental tug and barge contract, and also on the last two hulls of the Navy A.O. contract. This was done by taking the existing engineering drawings which were made in the conventional manner, by system, and "breaking" them down to suit on-unit outfitting prior to erection. This only proved to be moderately successful, however, due to the manner in which the drawings were made. Many valuable lessons were learned, though, by all involved in establishing our criteria concerning what could be installed and what could not.

Oufitting in any manner is a complicated business, consisting of thousands upon thousands of details, each one important in its own right; but, there is now a more organized method than any that we have tried before.

The zone outfitting method, which has now been adopted and which is currently being implemented at ASI, was developed over a period of time by the Ishikawajima-Harima Heavy Industries Company, Ltd. of Japan (IHI) to avoid the many problems and higher costs of conventional outfitting.

At ASI, we have been involved with the IHI zone outfittin method now on two contracts - three container ships for tl President Lines and a hopper dredge for Zapata. On these two contracts, which are presently in various stages of completion, the drawings were made, for the most part, to reflect the zone outfitting philosophy and the outfitting was, and is still being, performed in the manner prescrib as best we can manage this early in our evolution. Full implementation, we realize, will not be completed for som time.

The IHI zone method of outfitting is an offshoot of the ur or block method of hull construction, which was to build : place on the building ways.

In the unit or block method of hull construction, the shi is broken up into relatively small sections which are fabr cated and assembled remote from the erection site to pre- clude the unsatisfactory conditions caused by on-site building, then brought individually to the erection site f assembling together to make up the hull.

The zone outfitting method is similar, whereas the out- fitting components are separated into relatively small, le complicated packages that have been designed, for the most part, to be installed on the units or blocks at the proper stage of their construction, away from the erection site. The outfitting drawings, as they are now made, ignore Sys- tems per se and concentrate in smaller areas in order to maximize the amount of interim material that can be installed in these smaller areas (on-unit) remote from the building ways in safer, open areas, and most usually requiring no scaffolding.

The remaining outfitting material that must be installed after the units are erected follows the same principle of relatively small, less complicated packages of material, confined to a specific area (on board), which is not over- crowded due to the work previously performed on unit and i which a minimum of scaffolding is now required.

Also, following this same principle are machinery and pipe rack packages which are components of various sytems, but are designed to be fabricated and assembled complete with supporting structure, machinery, piping, walkways, etc. aw from the unit and hull assembly site, then installed eithe on the hull units prior to erection or on the hull (on board) at the proper time.

The various systems are only recognized and approached, as such, at the stage of construction where system progress requires assessment, such as at the beginning of testing, etc.

So, then, we have these advantages in using the zone outfitting method:

- less complicated;
- better working conditions;
- less scaffolding;

more cost efficient;

safer working conditions;

more work is complete at launch; consequently, the ship is at the completion dock a shorter time after launch, which enhances timely delivery or possibly earlier delivery.

II. PRODUCTION OUTFITTING PLANNING PROCEDURE

The phrase "outfit planning" describes the planning and scheduling necessary to install and test and operate all the components of a ship, other than the hull structure.

The objective of this procedure is to explain the Production Planning effort required to develop the information, documents and the schedules necessary to implement and accomplish zone outfitting at ASI and, also, to show the interface between Outfit Planning, Hull Planning, and the Engineering Department during this process.

A) PRE-CONTRACT

- As early as possible in the pre-contract negotiating period, the Production Planning Department establishes the major milestone dates of keel, launch and delivery. After contract" signing, these dates are shown in the Master Yard Schedule.
- Production Outfit Planning then develops the zone outfitting master planning schedule, which is a schedule of schedules, activities, and events. This is accomplished by applying dates to the standard format.
- Production Planning receives, from Advanced Programs/Hull Technical and Design Section, updated Key Plans:

- Contract Specifications
- Midship Section
- Scantling Plans, Sections and Details

In addition, during the pre-contract period, Productio Planning receives relatively "fixed" contract:

- General Arrangement
- Machinery Arrangement
- Key Systems Diagrams

- The ship is then divided into large purchasing zones b Outfit Planning for the advance ordering of material a equipment. A date for the earliest required items is assigned to each zone. These large purchasing zonesd a subdivided at a later date, and then become distinct o fitting zones for drawing and work scheduling.

- Production Hull Planning develops the preliminary unit arrangement, with master butts, and develops the preli nary pre-fabrication and sub-assembly schedule and the main assembly and erection schedule, which are the bas for the Production Outfit Planning and Engineering Pla ning Sections' early activities.

  NOTE: Hull and Outfit Planning Sections must work ve closely together during this period, so that whatever advantages that can be gained for the outfitting, in the manner in which the ship is broken up, are fully utilized.

- Production Outfit Planning and the Engineering Outfitt Sections study the Key Plans concurrently and decide preliminarily the application of:

  machinery package units;
  pipe package units;
  the various types of on-unit outfitting (innerbottoms flats, etc.);
  zone outfitting on board.

B) CONTRACT SIGNING

- Production Outfit Planning develops the detailed zone arrangement and the preliminary pallet list.

- Engineering develops the Preliminary Drawing Schedule, which is submitted to Production Planning for need date

- Production Outfit Planning develops the Master Mileston Construction/Zone Outfitting Schedule.

- The Hull Construction and Miestone Schedules are reviewed by Production Operations, Production Engineering and Production Planning, and joint meetings are held to finalize them. Concurrent with these reviews, Engineering is developing hull drawings and review meetings are held between them, Production Planning, and Production Operations for further developing and finalizing the unit breakdown. Some compromises to accommodate the outfitting or hull construction may be made during this period.

  (The early definition and finalizing of the unit arrangement are vital to the Engineering Outfitting Section for the making of the working drawings to meet the schedule.)

- All the schedules previously discussed are submitted to upper management for approval and, upon approval, are distributed to the yard.

- Unit construction plan (where and how) is finalized by Production Hull Planning at a series of meetings with Production Operations, Outfit Planning, Mold Loft, Engineering, and all other interested parties.

- Outfit Planning begins publication of the Unit Outfitting Synopsis, a brief description of the outfitting procedure for each unit.

  NOTE: After it has been decided how and where each unit is to be constructed, e.g.: upside down on Platen 20, then turned for weld completion, moved to blast and paint in the upright position, etc., it is of the utmost importance to the zone outfitting philosophy that this plan be maintained by the field. It is upon this plan that the outfitting plan is built, which includes the engineering drawings, the assignment of pallet numbers, and the marshaling of the outfitting material for delivery to the site at the proper time. Therefore, the plan should not be changed until all the ramifications have been considered and thoroughly discussed before the decision is made.

- The Pallet Schedule is finalized by Production Outfit Planning and issued to the yard.

- The Engineering Drawing Schedule is finalized and weekly meetings begin between the Engineering Outfitting Sections, Production Hull and Outfit Planning, and Production Operations to review and discuss as they develop:

advance design composite sketches,
the working drawings,
pallet codes and the pallet. lists of material.

NOTE: It is imperative that, during the drawing development stage, Engineering and Production maintain very close contact and communications for it is during this period that the final criteria are applied as to exactly what outfitting material will be installed at each sta of construction, and the contents of the palle are cast as final.

- Outfit Planning begins publication of the "Unit Outfitting Lists of Material," and the "Zone Outfitting Lists of Material."

- Work orders are issued by Production Engineering, and fabrication, sorting, collection and packaging of outfitting material begins.

- On-unit and package unit outfitting begins.

- On-board outfitting begins.

- Production Outfit Planning issues the Compartment Comp tion and the Machinery Testing Schedule, which are deve oped from information contained in the Master Mileston and Pallet Schedules and from the Test Memoranda developed by the Q.A. Section of Engineering.

NOTE: This procedure is only one of many which are requir in the process to implement zone outfitting. Each section of the yard must also have a procedure that is consonant with the philosophy and which dovetail with all the others.

III. THE PALLET CONCEPT IN ZONE OUTFITTING

The key instruments for outfitting in the manner that is bein presented here are the pallets, under whose numbers the packages of outfitting material are grouped, and which will be explained in the following text.

NOTE: The pallet numbers with the drawing required dates are issued to Engineering early in all jobs. The pallet numbers that are assigned by Production Outfit Planning for use by Engineering at this stage may be best understood if the analogy is made that, the pallet numbers a at this point "empty buckets," because no one knows at this time what the “buckets” contain. Production has furnished them, Engineering is to fill them and return them to Production via the drawings.

The pallet, as discussed here, requires that you put aside what you usually think of when You hear the word. which is the familar wooden framework platform used to move material about with a forklift truck. Pallet material, for the pallet as defined here, may be stored or moved using a variety of containers, including the familiar wooden platform.

For the purposes of this discussion, the pallet, as the term is used for zone outfitting, has an entirely different meaning.

A) <u>THE PALLET FOR ZONE OUTFITTING CONSISTS OF:</u>

1) <u>A work package, or kit of outfitting material</u>, that is designed by Engineering, based on pre-established criteria, to be installed in the hull of a ship in a specific place and at a specific advantageous time, during construction.

2) <u>The manhours allowed for its installation</u>. Ideally, the pallet should require approximately 100 manhours to install, or one week’s work for two men. (Engineering is not being asked at this point at ASI to designate the pallets to this parameter. Production will break the large pallets into smaller ones to suit need. However, in the future, Engineering is expected to be cognizant and to pallet code the material accordingly.)

3) <u>A pallet number</u> which identifies the material and which is both significant and unique.

The pallet numbering system currently in use at ASI was developed by Outfit Planning, using certain well-known yard terminology in its structure. We have used this system with success on the two contracts previously mentioned.

B) <u>THE PURPOSE OF THE PALLET NUMBER AS USED AT ASI IS:</u>

1) To identify the material it represents by labor cost code, which allows cost collection by pallet.

2) To identify where the material is to be installed.

3) To identify the material by a serial number, which all
segregation into manageable packages.

4) To identify the stage or time at which the material is
be installed.

C) THE THREE APPLICATIONS OF PALLET NUMBERS TO OUTFIT MATERI
ARE:

1) Organizing material for the hull units at their variou
stages of construction completion before they are erec
on the ways.

2) Organizing material for the various outfitting zones (
board) after the hull units are erected that form the
zones.

3) Organizing material for installation on machinery and
pipe rack packages.

D) ON-UNIT OUTFITTING PALLETS

1) Typical On-Unit Pallet Numbers

06-001-01S
09-001-01U
16-001-01T
07-001-01V
20-001-01J

2) Pallet Number Breakdown

a) The first two characters represent a craft labor co
code:

06 - Piping . . . . Pipefitters
07 - Machinery . . . . . . Machinists
08 - Electrical . . . . Electricians
09 - Ventilation . . . Sheet Metal Workers
16 - Fittings . . . . . . Shipfitters
17 - Outfitting . . . . Shipfitters
20 - Foundations . . . Shipfitters

b) The middle three characters establish hull unit numb

001 . . . . On Unit One
060 . . . . On Unit Sixty
etc.

c) The sixth and seventh characters establish serial number:

01 . . . . Serial Number One
02 .... Serial Number Two
etc.

d) The eighth character represents a code for the stage of unit construction at which the material is installed. There are five (5) stage codes:

S = To be installed on a unit sub-assembly piece before it is joined with other sub-assemblies at main assembly to make up the unit (prior blast and paint).

U = To be installed at main assembly or while the unit is at the pre-outfitting position on the platen. Normally, while the unit is upside down and open before closing in with shell plating, deck plating (prior blast and paint).

T = To be installed after the unit has been turned for welding (prior to blast and paint). Some types of material that are installed prior to paint:

- steel piping, including valves;

- CUNI piping, including valves (except small tubing);

- galvanized piping;

- splash plates, striking plates, doublers, coamings;

- independent tanks;

- lifting devices, padeyes, monorails, overhead crane rails;

  electric cable hangers, collars, transit frames, kickpipes;

- foundations, vertical and inclined ladders, docking plugs;

- chocks, bitts, cleats, manholes, hatches, heavy doors;

- vent spools, heavy gauge duct, heavy construction louvers.

V = To be installed after the unit has been blasted and painted. This stage is usually reserved fo the installation of material and equipment that would be damaged by the blast and paint process Some examples are: sheet metal gauge duct, pla tic pipe, machinery, etc.

J = To be installed after the unit has been joined blocked with another unit, after blast and pain and prior to erection.

NOTE: Every effort must be made by all sections of Engineeri to place the maximum amount of material on the units i all stages of their construction, so that on-board installation is confined to an absolute minimum. This involves great attention in design to suit the unit bou daries and its conditions.

The ideal design would allow all work to be performed i the down-hand position and would require no scaffolding The reality, of course, is a compromise that asks for minimum of work to be performed in difficult positions, and in which a minimum of scaffold is required.

3) General On-Unit Design Criteria, all Engineering Groups

a) Do not place material nearer than one foot to either side of an erection joint. This two-foot area is required for fitting and welding of the joint.

b) Study the adjoining unit structure, also, before placing material near the allowable distance from th joint. There may be protruding structure or equipme that extends into the unit you are working.

c) Relocate material, whenever possible, that falls on too near an erection joint. Examples would be: fou dations whose exact location are flexible, reach roc operators and rods, mooring bitts, etc. Each case must be studied individually.

d) Tools for the engineering of material to be installe on the units and on board:

the Unit Arrangement (Production Planning);
the Unit Summary Sheet-Construction Procedure (Production Planning);
structural drawings showing unit breaks (Production Planning, Hull Engineering);
isometric drawings (Engineering).

E) ON-BOARD OUTFITTING PALLETS

1) Typical On-Board (Zone) Pallet Numbers

- 06-M12-01X
- 07-M21-01X
- 08-M32-01X
- 09-A10-01Y
- 16-D00-01Z

2) On-Board Pallet Number Breakdown

a) The first two characters represent the labor cost code as they did for the unit pallets:

06 - Piping . ... Pipefitters
07 - Machinery ..... Machinists
etc.

b) The middle three characters are the location code.

The first character denotes the main zone:

M = Machinery Spaces
A = Accommodation Spaces
D = Deck and Hold Spaces

(These main zones are now standard on all jobs.)

The second character of the location code is used to establish the sub-zone (see zone arrangement).

The third character of the location code is used to designate either the port or starboard side of the sub-zone or the sub-zone in its entirety:

1 = starboard side
2 = port side
3 = whole sub-zone

Hence: M = Machinery Space
Ml = Machinery Space Lower Level
Mll = Machinery Space Lower Level, starboard side
M12 = Machinery Space Lower Level, port side
M10 = Machinery Space Lower Level, throughout.

c) The sixth and seventh characters are the serial num of the pallet. The serial number may be used to divide pallets that contain large amounts of materi into smaller packages for easier handling, etc.
Exampe: Pallet O9-M10-01Y contains 60 pieces of fab cated ventilation duct and 40 pieces of spi duct. This pallet could be divided thus:

O9-M1O-O1Y - 30 pieces fabricated duct
20 pieces sprial duct

O9-M1O-O2Y - 30 pieces fabricated duct
20 pieces spiral duct

d) The eighth character establishes at what time or st of hull construction the material is installed and also its priority. There are three on-board stage codes:

X = Load Aboard Prior To Closing In - First Priority

To be installed prior to closing in an area whe the existing openings will not accommodate the material or equipment after erecting a hull uni over alongside, etc. The weight of an item is also a consideration, where extra effort would b required to move the item into place, even thou it would fit through existing openings.

Y = Easy Access - Second Priority.

Material and equipment that may be passed or carried through existing openings because of its smaller size or lighter weight. This stage code is also used for items on open deck areas.

Z = Final Outfitting Items - Third Priority.

This code is reserved for final outfitting items that would not normally be installed until just prior to sea trial or delivery (pilferables, fi hose, portable test instruments, spare parts, etc.). Location codes for this type of material usually are given to the whole main zone.
Example: 06-MOO-O1Z - install throughout zone M
17-AOO-O1Z - install throughout zone A
etc.

F) SPECIAL PALLET NUMBERS THAT ARE USED TO GROUP ASSOCIATED MATERIAL AND COSTS TO VARIOUS EQUIPMENT

1) Examples

- M/E = Main Engine . . . . .Pallet #07-M/E-O1X

  Associated Items:
  M/E Chocking and Bolting . . . . Pallet #07-M/E-O1Y

  M/E Sway Bracing . . . . Pallet #16-M/E-O1Y

  M/E Spare Parts . . . . Pallet #17-M/E-O1Y

- B/R = Boiler . . . . Pallet #07-B/R-O1X

  Associated Items:
  Smoke Indicator Piping . . . . . Pallet #06-B/R-O1Y

  Safety Lifting Gear . . . . Pallet #07-B/R-O1Y

  etc.

NOTE: One of the main features you should not miss in the pallet system concerns the organization of the material. This organization allows the control of people through the scheduling of the pallets. The workman cannot work out of phase, which usually lessens the effectiveness of others involved, if he does not have the material. The material is controlled and, thereby, the people in the system are controlled.

The significance of this fact is pointed out in a footnote in the "Product Work Breakdown Structure" publication, "In Japan We Have To Control Material Because We Cannot Control People." (Y. Mikami to L.D. Chirillo, June, 1980)

IV. CLOSING REMARKS

It is now possibly clear to you that the zone outfitting method is a highly organized and methodical approach to integrate the outfitting of a ship with its construction and erection. There are many advantages in the system that are inherent and not readily apparent, but of which you will become aware once it is decided to implement the system. In closing, allow me to briefly cover some of the innovations that have been introduced since inception and the effects of them on the yard.

A) ENGINEERING PLANS

1) Drawings are made to suit unit construction and the uni construction schedule. This establishes a realistic schedule for engineering. It is very easy to see where the "tight" spots are and the man loading required to meet the schedule. Piping arrangement drawings are mad to cover multi-units with a separate P/D and L/M bookle for each unit. Pipe down through two inch is develope and below that is dimensioned on the arrangement. Ther is no "field run" piping except small tubing. The material in the L/M and pipe pieces in the P/D are pal numbered and coded to the proper stage.

Ventilation arrangement drawings are made to cover multi-units with a separate L/M booklet for each unit. Each piece of duct is numbered on the arrangement and a material, includng the duct pieces, are numbered and pallet coded in the L/M.

Outfitting section drawings cover multi-units and list the material by pallet numbers. Additionally, paintinc information is listed for each item and also the weight of the finished assembly. Most of their drawings are organized in a manner that allows separation of the fabrication from the installation sections, so that the workman only sees what is necessary for his work, if sc desired.

Mechanical Section drawings, also, follow suit (reach rods, exhaust piping, cargo pump installation, etc.) wi multi-units in the arrangement and a separate listing b pallet number.

One principle that has been emphasized to Engineering i all our policy discussions is, "Production does no mate ial take-off from the drawings." They have responded admirably and, to date, have made great progress in con forming.

2) It must be pointed out that making the drawings, in the manner required to suit zone outfitting, requires a muc greater effort and expenditure "up front" in Engineerin than was necessary previously. The drawings are more difficult and, therefore, more time consuming.

B) **<u>PRODUCTION MAY ALSO MAKE MORE REALISTIC PLANS AND SCHEDULES FOR ALL ITS FUNCTIONS. THIS INCLUDES LONG TERM FABRICATION AND INSTALLATION PLANNING. PRODUCTION'S VARIOUS FACETS ARE ENHANCED BECAUSE:</u>**

1) <u>Fabrication</u>

   a) Now geared to actual need dates.

   b) Shop level loading easier to plan and execute.

   c) Material storage problems are less.

2) <u>Installation</u>

   a) On-unit at the proper time and attitude (down hand, etc.).

   b) On-board at the proper time, in a more orderly fashion.

   c) Working conditions are better and safer overall.

   d) Management has better control.

   e) Better physical progress assessment at any given point.

   f) More cost effective.

3) <u>costs</u>

   a) Easier to monitor.

   b) Easier to manage.

   c) Easier to pinpoint individual performance.

   d) Easier to gauge overall performance.

   e) Better and more accurate feedback to Estimating on what the job actually cost.

LEGEND

ZONE "M" - MACHINERY SPACE

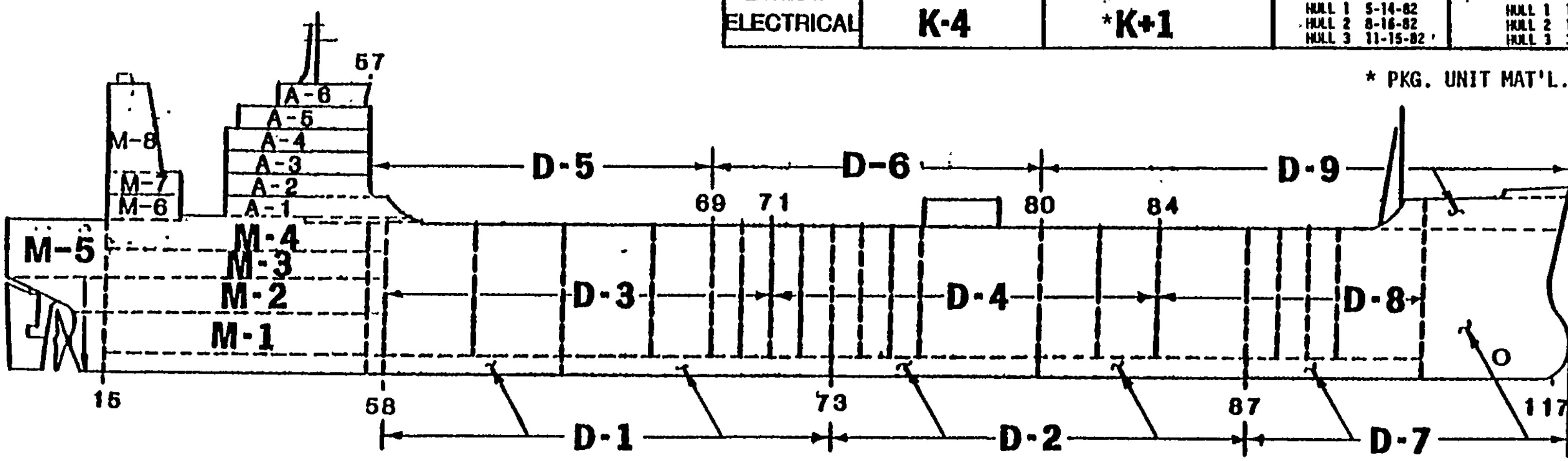
ZONE "A" - ACCOMODATIONS

ZONE "D" - DECK & HOLDS

1

OUTFITTING MATERIAL - ADVANCE PURCHASING ZONES				
ZONE	STANDARD TIME		DATES	
	FAB MAT'L.REQ.	PURCHASED ITEMS REQ.	FAB MAT'L.REQ.	PURCHASED ITEMS REQ.
D-1,D-2,D-3 D-4,D-5,D-6	K-4 MONTHS	K-2 MONTHS	HULL 1 5-24-82 HULL 2 8-16-82 HULL 3 11-15-82	HULL 1 7-19-82 HULL 2 10-11-82 HULL 3 1-10-83
M	K-4	K-3	HULL 1 5-24-82 HULL 2 8-16-82 HULL 3 11-15-82	HULL 1 6-21-82 HULL 2 9-13-82 HULL 3 12-13-82
A	K	K+2	HULL 1 9-14-82 HULL 2 12-7-82 HULL 3 3-1-83	HULL 1 11-8-82 HULL 2 1-31-83 HULL 3 4-25-83
D-7,D-8,D-9	K+1	K+2	HULL 1 10-11-82 HULL 2 1-3-83 HULL 3 3-28-83	HULL 1 11-8-82 HULL 2 1-31-83 HULL 3 4-25-83
ELECTRICAL	K-4	*K+1	HULL 1 5-14-82 HULL 2 8-16-82 HULL 3 11-15-82	HULL 1 10-11-82 HULL 2 1-3-83 HULL 3 3-28-83

* PKG. UNIT MAT'L. K-3



EXAMPLE B

C1-0015
EXXON PRODUCT CARRIER

LENGTH O.A. 635'-6"

BREADTH MLD. 105'-10"

DEPTH MLD. 60' 0"

	KEEL	LAUNCH	DELIVERY
NO. 1	9-14-82	5-14-83	10-15-83
NO. 2	12-7-82	8-6-83	1-7-84
NO. 3	3-1-83	10-29-83	3-31-84

PRODUCTION PLANNING JAN. 1981

ZONE A - Accomodations

A1-Service Desk - Main Deck to 65'6" Level Fr. 34 - 57 & Main Deck to under side of boat deck (75'6" Lvl.) Fr. 34 - 57 - Exterior Areas, Fr. 57 to Mach. Casing

A2 - Boat Deck - 75'6" Lvl. to under side of a deck 84'9" Lvl. & Exterior area Fr. 34 - 57.

A3 - A Deck - 84'9" Lvl. to under side B Deck 94'0" Lvl. & Exterior area Fr. 34 - 57

A4 - B Deck - 94'0" Lvl. to under side C Deck 103'3" Lvl. & Exterior area Fr. 34 - 57

A5 - C Deck - 103'3" Lvl. to under side of Nav. Bridge Deck 112'6" Lvl. & Exterior area Fr. 36 - 57

A6 - Bridge Deck - 112'6" Lvl. and P.H. top including Main Mast & Exterior area Fr. 39 - 56

EXAMPLE C

PALLET NUMBERS AND CODES

CONTRACT: C1-015

HULL "B" 2335

PALLET CODES

S - During Sub Assy./ On a Sub. Assy.
U - Before Turning - During Mn. Assy.
T - After Turning - Prior B & P
V - After B & P - Prior Erect

ON UNIT OUTFITTING

ZONE	UNIT	DESCRIPT.	FRAME	LOC.	PALLET NUMBER STAGE	OUTFITTING DRAWING REQUIRED	START FAB OUTFIT MAT'L	PALLET REQUIRED
D1	2	IB	58-61	P	S,U,T,V	3/22	5/17	7/19
	3	IB	58-61	S	S,U,T,V	↓	↓	↓
	1	IB	61-65	CL	S,U,T,V	3/29	5/24	7/26
	4	IB	65-69	CL	S,U,T,V			
↓	5	IB	69-73	CL	S,U,T,V			
M1	8	IB	44-58	P	S,U,T,V			
	9	IB	28-49	CL	S,U,T,V			
↓	10	IB	44-58	S	S,U,T,V			
D3	16	BHD	64	CL	S,U,T,V	↓	↓	↓
D1	6	IB	61-65	P	S,U,T,V	4/5	5/31	8/2
	7	IB	61-65	S	S,U,T,V			
↓	13	IB	73-77	CL	S,U,T,V			
M1	17	IB	29-44	P	S,U,T,V			
↓	18	IB	29-44	S	S,U,T,V	↓	↓	↓
D1	12	IB	65-69	S	S,U,T,V	4/12	6/7	8/9
D2	13	IB	73-77	CL	S,U,T,V			
D5	14	INB WG	58-61	P	S,U,T,V			
D5	15	INB WG	58-61	S	S,U,T,V	↓	↓	↓
D1	19	IB	69-73	P	S,U,T,V	4/19	6/14	8/16
D1	20	IB	69-73	S	S,U,T,V			
D5	23	INB WG	61-65	P	S,U,T,V			
D5	24	INB WG	61-65	S	S,U,T,V			
M1	25	IB	15-29	CL	S,U,T,V			
D2	29	IB	77-81	CL	S,U,T,V			
D2	30	IB	73-77	P	S,U,T,V	↓	↓	↓
D5	27	OBD WG	58-61	P	S,U,T,V	4/26	6/21	8/23
D5	28	OBD WG	58-61	S	S,U,T,V			
D2	31	IB	73-77	S	S,U,T,V			
D2	39	IB	77-81	P	S,U,T,V	↓	↓	↓

EXAMPLE D

SPECIAL DESIGNATION CODES
A/W Anchor Windlass
B/R Boiler
B/T Bow Thruster Mach'y
C/W Const. Ten Winch
D/G SS Dsl. Gen.
E/G Emerg. Gen.
E/C Eng. Rm. Console
M/E Main Eng.
P/R Propeller
R/D Rudder
S/B Main Swbd.
S/H Shaft
S/G Steering Gear
W/H Waste Heat Boiler

PALLET NUMBERS/CODE

DRAWING REQ. SCHEDULE

CONTRACT C1-0015 "B"

HULL 2335 EXXON

INSTALLATION CODE
X = Prior Closing
Y = Easy Access/Prior Launch

ON BOARD OUTFITTING

ZONE SUB-ZONE	LOCATION	PALLET NO/CODE	OUTFIT DWG. REQ.	START FAB	START INSTALL
M-1	ENG. RM.LWR.LVL				
M-1	ENG. RM.LWR.LVL	20-M11-1X	6/28/82	8/23/83	10/25/82
M-1	ENG. RM.LWR.LVL	20-M12-1X			
M-1	ENG. RM.LWR.LVL	07-M11-1X			
M-1	ENG. RM.LWR.LVL	07-M12-1X			
M-1	ENG. RM.LWR.LVL	06-M11-1X			
M-1	ENG. RM.LWR.LVL	06-M12-1X			
M-1	ENG. RM.LWR.LVL	16-M11-1X			
M-1	ENG. RM.LWR.LVL	16-M12-1X			
M-1	ENG. RM.LWR.LVL	08-M11-1X			
M-1	ENG. RM.LWR.LVL	08-M12-1X			
M-1	ENG. RM.LWR.LVL	09-M11-1X			
M-1	ENG. RM.LWR.LVL	09-M12-1X			
M-1	ENG. RM.LWR.LVL	17-M11-1X			
M-1	ENG. RM.LWR.LVL	17-M12-1X	↓	↓	↓
M-1	ENG. RM.LWR.LVL	20-M10-1Y	7/26/82	9/20/82	11/22/82
M-1	ENG. RM.LWR.LVL	07-M10-1Y			
M-1	ENG. RM.LWR.LVL	06-M10-1Y			
M-1	ENG. RM.LWR.LVL	16-M10-1Y			
M-1	ENG. RM.LWR.LVL	08-M10-1Y			
M-1	ENG. RM.LWR.LVL	09-M10-1Y			
M-1	ENG. RM.LWR.LVL	17-M10-1Y	↓	↓	↓
M-2	ENG. RM.24'3"LVL	20-M21-1X	7/12/82	9/6/82	11/8/82
M-2	ENG. RM.24'3"LVL	20-M22-1X			
M-[illegible]	[illegible]	[illegible]21-1X	↓	↓	↓

EXAMPLE D1

UNIT 24 - REV. 1 - 2/17/82

24. UNIT 24 (CAT. 1 PLATEN 20) STBD. INBD. WING FR. 61 - 65

PRIOR BLAST AND PAINT

A. 18'6" BHD, IS BASE PLT.

B. UNIT PASSES THROUGH OUTFIT AREA IN TWO SECTIONS, MN, DK, SECTION & LONG'L BHD, SECTION, NOTE: TRUNK SECTION ASSEMBLES ON PLATEN 23

C., OUTFIT SUB ASSY'S

(1) MN. DK. SECTION
- A. HATCHES, ETC.
- B. TIME REQ'D 2 DAYS

(2) LONG'L BHD. SECTION
- A, FIELD RUN PIPE
- B, INCL, LADDERS, (FWD, BHD,) FDNS.
- C. TIME REQ'D 2 DAYS

(3) TRUNK SECTION
- A. GRATING, ETC, NOTE: FOLD BACK FLAT AGAINST TRUNK BHD. W/ TOGGLE PRIOR ERECT
- B, TIME REQ'D 1 WEEK DURING ASSY,

D. MOVE TO MN. ASSY. & JOIN DK. & BHD.

E. MOVE TO END OF PLATEN (NO TURN)

F. OUTFIT
- (1) COMP. INSTALL PIPE
- (2). TIME REQ'D 5 DAYS

PRIOR TURN AFTER & BLAST AND PAINT

G. OUTFIT
- (1) BOMDSTRAND
- (2) TIME REQ'D 2 DAYS

H. TURN UNIT AND INSTALL PRECOATED TRUNK & BRKTS.

1. OUTFIT
- (1) VERT. LADDERS, ETC.
- (2) TIME REQ'D 1 WEEK DURING GRAND ASSY.

J. TOUCH UP PAINT

K, ERECT

EXAMPLE F

UNIT OUTFITTING PALLET L/M

PRODUCTION PLANNING

JOB NO. C1-15 UNIT 10 **PALLET NO.** 010-1U

HULL 2335 "B" ZONE M PALLET REQ'D. **AS PER SCHED.**

UNIT DESCRIPTION: INNER BOTTOM (S)
FRAME(S): 44-58

GROUP	LINE	DESCRIPTION	DRAWING	SHEET, DETAIL, ITEM OR PIECE MK.	REMARKS
16		MAN HOLE, HATCH & SCUTTLE LIST	16-02-018	3 12-11-81	
↓	1	MANHOLE W.T. MS-16-MH-8 (2)	↓	SHT-17	SEE LINE 56, 57
	2				
	3				
	4				
	5				
16		SHELL FITTINGS	11-01-019	0 3-29-82	SEE A.S.I. STD MS-16-DP-1
↓	6	DP-1 (4)	↓		
	7				
	8				
	9				
	10				
	11				
02		FDNS. IN ENGINE ROOM	11-12-04	1 4-14-82	2
↓	12	HEADERS (2)	↓	5AA-A	↓
↓	13	↓ (2)	↓	5AA-C	↓
	14				
	15				
	16				
	17				
16		INT. ACC. LDRS BLW. MN. DK. AFT. FR. 58	16-04-08	0 4-27-82	2
↓	18	VL "6 W/CLIPS SHT 12 LINE 8	↓	FAB 14-A LIST 30A-C	↓
↓	19	↓ "3 ↓ ↓ 9	↓	↓ 30A-D	↓
↓	20	↓ "4A SHT 12-B 53	↓	↓ 30Q-B	↓
↓	21	IL "14 ↓ SHT 16 ↓ 1	↓	18A 29A-A	↓

EXAMPLE H

REVISION 2

PAGE NO 10-U-A
PRODUCTION PLANNING

ZONE OUTFITTING PALLET L/M

PRODUCTION PLANNING

JOB NO. C1-15 ZONE D PALLET NO. D50-14

HULL 2335 "B" SUB. ZONE D-5 PALLET REQ'D. AS PER SCHED.

ZONE DESCRIPTION: MAIN DECK

FRAME(S): 57 - 69

GROUP	LINE	DESCRIPTION	DRAWING	SHEET, DETAIL, ITEM OR PIECE MK.	REMARKS
16		EXPANSION TRUNK FOR BALLAST TANK ACC	16-02-04	△3 4-27-82	
↓	1	EXPANSION TRUNK ET-4	↓	SHT. 6,7,8 9-D	
↓	2	↓ -3	↓	↓ ↓	
↓	3	↓ -8 (2)	↓	↓ ↓	
↓	4	↓ -7 (2)	↓	↓ ↓	
↓	5	↓ -4	↓	↓ 9-A	
↓	6	↓ -3	↓	↓ ↓	
↓	7	↓ -7	↓	↓ 9-B	
↓	8	↓ -8	↓	↓ ↓	
	9				
	10				
	11				
	12				
16		MANHOLE HATCH & SCUTTLE LIST	16-02-01 B	△2 12-11-81	
↓	13	HATCH R.W.T. OF-108-17	↓	SHT 10	
↓	14	↓ 18	↓	↓	
↓	15	↓ 19	↓	↓	
↓	16	↓ 20	↓	↓	
↓	17	↓ 21	↓	↓	
↓	18	↓ 22	↓	↓	
↓	19	↓ 23	↓	↓	
↓	20	↓ 24	↓	↓	
	21				
	22				
	23				
	24				
	25				
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EXAMPLE H1

REVISION

SECT OF 11 PAGE NO. D50-14-A

PRODUCTION PLANNING

ENGINEERING INTERFACE

DESIGN ENGINEERING INTERFACE FOR
PRODUCTION PLANNING AND SCHEDULING PRESENTATION
AVONDALE SHIPYARDS, INC.

Prepared By: J. J. O'CALLAHAN

DESIGN ENGINEERING INTERFACE FOR
PRODUCTION PLANNING AND SCHEDULING PRESENTATION

I. INTRODUCTION

- Yesterday you heard the presentation on Hull and Outfitting Planning for Zone Outfitting; today Engineering, in the time allowed, will provide a "thumbnail sketch" of the impact of zone outfitting on its operation and procedures. As will be explained in the brief presentations which follow, Avondale Engineering has had to change the type and method of preparation of much of the documentation it prepares in order to accommodate the implementation of IHI shipbuilding technology at Avondale Shipyards. In reviewing engineering operating practices and procedures, the goal was always to change only what had to be changed so that the impact of the move to zone outfitting could be cushioned as much as possible with things familiar. For example, only two Engineering Sections underwent slight reorganization. The Mechanical Section added a "Machinery Package Group" to handle the entire development of machinery package units, and the Engineering Administration Section added an "Operations Services Group" to handle the lifting arrangements required by Production so that outfitted structural units could be lifted with safety. Avondale Engineering has demonstrated that zone outfitting can be absorbed into the design organization without the need for violent internal reorganization.

  Because design development under zone outfitting proceeds unit-by-unit rather than system-by-system, the engineering work effort must be accomplished in an earlier time frame than is the case, utilizing conventional design methodology. The earlier the start that Engineering has, the better the chance that all required engineering work will be completed at start of pre-fabrication. To this end it is most desirable that engineering work start prior to contract signing, if at all possible. This can be done through a "letter of intent" arrangement or through some other means, but the owner, as well as the shipyard, will reap benefits for money spent during the "pre-contract" phase. If a "pre-contract" start is not possible, the engineering effort must commence immediately upon contract signing. In either case, potential problems will come to light at an early stage, the chance for timely material procurement of long lead items will be enhanced, the shortened building period that zone outfitting offers will be protected and initial regulatory reviews can be conducted early.

  Pre-contract engineering effort should include work on mechanical system diagrams, weight estimate, longitudinal strength, hydrostatics, tank capacities, bon jeans curves, intact trim and stability data, loading conditions, damag stability evaluation, wake survey, resistance and self-propelled tests, electric load analysis, electric one-lin diagram, vent system development and duct opening, as wel as the development of procurement specifications on long lead material items such as main propulsion engines, dies generators, cargo oil pumps, anchor windlass, steering gea etc.

During the pre-contract phase, a constant dialogue must b maintained between Engineering and Production concerning such areas as preliminary unit definition, identification construction method, the establishment of outfitting zone for purchasing and the preliminary assignment of machiner package units and pipe racks for main deck. This dialogu which begins during pre-contract is essential to the successful implementation of zone outfitting techniques and must continue throughout contract design development and construction. In fact, the major beneficial "fall out" o the implementation of zone outfitting at Avondale has bee the renewed spirit of cooperation between the Engineering and Production organizations.

You heard yesterday about the importance of planning and scheduling for the Production Department in the implementa tion of zone outfitting. Good planning and scheduling te niques are just as important for the Engineering Departme in order for zone outfitting to be successfully implemented. This is due to two major factors: (1) more drawings are required than with conventional design techniques, and (2) the drawings must be produced in a much shorter period of time than with conventional design techniques. Avondale's Engineering Planning and Scheduling Section works with the Technical Engineering Sections to establish drawing schedules and material procurement schedules and then monitors these schedules weekly, reporti the results to Engineering Management.

Thus far, Avondale Engineering's implementation of zone ou fitting techniques has been most satisfactory. By and large, the problems encountered are many of the same ones which plague the engineering effort utilizing conventional design techniques -- lack of vendor information, lack of industry standards, customer changes, etc. However, with zone outfitting the consequences of these problems are mor acute than with conventional design techniques. The philo ophy that must be adopted by an Engineering organization that is going to implement zone outfitting techniques coul be condensed into the following key items:

- START ASAP - before contract signing, if at all possible, you will need all the time you can get.

- COMMUNICATE - with Production from the start.

- MATERIAL SPECIFIED AND ORDERED ASAP - have vendors ready to go upon contract signing - the sooner you issue purchase orders, the sooner you'll get vendor information required for drawing development.

- PLAN & SCHEDULE ENGINEERING WORK - with all the drawings you'll have to do and the short amount of time to do them, you'll need a good plan and a good schedule.

- REMEMBER TO MAKE IT HAPPEN -with zone outfitting, you won't have time to sit around and wait for the "other guy" to call you - if you need something, push until you get it.

The following sections are brief presentations on the way in which Avondale's Engineering Sections have been affected by the implementation of zone outfitting.

II. NAVAL ARCHITECTURE AND HULL STRUCTURES

A) NAVAL ARCHITECTURE

- Since the introduction of zone outfitting at Avondale, the Hull Technical & Design Section which handles the Naval Architecture function, has shifted the majority of its work effort to a much earlier time frame within the contract period. The primary reason for the shift is the fact that zone outfitting requires the Hull Technical and Design Section to produce structural drawings called "Key Plans."

  Simply stated, Key Plans are very detailed scantling plans which show the entire overall structural envelope of the vessel and detailed information of all decks, frames, bulkheads, stringers, flats and shell plates. The Key Plans must also incorporate major interfaces from all Engineering disciplines (e.g. foundations, vent trunks, large penetrations, etc.). By having these Key plans, all Engineering and Production Departments can proceed with their planning and drawing preparation using a common drawing. Therefore, by design, the Key Plan must be available to all departments very early within the contract period so that the accelerated IHI drawing issue schedules can be met.

In order to issue the Key Plans early, support tasks th are used to develop the Key Plans must be completed soo than under conventional systems. Scantling plans, dama stability studies, hull girder strength calculations, fairing and finite element studies must all be complete prior to issue of the Key Plans. The early comletion o these support tasks assures that major changes to the v sel will not occur after issue of the Key Plan, thereby avoiding cascading disruptions of all subsequent work.

Aside from the Key Plans, the next major impact of zone outfitting on the Hull Technical & Design Section has b the added responsibility of loading and maintaining the computer data base used in the entire phase of developm and construction of the vessel under contract. This da base allows drawings to be prepared from computer con- trolled drafting machines and, ultimately, for steel to marked and cut by computer controlled burning machines. The information contained within the data base must be developed and loaded to the faired hull form created during the line fairing process. Under the conventiona system, the Mold Loft had the responsibility to load an maintain the data base once fairing was complete. How- ever, since the Hull Technical & Design Section was loading the data base with "Key Plan" information, ASI management decided that the remainder of the hull loadi should be accomplished by the same department so as to avoid any duplication of work.

This new job function has created a good deal of daily interface with the Production Department and the Hull Technical & Design Section. Before zone outfitting, th Mold Loft communicated with Engineering through the Hul Structures Section. It is also envisioned that the Hul Technical & Design Section could become involvd directl with field problems once the yard begins to cut steel o ASI Job C1-15 (Exxon Product Carriers). This added rol of the Hull Technical & Design Section will eventually define both design and production problems so that futu designs can circumvent these problems, thereby reducing overall cost and construction time.

B) HULL STRUCTURES

- Prior to the introduction of zone outfitting at Avondal the hull structural drawings were developed and present to the Production Department utilizing a system-by-syst approach. The drawings were developed presenting the decks as a system, the shell as a system, the web frame as a system, and so on. We can think of these various structural components as systems of the hull envelope.

The system-by-system approach presented the entire shell, deck or longitudinal bulkheads to the Loft, from which the various structural units had to be extracted. The system-by-system drawings did indicate the unit breaks or erection joints, but the individual unit's demarcation lines and extent was not so easily discernible graphically. Additionally, the system-by-system approach required the user to possess other system plans in order to obtain the knowledge of all of the components of a particular unit. Many reference plans were necessary.

- The greatest influence that zone outfitting had on the functions of the Hull Section was in the development of the hull structural plans.

  Zone outfitting introduced four (4) major ideologies regarding methodology for producing the structural drawings. :

  1. The structure would be developed and presented unit by unit.

  2. The individual units would be developed from a Key Plan rather than a rough scantling plan. The Key Plan conceptually is a more complete scantling plan delineating secondary structure to a more detailed level.

  3. The structural drawings would have their respective unit's various components identified by a designation system that was keyed to the intended construction sequence or stages for that particular unit.

  4. Each unit drawing, or yard plan as they are referred to, would be accompanied by a complete accounting list of material for that unit, known as a Unit Parts List.

- ASI still maintains the obviously required system drawings, such as the rudder support system, mooring system, and anchor handling system. Their development methodology has essentially remained unchanged under the zone outfitting concept.

- <u>Standards</u> - The adoption of zone outfitting has led to the creation of a large number of standardized structural details. The adoption of standardized structural details has led to uniformity in configuration and application. Repetitious detail requirements are simply referred to the standards.

Some standardized notations, where certain letters of tl alphabet singularly, or in combination, are assigned certain meanings, are used in the yard plans. These st dardized notations are directly tied to ASI's Standard Structural Details.

- Symbolic Logic - The next area where the adoption of zo outfitting has had an influence is in the use of symbol logic. Prior to zone outfitting, ASI structural plans utilized symbolic logic to some degree. Now, the use of symbolic logic has increased significantly. Symbolic logic is now employed to denote mold line side, dimensioned side of member, stock allocations, etc. In the future, additional symbolism will be utilized in an eff to further standardize repetitious meaning or intent, a thus reduce wording or graphic presentations on the plans. The attending cost saving is an obvious initiat factor.

- Unit Parts List - The next area, where the adoption of zone outfitting has a significant influence, lies in the decision to create a document known as the Unit Parts List, or UPL. Essentially, the UPL is a document that accounts for all the pieces in a unit. In addition to accounting for every piece, the pieces are presented to the user in the order of ascending stages of constructic grouped into the various partial sub units, sub units, a pieces required for both the assembly and erection stage of construction. The UPL is an accounting system that presents its information in the same order as a document produced by the Production Planning Department, the "Uni Breakdown Summary Sheet."

  The UPL is constructed from the "Unit Breakdown Summary Sheet." There are additional items of information that are contained in the UPL. These additional items of information are notations to the Loft as to what pieces require "lofted" dimensions, what pieces require stock, what pieces require special attention in the lofting anc manufacturing stages, etc. The UPL will be used at the various work stations.

  It is envisioned that the UPL will be a baseline documer that can be used by other groups or departments in the Production Establishment for such functions as material accounting, sorting, routing, storage, etc.

- Penetrations - Penetrations in structural components, du to piping, ventilation, mechanical and electrical routings, are presented in the yard plans when those pen trations fall into either one of two categories: penetr tions requiring structural reinforcement, and those that can be cut by numerical burning.

Until the advent of zone outfitting, only the penetrations that required structural reinforcement were shown. Zone outfitting has provided for earlier identification of system routings, with the attending benefit of being able to include those penetrations into the yard plans.

Process Lanes Integration - As mentioned earlier, under the discussion of the Unit Parts Lists, the concepts of process lanes have been incorporated into the yard plan. The notations for the various structural components, designating them as sub units, partial sub units, combined partial sub units or just individual pieces to be left loose until assembly or erection, are a function of the area or location of their manufacture.

This designated manufacturing location is one of the basic concepts of the Process Lane principle. The yard plan notations are obtained from the Unit Breakdown Summary Sheet prepared by the Production Planning Department. By knowing the meaning of the process lane coding notations, one can determine the location of manufacture of a particular structural component.

Interface between the Hull Section and the Production Establishment can be broken down into two (2) broad types. The first type of interface is one which is necessary for the accomplishment of Hull Section responsible work. This type of interface is termed primary interface. The second type of interface is one which the Hull Section engages in, in order to assist other entities to accomplish their assigned tasks. This type of interface is termed support interface.

Primary Interface - The primary interface between the Hull Section and the Production Establishment lies mainly in the information that the Production Establishment provides to the Hull Section prior to, and for use in, preparing the yard plans. This primary interface provides information for three (3) distinct "systems" which appear on the yard plans:

a. Ship Erection Breakdown
b. Plate Edge Preparation
c. Ship Unit Construction Method

The three (3) above mentioned "systems" are governed by production considerations, and the need to accommodate production techniques and methods. The three (3) "systems" and their interaction profile with the Production Establishment will be briefly reviewed.

a. Ship Erection Breakdown - Ship erection breakdown starts with the Production Planning Department "breaking up" the vessel's hull into main and sub assemblies. Once the major planes of division are established by the Production Planning Group, this information is passed to the Hull Section in the form of a document known as the "Hull Unit Arrangement," whereby the yard plans are developed incorporating the desired erection planes. If a Production Department desired erection plane is not desirable from an Engineering consideration, then this structural division line is brought back to the Production Planning Department where a compromise new erection joint line is established. This interface, therefore, establishes a structural erection line that preserves both sound technical parameters and production fabrication methodology.

b. Plate Edge Preparation - Every yard plan addressing itself to main hull and superstructure construction displays plate edge preparation weld identification notations. The selection of the proper edge preparation is a result of interface between the Production Welding Department and the Production Planning Department and the Hull Section, whereby the joint design is discussed and the Production Welding Department recommendations are incorporated.

c. Ship Unit Construction Method - The Production Planning Department issues a document to the Hull Section known as a "Unit Breakdown Summary Sheet." This document describes in great detail the intended methods to be used to manufacture the unit in question. This document assigns partial sub-assemblies, sub-assemblies and main assemblies of the unit to the specific manufacturing process lanes. This document is utilized to develop the yard plan and Unit Parts List. Interaction discussion is carried on between the Production Planning Department and the Hull Section, whereby refinements are made to the Unit Breakdown Summary Sheet incorporating Engineering considerations.

There is one more area of primary interface and that consists of establishing drawing production need dates. The Production Planning Department provides the Hull Section with production required need dates for all structural drawings. After receipt of the production need dates, a review is conducted in the Hull Section and, if any changes are desired, the Production Planning Group is requested to review their initial requirements and provide revised dates, if possible. The production required need dates provide the Hull Section with the necessary information for the development of the drawing schedule which in turn delineates the required order of drawing development.

Secondary Interface - The secondary interface between the Hull Section and the Production Establishment exists primarily in providing the Production Establishment with information on Hull Section responsible material and providing the Production Establishment with yard plans and shop drawings in the case of systems such as mooring, anchor handling, etc. For example, discussions with the Machine Shop Superintendent are carried on during the development of the rudder support system in order to appraise the shop of specific engineering requirements as well as receive information on manufacturing limitations, procedures, requirements, etc.

With regard to the yard plans, the Hull Section is in constant communication with the Mold Loft during the Loft's development of the Unit Control Manuals.

III. MECHANICAL

- GENERAL

The concept of producing zone outfitting type drawings for the various mechanical systems requires a new design philosophy and requires that the Mechanical Section change its method of developing drawings. This change increases the engineering time required to produce the vessel's design, but should be offset by the manhour savings which can be realized by Production.

We will touch on the major engineering/design effort required by the Mechanical Section and try to briefly show the differences between traditional mechanical design and design incorporating zone outfitting.

- SCOPE OF THE JOB

The scope of the engineering required for any job is put into definition by formulation of the plan schedule required for that job. Traditionally, this has been easily obtainable by the Mecahnical Section at the beginning of the contract, since engineering drawings were system oriented. The plan schedule developed provided an early and fairly accurate definition of the job.

However, with zone outfitting, most Mechanical Section drawings are not system oriented but rather are unit or zo oriented. After a unit breakdown is made by Production Planning, the Mechanical Section must determine its drawin breakdown by units. Time must be spent for advanced planning in order to define what systems are contained in various units. This is accomplished with a comprehensive advance planning program for system routing.

At ASI, the Mechanical Section has implemented what is called “Advance Design Composite Study” (ADCS). ADCS’s ar produced by top designers taking the functional system-diagrams and making a schematic one line routing of the systems on scaled arrangement drawings. When the designer are routing the systems, they must insure that the routing shown is realistic and can be obtained. The ADCS is great improved if the designer has good scantling drawings and major equipment drawings. A well thought-out ADCS by top designers will completely define the scope of the job. Then, from the ADCS, a realistic plan schedule for Mechanical Section drawings can be obtained.

It should be noted that as the zone outfitting method is being developed at Avondale, the Engineering scope of work is constantly being changed as Production realizes additional information they require on the drawings. This has made it difficult at times to estimate manhours required f drawing completion. As both Production and Engineering at Avondale become more familiar with zone outfitting, this problem of expanding work scope should be minimized.

- COMPOSITES

Development of detailed composites has changed from the traditional development methodology as follows:

- The breakup of the composite area follows the unit breakups rather than the traditional level breakups.
- Development of the composites is done basically unit-by-unit in lieu of system-by-system. The proposed routing which has previously been determined on the ADCS’s is followed as closely as possible.

- ARRANGEMENT DRAWINGS

Since Production personnel are outfitting small pieces of the ship which are basically unrelated to the ship as a whole, arrangement drawings are done unit-by-unit with accompanying lists of material done unit-by-unit in lieu of the traditional system-by-system. In addition, all material and pipe spools must be coded to the unit, so that Material Control can palletize the material and deliver it to the unit outfitting site.

Following is a list of problems which had to be overcome by the Mechanical Section in the implementation of zone outfitting as it relates to arrangement drawing preparation:

1. The total quantity of drawings is increased which increases the basic burden of interface control, drawing handling and distribution.

2. A system change which would have only affected one drawing in the traditional design may now cause revisions to many arrangement drawings and associated L/M's and pipe spools.

3. Additional detailing is required in dimensioning the drawing, since such traditional items such as frame lines and ship's centerline may be non-existent on particular drawings.

4. Since finished painting is part of the zone outfitting philosophy, all pipe spool drawings must contain the internal and external coating requirements which are dependent on system and location.

5. Designers must be more aware of each system's requirements, since many systems are involved in each unit drawing. Materials can be easily confused since many diagrams must be used for one drawing. There can be no system specialist designers.

6. Designers must be aware of which materials can be installed at various stages of construction (e.g. fiberglass piping cannot be installed before blasting without damage).

7. The system arrangement must be developed to be compatible with the method of fabrication for a particular unit (e.g. if a unit is fabricated with a bulkhead facing down, pipe should not be routed on the underside of that bulkhead if at all possible).

- PACKAGE UNITS

Engineering has organized, within the Mechanical Section, a Package Unit Design Group. This group is responsible for the complete design of all Machinery Package Units, **including piping**, structure, outfitting, instrumentation, painting, label plates, etc. Having this design in one group insures the integration of all design facets. This method also simplifies the development of the Machinery Space Composites, since a package unit becomes a “mini-composite.”

PIPING RACKS

As much as possible, ASI tries to rack piping on structural frames which then can be installed as one complete assembly. The Mechanical personnel responsible for the piping racks are also responsible for the detailing of the rack structure in order to insure integration of structure and piping.

COMPUTER AIDED DRAFTING

ASI is presently developing a computer aided drafting syste with Lockheed and IBM known as CADAM. A pipe spooling program is presently being used to improve the accuracy of the pipe spools and increase productivity.

MATERIAL PROCUREMENT

Material procurement must be done at a very early stage of the contract for all systems due to the possibility that th first unit planned by Production for zone outfitting may have contained within that unit a small portion of many systems. Therefore, in order to have material in time for Production’s needs, advanced ordering of material must take place. Advanced ordering of long lead material is done fro the complete ADCS’s, rather than the functional schematic diagrams, since a more accurate material take-off can be obtained.

All material on systems is coded to coincide with actual fabrication and installation sequence. This requires close working contact with Production personnel.

VENDOR INFORMATION

In order to do worthwhile advanced planning, vendor information is required at a much earlier stage in the contract. This is required for feasibility of equipment hook-up and determination of any problems with the physical location of the equipment. Also, the arrangement of certain systems is dependent upon individual manufacturers.

IV. OUTFITTING

- GENERAL OVERLOOK

As a result of the implementation of zone outfitting, Outfitting Engineering has had to undergo a significant change. It's not that Outfitting Engineering had to create new data, but that the old data had to be expanded and placed in different order on the drawings and, in some cases, additional details developed in order to support the zone outfitting concept.

The major impact of zone outfitting on the Outfitting Section is the pallet system of material numbering for handling and routing. Following is a more detailed view of the various changes which Outfitting Engineering had to undergo in order to implement zone outfitting.

- PALLETIZING SCHEDULES AND PALLET NUMBERS

The assigning of material to "pallets" has caused Outfitting Engineering, like all Engineering sections, to generate material lists broken down for one unit (or "pallet") at a time and to provide the field with a list of all units (pallets) which may be covered in the drawing. Generally, this has been handled by adding schedules of pallets included and for material per pallet to the drawings.

- UNIT DIVISIONS IN LARGE DRAWINGS

The Outfitting Section's large drawings had to be broken down into unit books to accommodate zone outfitting. On some drawings, such as walkways which extend into more than one unit, it is necessary to provide "fit-up" details to be used when the units are assembled into the hull form.

- METHOD OF DIMENSIONING DRAWINGS

"Datum lines" and "nearest structure" type dimensions, in lieu of the conventional off-centerline and off-frame dimensions, had to be utilized on drawings. This problem was common to all Engineering Sections.

- PILE-PLANNING OF DRAWINGS

Pre-planning of drawings, while not new to Outfitting Engineering, has assumed a much more important role. It provides an efficient method of pin-pointing potential pr lem areas and provides a vehicle for communication withi the Engineering Department which is more effective than w the case with the conventional method of drawing developm

SEPARATION OF FABRICATION & INSTALLATION INFORMATION

Because more and more Outfitting material is coming to th assembly site in a "finished" or "package" state, the nee for fabrication information at the assembly site has grea diminished. As the workmen at the assembly site become m and more "installers" and "handlers," their need for inst lation information supersedes their need for other types information. This has lead to a natural separation of th two types of information (fabrication and installation) c the drawings.

While the need for more information and planning increase the Engineering effort, this is expected to be more than compensated for by savings in Production time. A spin-o of this development is the possibility of increased reuse details for future jobs and easier standard development a application.

- ADDITION OF WEIGHT INFORMATION

With much more material being added to the units before t are assembled one to another, the weight of the added Out fitting material becomes an important factor in unit hand ling. It has, therefore, become necessary to indicate th weight of the Outfitting material (sub-assemblies) on the drawings.

- MISCELLANEOUS

The use of automated equipment for material control, pal- letizing schedules, and generation of work orders, while n part of zone outfitting per se, are logical extensions of the system and in themselves generate changes to Outfittin Engineering procedures. Standard raw material catalogues, sub-assembly concepts and sub-assembly parts lists are amo some of the items that have had to be developed.

The learning curve, unit “break recognition, the frustration factor of suddenly finding that the “old way” is not good enough and the increased time and degree of difficulty in drafting and checking in the new procedures, all combine to produce a need for re-education of engineers, designers and drafters; a need which is continuous as we become more familiar with the new methods.

V. ELECTRICAL

- INTRODUCTION

The impact of the Electrical Engineering implementation of zone outfitting primarily concerns wireway design changes and changes in the list of material format for deck plans and isometric wiring diagrams. Most electrical equipment and cabling is installed during the “on board” phase of zone outfitting. This is necessary to insure that the electrical components are not subjected to adverse factors such as weather, sandblasting, dust and paint spray, during the early stages of zone outfitting. Electrical equipment installed “on unit” tends to be concentrated on vendor supplied module packages and shipyard built machinery package units.

- WIREWAY DESIGN

Wireway design is well suited to modular construction techniques. The wireway hangers are made of steel and can, therefore, be phased in with the orderly erection of a unit during main assembly prior to blast and paint. In designing the wireways for “on unit” installation, ASI has experienced an increase in design time of approximately 50 percent due to the increased level of detail required for modular construction as opposed to the manner in which wireways have historically been designed.

Using the zone outfitting concept, wireway arrangement drawings are segmented by unit number to allow the production foreman to identify exactly which hangers are in each unit. The list of material is broken down by unit to show the number of hangers of each type required. Each type of hanger is detailed. For zone outfitting, the number of hanger types can be in the hundreds. Each slight variation of one hanger from another generates a new hanger detail. The end result of the additional detailing is to generate a unique piece mark number for each hanger which can then be entered into a computer program for tracking purposes by Production Planning and Management.

The fabrication and installation of wireway non-watertigh collars is an area where zone outfitting has made a signi cant contribution. Using the traditional manner of colla fabrication, the production foreman obtained dimensions f hole lists and then had the collars constructed by a spe- cialist in his Electrical Department. Before installatic of the collars in the bulkheads, the holes would be burne out by the layout crew utilizing dimensions provided by t hole list. In zone outfitting, the production field crew work effort is reduced considerably. Collars are standar dized to a limited number of commonly used sizes.

Early in the design of the vessel, dimensional informatic for numerical hole cutting by automatic burning machines provided to the Mold Loft. This allows the holes for the wireways to be accurately cut by the automatic burners during the erection of the unit in main assembly. Effec- tively, the electrical field production crew's responsi- bility for non-watertight collar fabrication and installa tion is reduced to simply obtaining the pre-made nonwater tight collars and installing these collars in precut hole

- DRAWING FORMAT CHANGES

To facilitate zone outfitting, the formats of electrical deck plans and isometric wiring diagrams have been revise to include additional unit construction information. Pre viously, these drawings depicted the electrical system ir the body of the plan with a list of material which listec total quantities for the material distributed throughout drawing. For zone outfitting, these same drawings now ha leader lines in the body of the plan which segment the sh into the various zones. Also, the front of the drawing h a table above the title block which flags for cursory drawing reviewers that the drawing contains material whic must be installed in any of twelve different stages of cc struction; such as, during subassembly on unit, or before closing in on board. As a further aid, the title block itself identifies the ship zones affected by the electric system shown on the drawing.

The list of material for deck plans and isometric drawing is sub-divided by the pallet codes associated with each u or zone. Under each pallet code is listed the electrical material contained on the drawing which will be installed a particular unit or zone. An exception to this techniqu of material listing is the listing of cable quantities. Cables are summarized at the end of the list of material with no reference to any particular unit or zone. The reason for this apparent anomoly is related to the manner which cable is handled and installed in the shipyard.

Cables are purchased, stored, and transported to the work-site on reels. As the cable is being installed, the electrical crew cuts the length required for the installation from the reel. The Production foreman coordinates the overall cable installation to minimize cable waste. Since cable is expensive and is a long lead item for procurement, cable footage must constantly be monitored. Therefore, to identify specific cable lengths in each pallet would not contribute to a more efficient, less costly installation.

- PACKAGE UNITS

Machinery package units constructed by the shipyard require coordination during the design phase of a job to insure that all devices belonging on the package unit are installed during assembly of the package unit. Typical electrical devices which are installed on the package unit are motors, motor controllers, pushbutton stations, solenoids, sensors, and heat tracing cabling. The locations of these devices are established by the package unit designers with inputs supplied from the various Engineering disciplines, including Electrical. Particular attention is paid to electrical equipment and cabling which will be installed on tanks, that are a part of the package unit, to insure that the proper provisions have been made for foundations and cable studs. Since the tank will be fully constructed and tested before it leaves the package unit shop, any welding to the tank exterior in the field would result in damage to the tank interior coating and require the tank being retested. In some instances, the machinery package unit is designed before certified drawings are received from the electrical equipment vendors. To minimize the disruption to the package unit design, the size of devices such as motor controllers and pushbutton stations is estimated based on previous experience with the particular equipment. Also, by using motor control centers, many of the vagaries of motor controller sizes are eliminated as the controllers would then be part of a motor control center remote from the package unit.

On the main deck of the Exxon Multi-Product Carriers, presently being designed at ASI, there are a number of pipe rack package units. As an integral part of these pipe rack package units are a number of wireways. In the past, wireways were provided for the main deck based on capacity requirements of the wireways at various points along the main deck. This technique allowed wireway sizing to proceed in the early stages of the ship design without the knowledge of exact locations of equipment on the main deck. It was left to the production foreman to run local runs of cables from the wireways to individual pieces of equipment scattered around the main deck. Since the pipe rack package units are essentially complete when installed on the ship, exact locations of main deck cabling must be known much earlier in the contract to allow the wireway development to be complete on the pipe rack package units. This requires significant increase in the work effort of the wireway designer since he must now determine exact locations of electrical equipment and provide small branch wireways to this equipment from the main wireway runs.

- FEEDBACK FROM APL JOB

Feedback from the electrical production crew in our yard in their working with zone outfitting indicates that the problems have been minimal. Misalignment of wireways between units has not occurred to any appreciable extent. Where it has happened, the production crew has repositioned the hangers at the unit break point to allow a smoother transition of the cables through the wireway from one unit to the next. Another area where some dislocations of equipment ha occurred is the positioning of equipment in units which do not have the ship's centerline in the unit. In these units, it is necessary to measure locational dimensions of equipment from the nearest substantial structure. The Electrica Section, as well as other Engineering groups, have attempte to alleviate this problem by providing dimensional information of equipment in these units from the nearest substantial structure, as well as from the centerline of the ships

OUTFITTING PLANNING AND SCHEDULING
AVONDALE SHIPYARDS, INC.

Prepared" By: E. E. BLANCHARD, JR.

OUTFITTING
PLANNING AND SCHEDULING

I. INTRODUCTION

As a result of IHI technology implementation of planning and scheduling at ASI, certain changes to Mold Loft procedures were required (see Graph No. ML).

The following (Graph No. 1 ML) depicts the flow of information through the Mold Loft operation.

The areas which are shaded represent those functions which have been influenced by IHI technology at Avondale Shipyards.

With assistance from IHI personnel, a Mold Loft Planning Group was established. The need for this group was necessitated by the amount of data flowing through the Mold Loft from other departments. From the Engineering Department came drawings, unit parts list, material list, and computer data base information. From the Steel Department we receive screened material list and material transfer list. The Production Planning Department sends to the Mold Loft unit schedules, unit summary sheets, and hull unit jig designations.

Previously, this information was processed by the group leaders and parts programmers. Because of this, there was a lack of continuity in our Mold Loft output due to different evaluations by these individuals of how and where parts should be produced.

Now, the Mold Loft planners, equipped with standard planning procedures, direct the Mold Loft operations and the results are consistent and accurate information released to the field.

Some of the duties of the Mold Loft planners are as follows:

- Review all documents for any errors, omissions or inconsistencies and feedback and resolve any deficiencies.

- On the unit parts list, Mold Loft processing information required for each part will be noted such as numerical control part, templates, declevity, servograph, roll, knuckle, etc.

- The planner will gather all information from reference drawings and "red pencil" on Engineering drawings such information as datum lines, stock, bevels, tangent line, and any other information needed by the programmer or loftsman which does not appear on that drawing.

- Notes shrinkage factor to be used by programmer and loftsman at each stage.

- Indicates where steel tapes are required and assigns tape numbers.

In conclusion, it is believed because of the Mold Loft planners, the loftsman and programmers will become much more efficient in their work and will forward to the field documents and information thatlwill be accurate and consistent in its format. This will result in increased productivity and reduced *cost* during construction.

A) PLANNING AND SCHEDULING

On previous contracts, the Mold Loft workload *was* scheduled and furnished to the Production Department on a unit-by-unit basis. Numerical control burning information, as well as conventional Mold Loft templates, came together on the day on which the unit was scheduled *to* be processed as per the Planning Department schedule.

Presently, the Mold Loft must schedule its workload to the pre-fabrication level. This requires that for each stage of construction - Pre-Fab (PC.), Fabrication (P.S.U.), Sub Assembly (S.U.), Main Assembly (M.A.), and 'Erection - *a* level loaded schedule must be produced to control the Mold Loft efforts to meet the schedule requirements. No longer can the Mold Loft schedule their work to the unit level. The prime rea.on for this type scheduling performed today was the implementation of the process lane approach *to* construction. Similar hull parts routed to work stages which required level load scheduling of these stations causes components within a particular unit to be processed at different times; thus, Mold Loft information must be produced to accommodate level loaded process lanes.

B) UNIT CONTROL MANUAL

Another aspect of Mold Loft work effected by process lane concept is the production of "Unit Control Manuals." As was the case with numerical and conventional loft information, the U.C.M. must now be produced and scheduled stage by *stage.*

Although the U.C.M. will be discussed in great detail at a later seminar, I will briefly discuss the subject.

The Unit Control Manual (U.C.M.) is a document associated with hull work only, produced by the Mold Loft from Hull Engineering drawings. This document is designed to address each stage of construction, pre-fabrication (cutting list), fabrication (partial sub-units), sub-assembly (sub-unit), main assembly and erection (see Graph No. 2 ML through Graph No. 10 ML).

The objective of the U.C.M. is to give to the worker at each stage only the information he "needs to know" to perform his work task. The format used on the U.C.M. documents does not require the worker to access any other information to do his job. It allows the worker to work accurately and quickly. The simplicity of the instructions on the U.C.M. drawings releases the supervisor from drawing research and allows him more time with his workers. This will improve both quality of work and productivity.

The productivity of U.C.M. drawings is performed with an integrated SPADES/CADAM system. Parts from the SPADES data base are pulled upon a CADAM tube, additional information added from CADAM standards file, then the drawing is plotted by a versa-tex plotter for reproduction and distribution to Production.

C) STEEL TAPE SYSTEM

To maintain continuity across units during the construction stages and to assure the accuracy of layout work, Avondale has adopted the use of "steel tapes" as a measuring medium. These steel bands are provided for all stages of ship construction. They relieve the production worker of conventional measures and eliminate costly errors in misread dimensions. Since the same information is used over a number of units, more consistency in construction becomes possible.

The steel bands are produced on a specially built table, housed in the Mold Loft. Computer data provides the loftsman with accurate information for structural locations such as:

1) shell longitudinals

2) seams

3) deck longitudinals

4) sight edges

5) frames locations

6) girder locations

7) expanded girths, transversally, and longitudinall

These locations are marked with a steel scribe on the ba and appropriately labeled. Expansion for steel shrinkag also included. Each tape is uniquely identified by a nu assigned at the Mold Loft planning stage.

U.C.M. documents guide the workers by indicating where a which steel tapes are to be used.

D) PIECE NUMBER SYSTEM

Also affected by the process lane implementation was the hull parts piece number system. With assistance from IH Avondale established an entirely new twelve (12) digit h piece number system. Each hull part receives a unique p number; this piece number also identifies the routing of that part through the different work stages.

Perhaps it should be noted that in order for the piece n bering system to be effective in its routing mode, each piece must be considered at the production planning stag The hullwork production planner, therefore, must record the unit summary sheet the stage of construction each pi will be used (see Graph No. 11 ML).

After many meetings and countless hours, we feel the fin version is a visable piece numb ring system that will satisfy our shipyard's need.

E) LINE HEATING

A method of heating steel plates in lines, rather than c ventional furnacing of plates, has been developed by IHI. It is very effective and works on sound scientific princ ples. It can be used to move and mold steel into many shapes. Proper application of line heating can produce rolled, twisted, and compound shaped plates, or any comb tion of these. It is a science that takes workers time become efficient with.

The Mold Loft provides roll templates with sight edges s (usually made at frame lines) with a plane established approximately normal to the roll axis, with a sight line the declevity angle the template will be held at the pla The roll set portion gives the desired transverse shape. The plane gives the amount of twist. The sight line (or thread line) gives the amount of compound shape. A plat has the correct shape only when the roll sets fit the plate completely at the prescribed declevity, the plane is sighted to be a good flat plane, and the thread or sight line is straight.

A similar method is used to twist formed longitudinal. This will be used on members that require excessive force to pull twist them in the field.

To date, Avondale has used the line heating method to form 145 shell plates. The results are very encouraging. The average cost of the 145 plates, line heat vs. furnace forming, is about equal. However, this has been a learning and training phase and expectations are that this cost will reduce considerably with time (see Graph No. 12 ML).

Using the heat forming method, the entire cost of solid steel jigs used in forming furnaced plates has been eliminated. The cost of these jigs is usually 3 to 4 times the actual cost of forming; therefore, savings is considerable. Further intangible savings have been realized at the assembly stage of construction due to the accuracy of the line heat formed plates.

F) THE KEYLINE METHOD OF MARKING LAYOUTS FOR CURVED SHELL UNITS

To assure accuracy of the curved shell units, we have integrated into our Mold Loft the IHI method for checking numerical control or manual layouts on curved shell units built in a solid or pin jig. This method of verification is called the “Key Line Method” by IHI.

The Key Line Method has been tested by ASI on units in solid and pin jigs. The results were very favorable and the method received well by the field personnel. The benefits expected from “Key Line Method” will be accurate layout to insure continuity of members and seams and accurate cutting of the shaped units periphery which will produce faster and cost efficient erection of the shaped areas of the vessels.

II. IHI TECHNOLOGY TRANSFER

A) IMPACT ON PRODUCTION ENGINEERING

1) Process Lanes

With the implementation of process lanes concepts at ASI, certain traditional production engineering policies and procedures will be impacted.

a) Labor Cost Coding - The process lanes concept of categorizing hull structure into "like" or "similar" kinds of work and in setting aside specific work centers to accomplish each of the categroeis of work, allows the production engineer the flexibility to establish a cost code system which will be compatible with the specific work center and the specific category of work that the center will accomplish.

The new cost code will, in effect, make each work center a "cost center," thereby enabling management to observe work center efficiency, as well as monitor job cost. The concept of scheduling the same category (type) of work to a specific work/cost center opens up a new spectrum of cost collection and analysis.

In the past, with "module" or "unit" type construction, our labor cost coding system was designed to provide detailed returns regarding actual direct labor cost for ech unit or module construction and became, to some degree, unmanageable due to the quantity of work orders required and issued. The new concept will now provide for direct labor cost collection by category of construction at a given work/cost center for a predetermined or scheduled period of time. The new result will be considerably fewer work orders to accomplish the same amount of work amd a much more manageable system. Cost returns on work orders under this system will be sore accurate, providing a sound basis on which to develop and refine labor rates and standards.

b) Operational Savings - Operating costs for the Production Engneering Department will be considerably less. The need for fewer work orders denotes the need for less people, or the option to reassign responsibilities to other productive effort. Fewer orders in the field or shops become more manageable in terms of production engineering effort to monitor the activity, thus producing greater production engineering efficiency. This, in turn, can free the production engineer to devote more time to develop resources in other areas.

The cost savings also "dominos" into other departments. The Data Processing department has fewer work orders to process and maintain, thus eliminating the need for people or, again, the option to re-assign. The manufacturing superintendent or shop department head also in turn has less paperwork, reducing the need for ancillary people who might otherwise be needed only to process the paper and not be directly involved in active production work.

For purposes of comparison, when considering the average numbers of work orders prepared and issued to the field under the old system for basic hull construction, we note the following:

Old System (Actual)	New System (Projected)
8,700 (4 ships)	2,530 (3 ships)
2,175 per ship	843 per ship

This represents an approximate 61% reduction in paperwork effort.

c) Pre-Outfitting Efficiency - The process lanes concept appropriately addresses the pre-outfitting activity by setting aside a special process lane or specific work/cost center for installing “on unit” those outfitting pallets of material that lend themselves to installation in a unit or module prior to erection of that module.

The effort impacts the Production Engineering Department (as well as other Engineering and Production manufacturing departments) by reducing the need for the quantity of work orders prepared under the old system. This, again, has the net result of providing for more efficient, cost effective production engineering within the Outfitting Section of the Production Engineering Department.

A more detailed review of the overall concept will be presented in another conference in the fall of this year.

“MOLDLOFT OBJECTIVES”

- oMOLDLOFT PLANNING & SCHEDULING
- oDEVELOPMENT OF UNIT CONTROL MANUALS
- oDEVELOPMENT OF STEEL LAYOUT TAPES
- oDEVELOPMENT OF NEW PIECE NUMBER SYSTEM
- oDEVELOPMENT OF LINE HEATING
- oDEVELOPMENT OF “KEY LINE METHOD’’ LAYOUT

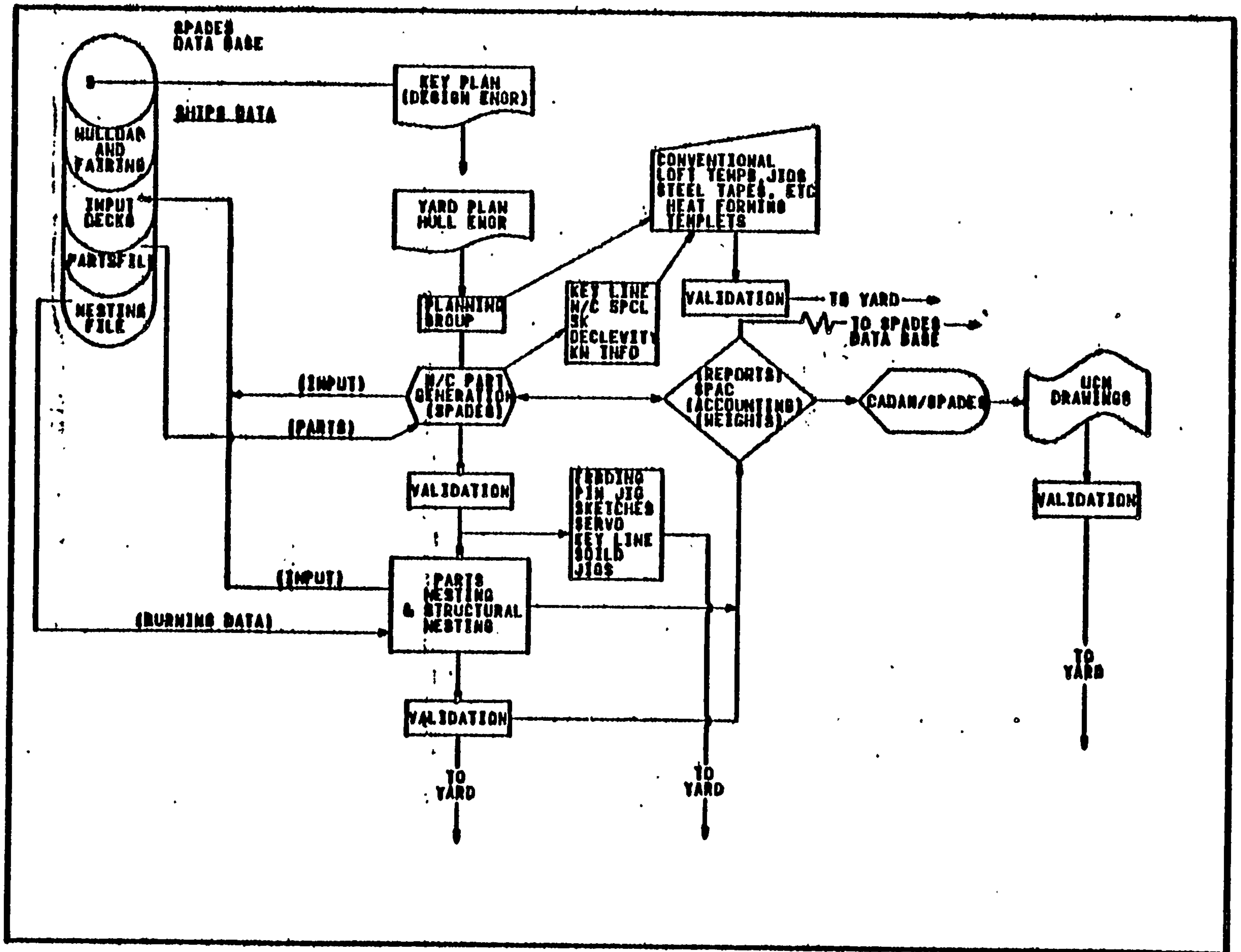

SPADES DATA BASE
SHIPS DATA
HULLDAF AND FAIRING
INPUT DECKS
PARTSFILE
NESTING FILE
KEY PLAN (DESIGN ENGR)
YARD PLAN HULL ENGR
PLANNING GROUP
N/C PART GENERATION (SPADES)
(INPUT)
(PARTS)
(INPUT)
(BURNING DATA)
KEY LINE N/C SPCL SK DECLEVITY KN INFO
CONVENTIONAL LOFT TEMPS, JIGS STEEL TAPES, ETC HEAT FORMING TEMPLETS
VALIDATION
TO YARD
TO SPADES DATA BASE
(REPORTS) SPAC (ACCOUNTING) (WEIGHTS)
CADAN/SPADES
UCN DRAWINGS
VALIDATION
TO YARD
VALIDATION
PARTS NESTING & STRUCTURAL NESTING
VALIDATION
TO YARD
PIN JIG SKETCHES SERVO KEY LINE SOLID JIGS
TO YARD

PLATE CUTTING LIST

△	LN	SUBN NO	UNIT-SUB-PSU-PC	QTY	LOCATION	MATERIAL	GRADE	DIMENSIONS	PRE FAB INFO	SPECIAL INSTRUCTIONS	HULL
	1		1 - 1 -20 -31	1	FLR.FR.64 STDD.	19/32"PLATE	AH.32		1610009		
	2		- - -								
	3		- - -								
	4		- - -								
	5		- - -								
	6		- - -								
	7		- - -								
	8		- - -								

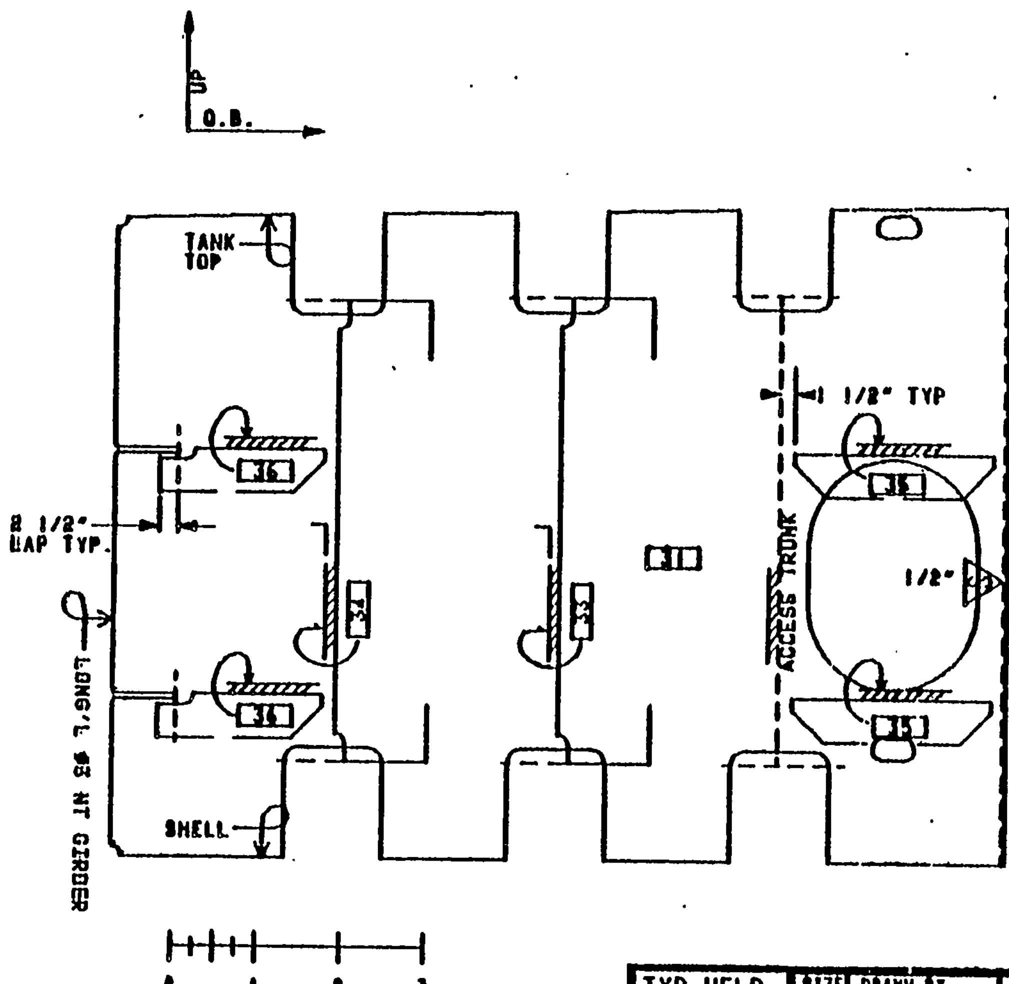
STRUCTURAL CUTTING LIST

△	LN	SUBN NO	UNIT-SUB-PSU-PC	QTY	LOCATION	MATERIAL	GRADE	DIMENSIONS	PRE FAB INFO	SPECIAL INSTRUCTIONS	HULL
	1		1 - 1 -20 -33	1	FLR.FR.64 STDD.	NC 13"X31.8#C/L	AH.32		HLCSK-17		
	2		1 - 1 -20 -34	1	FLR.FR.64 STDD.	NC 13"X31.8#C/L	AH.32		HLCSK-17		
	3		1 - 1 -20 -35	2	FLR.FR.64 STDD.	5/8"X 6"FB	A		HLCSK-10		
	4		1 - 1 -20 -36	2	FLR.FR.64 STDD.	5/8"X 6"FB	A		HLCSK-13		
	5		- - -								
	6		- - -								
	7		- - -								
	8		- - -								
	9		- - -								
	10		- - -								
	11		- - -								
	12		- - -								
	13		- - -								
	14		- - -								
	15		- - -								

SIZE	DRAWN BY	JOB	TITLE	ASX DWG NO
B	T DUFRENE	JOB C1-18	FLOOR FR.64 STDD.	DL 1-1-20
	CHECKED BY	REVISION	(FOR CONTINUATION SEE)	SH NO 34

PARTS LIST

LN	PIECE NO.	QTY P	QTY C	QTY S	MATERIAL	GRADE
1	1-1-28-31			1	19/32" PLATE	AH-32
2	1-1-28-33			1	13"Ø31.8# C/L	AH-32
3	1-1-28-34			1	13"Ø31.8# C/L	AH-32
4	1-1-28-35			2	5/8"X6" F.B.	A
5	1-1-28-36			2	5/8"X6" F.B.	A
6						
7						
8						



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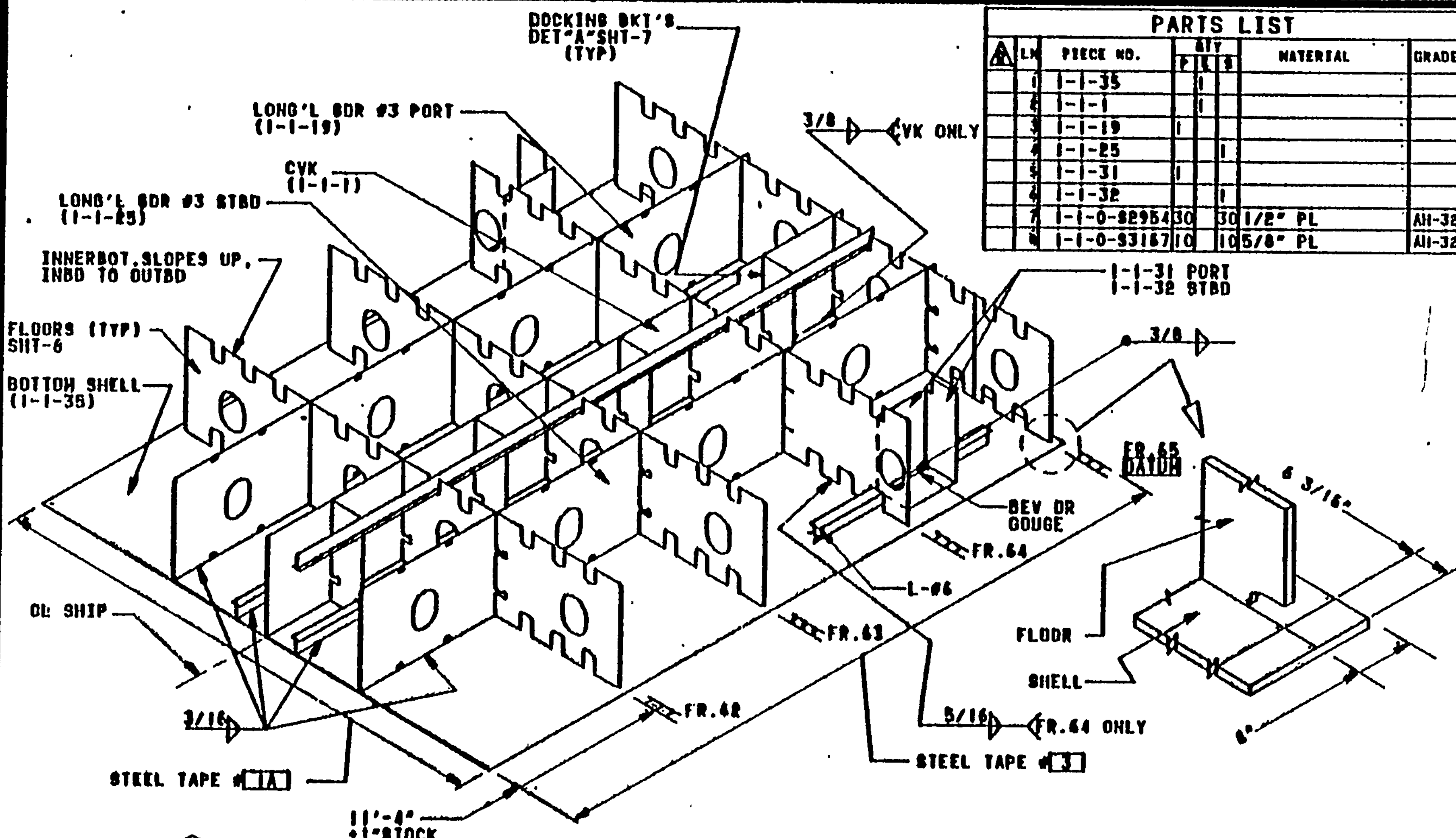
		CHECKED BY			

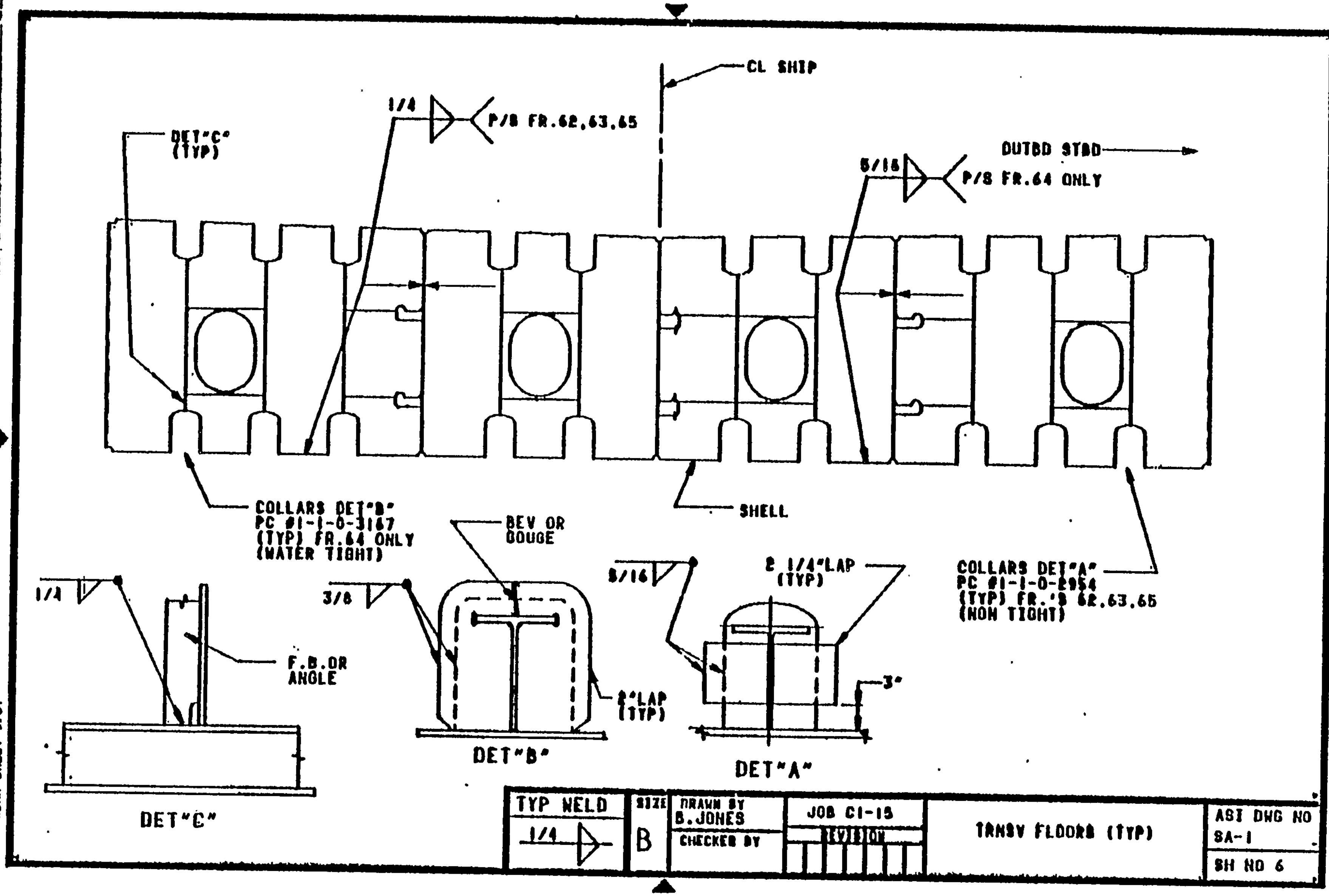


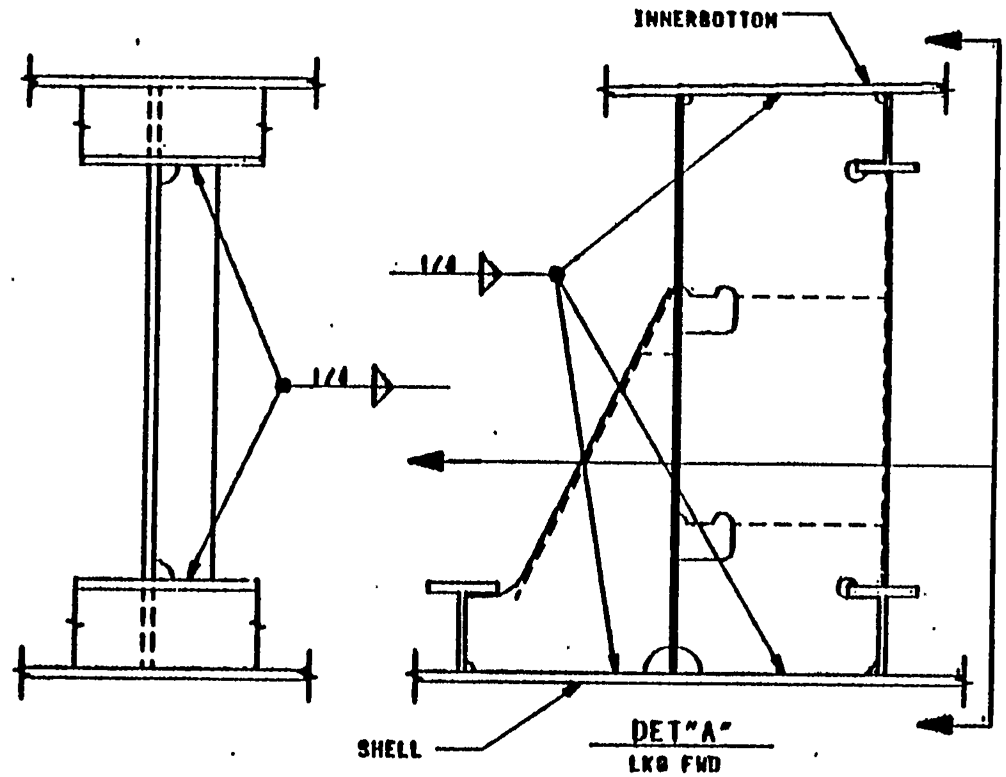
PARTS LIST

LN	PIECE NO.	QTY P	QTY C	QTY S	MATERIAL	GRADE
1	1-1-35		1			
2	1-1-1		1			
3	1-1-19	1				
4	1-1-25			1		
5	1-1-31	1				
6	1-1-32			1		
7	1-1-0-S2954	30		30	1/2" PL	AH-32
8	1-1-0-S3167	10		10	5/8" PL	AH-32

TYP WELD	SIZE	DRAWN BY	JOB C1-15	KEY PLAN	ASI DWG NO
1/4	B	B. JONES	REVISION		SA-1
		CHECKED BY			SH NO 5

ISG. WORK SHEET 9/81


CL SHIP
1/4
P/S FR.62,63,65
DET"C"
(TYP)
OUTBD STBD
5/16
P/S FR.64 ONLY
COLLARS DET"B"
PC #1-1-0-3167
(TYP) FR.64 ONLY
(WATER TIGHT)
SHELL
BEV OR
GOUGE
COLLARS DET"A"
PC #1-1-0-2954
(TYP) FR.'S 62,63,65
(NON TIGHT)
1/4
F.B.OR
ANGLE
DET"C"
3/8
2"LAP
(TYP)
DET"B"
5/16
2 1/4"LAP
(TYP)
3"
DET"A"
TYP WELD
1/4
SIZE
B
DRAWN BY
B.JONES
CHECKED BY
JOB C1-15
REVISION
TRNSV FLOORS (TYP)
ASI DWG NO
SA-1
SH NO 6



TYP WELD	SIZE	DRAWN BY	JOB CI-15	DETAIL SHEET	ASI DWG NO
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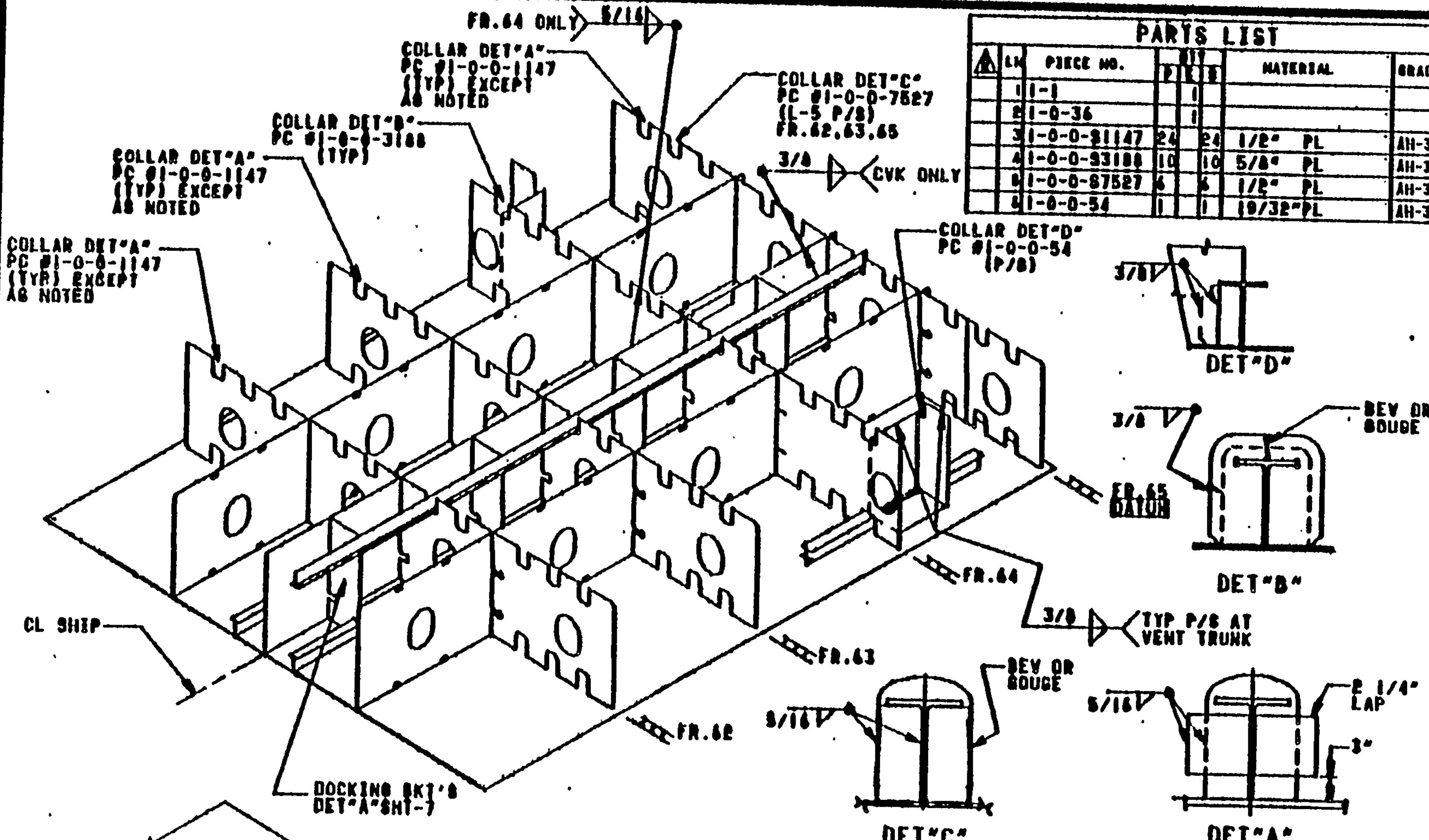
		CHECKED BY			SH NO 7

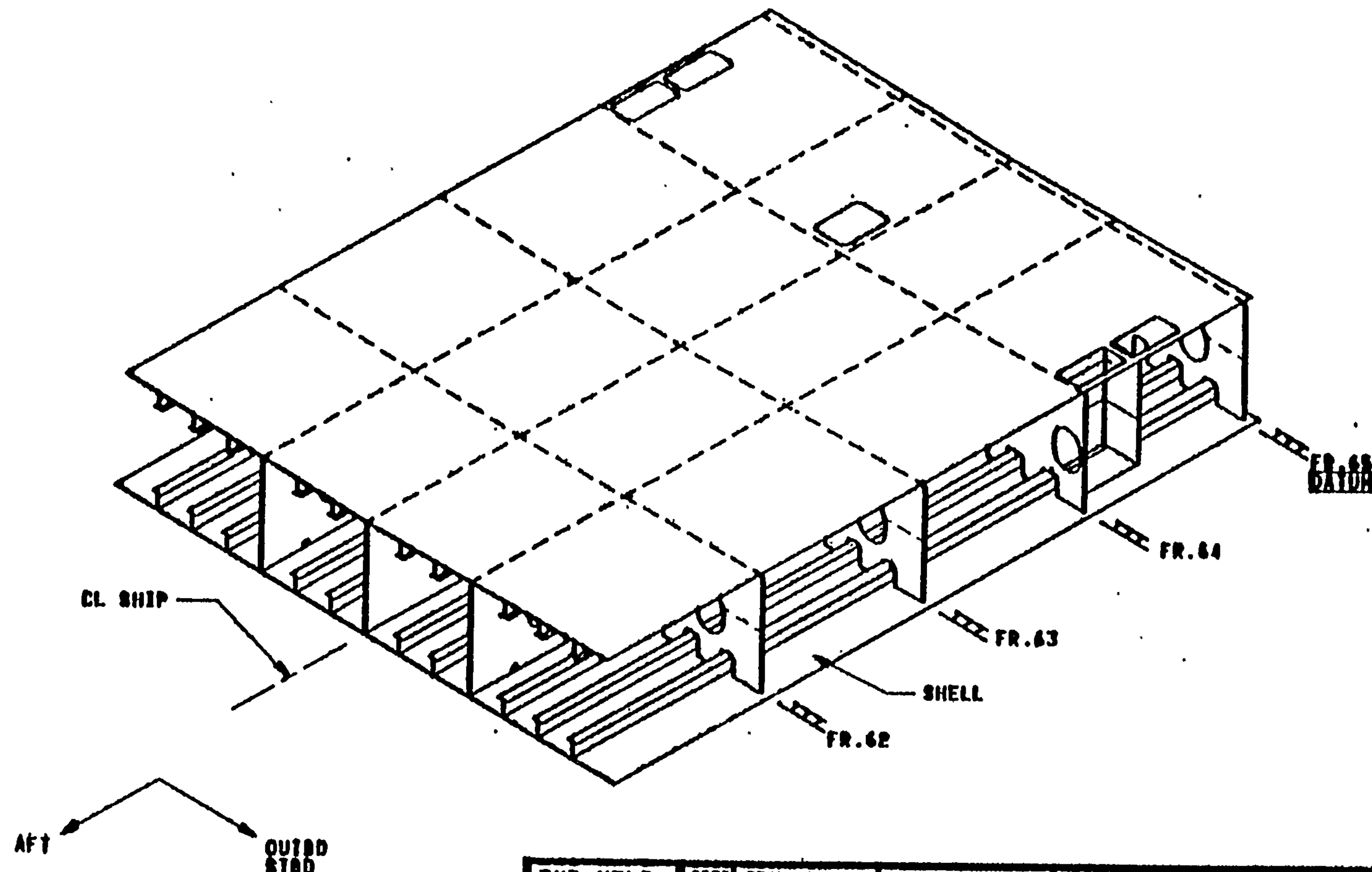


PARTS LIST

⚠	LN	PIECE NO.	QTY P	QTY C	QTY S	MATERIAL	GRADE
	1	1-1		1			
	2	1-0-36		1			
	3	1-0-0-S1147	24		24	1/2" PL	AH-32
	4	1-0-0-S3188	10		10	5/8" PL	AH-32
	5	1-0-0-S7527	6		6	1/2" PL	AH-32
	6	1-0-0-54	1		1	19/32" PL	AH-32

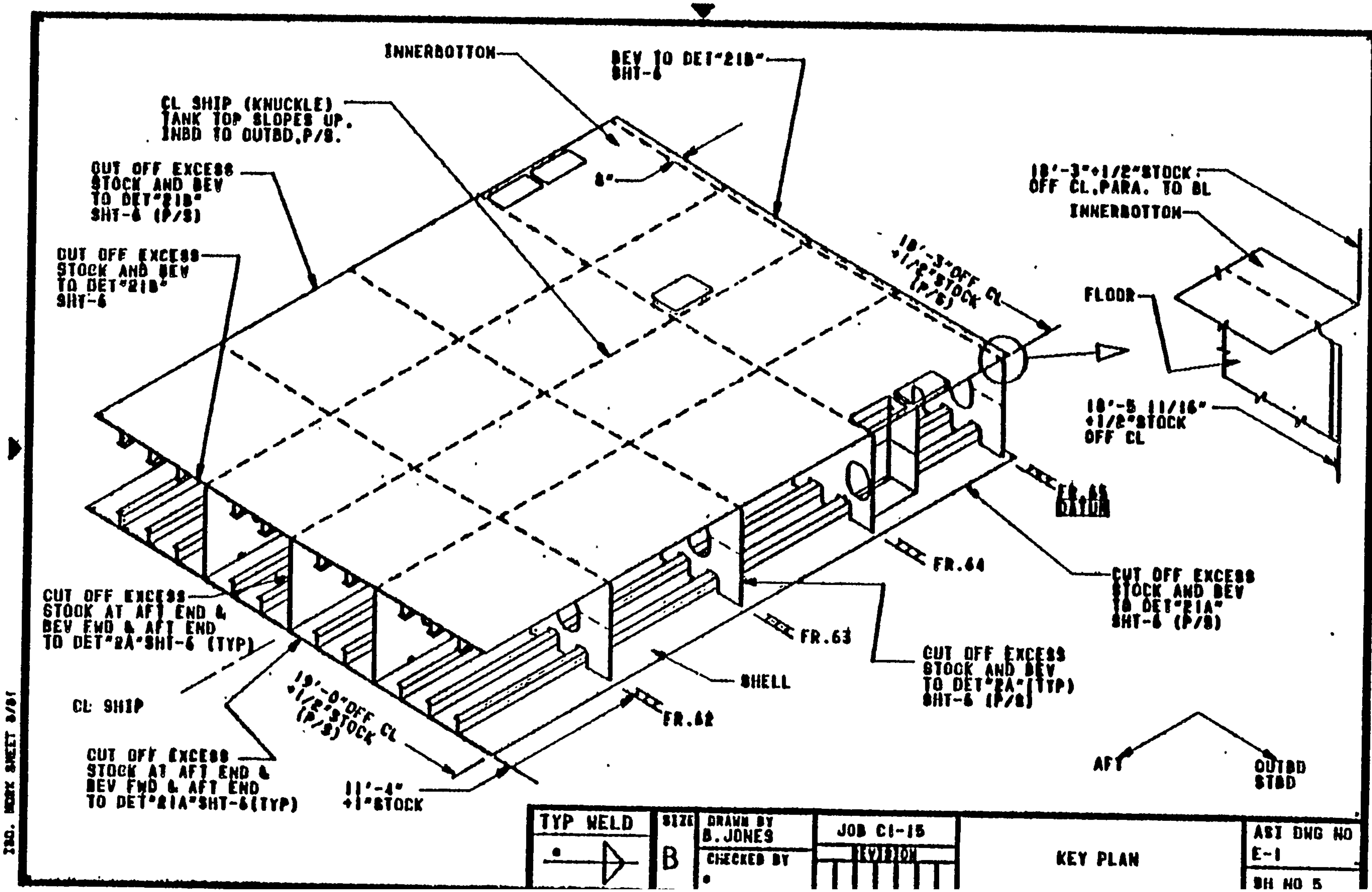
TYP WELD	SIZE	DRAWN BY	JOB CI-15		AGI DWG NO
3/16	B	B.JONES	REVISION	KEY PLAN #1	MA-1
		CHECKED BY			SH NO 6

ISS. WORK SHEET 8/81



TYP WELD	SIZE B	DRAWN BY B.JONES	JOB CI-15	ISOMETRIC OF COMPLETED UNIT	ASI DWG NO HA-1
		CHECKED BY	REVISION		SH NO 5

ISO. WORK SHEET 3/81



ISC. WORK SHEET 3/81

SPECIAL NOTES	SPECIAL NOTES

ERECTION OF UNIT-#1

1-HEIGHT OF TANK TOP AT CL SHIP,(THRU-OUT) = 7'-3" ABV B.L.

2-HEIGHT OF TANK TOP AT 18'-3" OFF CL SHIP,
(THRU-OUT) = 7'-7 1/8" ABV B.L.

3-PLATE THICKNESS OF TANK TOP = 9/16"

4-FRAME SPACING = 12'-0"

5-ALL DIMENSIONS GIVEN ARE MOLDED.

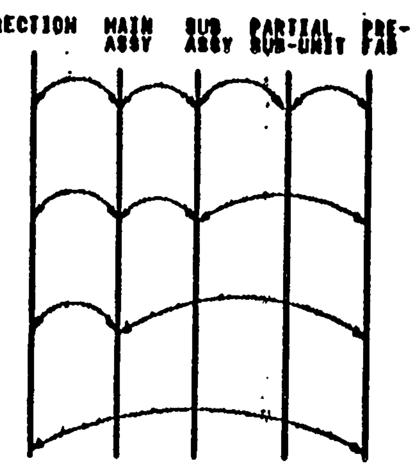
6-1"STOCK AT AFT END & 1/2"STOCK AT OUTBD EDGE P/S.

SPECIAL NOTES 9/81

SIZE	DRAWN BY	JOB C1-18	SPECIAL NOTES	ABI DWG NO
B	B.JONES	REVISION		E-1
	CHECKED BY			SH NO 4

"PIECE NUMBER SYSTEM"

UNIT (MAIN ASSY)	SUB-UNIT (SUB-ASSY)	PARTIAL SUB-UNIT (FABRICATION)	PIECE (PRE-FAB)	(TYPE OF PART)
001	001	001	011	PC 001-001-001-011 WEB FRAME FACE PLATE
001	001	000	012	PC 001-001-000-012 CONNECTION BRACKET
001	000	000	013	PC 001-000-000-013 COLLAR PLATE
001	000	000	014	PC 001-000-000-014 HEADER (CROSSES ERECTION BUTT)



(13ML) 1

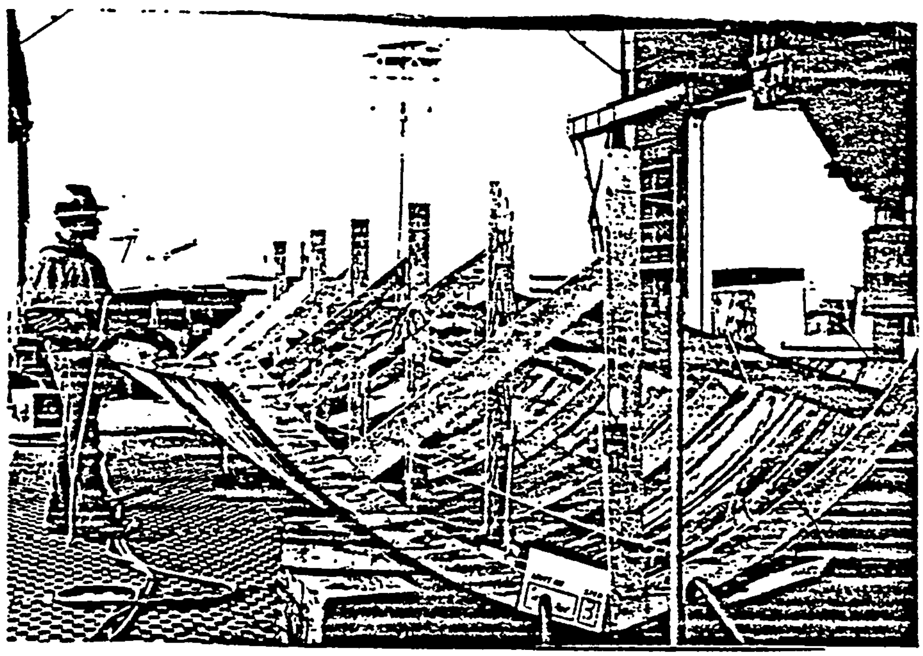
KEEL PLATE AND SIDE SHELL PLATE AROUND STERN FRAME.

A.P.L. - UNIT #46 & UNIT #106

THESE PLATES WERE APPLIED LINE HEATING METHOD INSTEAD OF TRADITIONAL BENDING METHOD.

I.H.I. RECOMMENDS THAT ALMOST ALL PLATES TO REQUIRE THE FORMING JIGS SHOULD BE APPLIED LINE HEATING METHOD EXCEPT SPECIAL CASES,

PHOTO 1



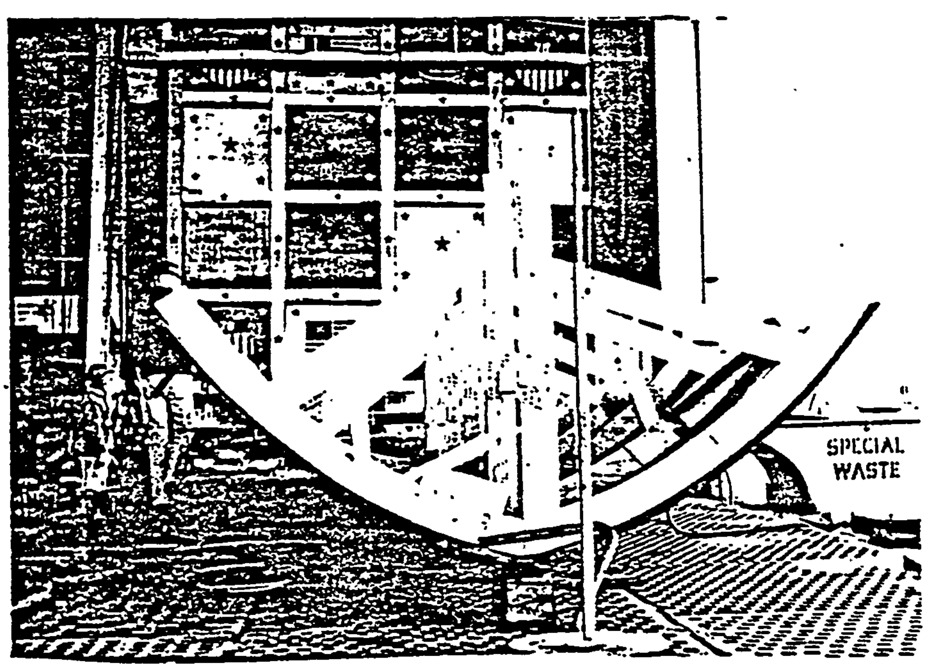


PHOTO 2

MATERIAL CONTROL INTERFACE

MATERIAL CONTROL PLANNING AND SCHEDULING
AVONDALE SHIPYARDS, INC.

Prepared BY: F. LOGUE

MATERIAL CONTROL
PLANNING AND SCHEDULING

I. INTRODUCTION

Material Control is one of the most important functions for shipbuilding. In this heavy indqstry, material costs account for about 60% to 70% of all the shipbuilding costs. Therefore, the material cost directly affects and may increase interest payable, handling cost, storage area, as well as the disruption of the production schedule and the cost of the material. The fundamental targets for material control are the saving of these undesirable surplus costs.

It is felt that the application of the IHI technology will greatly implement cost savings through material control at ASI. These cost savings are not necessarily to be realized in the Material Control Department itself, but throughout the various crafts served by the Material Control Branch.

In the past, the basic rationale for the listing, requesting, procuring, receiving, and issuing of material was on a system basis, as compared to the new technique of unit, zone, and sub-zone method employed today. The basic physical control of material is enhanced by this new technique in that it presents smaller increments of material to be handled with much less storage time on site in the field.

Historically, material handling by the Material Control Section at Avondale does not include the handling of raw steel. This is handled by the Steel Control Section. Material handled by the Material Control Section is categorized into the following areas:

- Pre-Fabricated Steel
- Fabricated Pre-Outfitting Items (such as Manholes, W.T. Doors, Deck Fittings, Foundations, etc.)
- Raw Piping Material-Input to Pipe Shop
- Fabricated Pipe Details from the Pipe Shop
- Warehouse (Purchased) Materials

A) PRE-FABRICATED STEEL

Prior to utilizing the zone outfitting and process lanes technique, virtually all pre-fabricated steel moved from Plate Shop to interim storage at the fabricated steel stc age area. Under the new concept, the reverse situation occurs in that only a small portion of pre-fabricated ste moves into the fabricated steel storage area for interim storage, with the vast bulk of material moving directly t the work queue storage areas.. This is possible as a resu of detailed process lane schedules based on the Volume ar quantity of work for each process lane.

Those items of pre-fabricated steel that will continue tc flow from the Plate Shop to interim storage will be neste plates from the numerical control burning machines that m have the tabs cut and then be palletized.

The pre-fabricated steel listed on the UCM'S for PSU'S, sub-units, and units will, in general, be tracked through the Plate Shop and the work platens by the supervision of the shop and the platens. It will not be tracked by the Material Control Group. This is a change from former pra tice. It is felt that due to the IHI concept of categori tion of units and the timely scheduling of events coupled with a direct flow, that significant cost savings will be affected here.

An overall material marshalling plan has been generated t accomplish the total logistics for recording, expediting, palletizing, and delivering the various categories of mat ial to the process lanes.

In the case of pre-fabricated steel, a contingency has be built in to this plan to allow marshalling to proceed in orderly manner, even if the process lane schedules are delayed, perhaps by inclement weather, and thus result in the process lane work centers falling behind the Plate Shop's pre-fabrication schedule.

In an average week, pre-fabricated material for fourteen (14) sub-units must be issued to the process lanes. By reviewing the various units to be fabricated, the size of the storage grid, or process marshalling area, can be readily determined. Unit 67, a double bottom unit, was selected as a large unit for this purpose. This unit wil require a grid 20' x 53'.

Since there is a requirement for fourteen (14) units per week, a three (3) week delay contingency was plotted with the result that forty-two (42) grids would require an area approximately 200′ x 275′, including a burning and sorting area.

The point to be made here is that even with this built-in contingency for three (3) weeks schedule interference, the size and scope of the storage requirements is overwhelmingly reduced in physical size and the capability to track the material is vastly simplified due to the new techniques being employed.

I wish to breifly review for your benefit one of the view graphs presented yesterday, to demonstrate the effectiveness of this stream-lining of pre-fabricated steel flow. The present method of producing and moving pre-fabricated steel from the shops and platens to interim storage requires handling approximately 9,174 pieces per week as opposed to 6,571 pieces per week, and requires 177 moves per week as opposed to 119 moves per week, or a reduction of 28.4% in pieces and 32.8% in moves.

In evaluating all facets of this movement study, a savings of approximately 30% in the handling of pre-fabricated steel material will be realized due to the implementation of the process lane concept.

The much smaller quantity of pre-fabricated steel that will continue to flow to interim storage, primarily nested plates, will be controlled by utilizing the UCM in a manual mode as opposed to formerly using the unit books.

B) FABRICATED PRE-OUTFITTING MATERIAL

Fabricated pre-outfitting items, such as foundations, ladders, W.T. doors, etc., were formerly fabricated in entire jobsets, thus creating many material handling problems, such as requirements for physically large storage areas, much double handling with normal attrition taking its tool with resultant loss, or damaged material and possible deterioration due to long term storage in the weather.

The process lane concept, with its thrust for level loading, will dictate a new approach in this category of material. With few exceptions, fabricated pre-outfiting items will not be fabricated in entire jobsets, but instead will be controlled in smaller groupings compatible with short term scheduling needs. This will very effectively eliminate most of the handling and storage problems presently encountered.

In the former method, some fabricated pre-outfitting item moved directly from the fabrication shop to the jobsite, whereas, now, all of this material will move to interim storage for palletization by unit, or zone, thus necessitating more overall line items to be handled by Material Control. The cost of this small additional volume of pieces to be handled will be greatly compensated for by the redution in remakes and resultant loss of time in the field when work is not completed due to the need for remakes.

The control of this material will be accomplished on a pallet basis for each hull. Requirements for pallet loading will be obtained from the unit and zone outfitting losts prepared by the Planning and Scheduling Department.

By utilizing this method, Material Control will be in a position to effectively expedite this material through the shops, using the pallet release date minus a two to four week lead time. Formerly, this expediting effort was lacking and thus, with a much more clearly defined management system, greater cost savings can be accomplsihed.

C) RAW PIPING MATERIAL INPUT TO SHOP AND FABRICATED PIPE DETAILS FROM THE PIPE SHOP.

Fabricated pipe details are presently being implemented for fabrication in our semi-automated Pipe Shop. The engineering and shoip fabrication effort will be driven by a CADAM/COPICS EDP program. While the vast detail involved in this system for enhancing the engineering and fabrication effort is the subject for a separate discussion, I would like to review the impact of the process lane concept on material control aspect of this operation.

Under the old system of outfitting procedures, the Mechancal Section of the Engineering Department would produce a pipe detail drawing for each piping system. This P.D. drawing and its attendant L/M gave the Material Department both shop fabrication and “on ship” installation information which had to be separated. When the Material Department received the P.D. and L/M lists from Engineering, it was necessary to do a material take-off on each P.D. to determine which materials were “shop load” and which were to-be installed “on board.”

With the new unit/zone outfitting procedures, the Mechanical Section of the Engineering Department produces a pipe detail drawing for each unit. These drawings include all shop fabricated piping within the confines of the unit, and each is assigned a pallet code. All of this information is input COPICS for scheduling through the Pipe Shop. From this information, a weekly load list is produced containing all materials for the P.D.'s that are scheduled to be built for that week. This list of material is reviewed by the Material Control Department to determine if all materials are on hand. Since only parts of systems and, in fact, only parts of units are fabricated weekly, a manual material take-off would be very impractical. The computer generated material listing makes this procedure unnecessary.

The procedures followed under the old system-oriented method for issuing materials to the Pipe Shop was triggered by the production work order. One work order was written to schedule a whole piping system of fabricated pieces through the shop at one time with only a tentative start and complete date. When this work order was received at the Material Department, the material take-off that had been made earlier and kept current with any revision was reviewed and material requisitions were written for all materials on hand at that time. Before releasing any material to the Pipe Shop, however, it was necessary to confer with the Pipe Shop superintendent to determine if the shop load was such that this material could be accommodated at that time, since shop loading was not considered in the overall schedule. If it was determined at that time that the Pipe Shop could handle the system in question, the Material engineer released the material requisitions to the Warehouse for issue and, at the same time, sent a copy of all shortages listed against that system to the Pipe Shop for information and to the Expediting Department of Purchasing for action. The Warehouse would then fill all the material requisitions and send all the material available to fabricate the whole system to the Pipe Shop. All materials not on hand were assigned to the "deliver on arrival" category and sent to the Pipe Shop whenever they arrived. If, after consultation with the pipe superintendent, it was decided not to fabricate the system due to shop loading or overloading, the material requisitions were held by the Material engineers-until called for by the pipe superintendent.

The system for issuing materials to Pipe Shop under the new "shop management, unit outfitting" procedures is somewhat reversed from the old method. After reviewing the material listing from Data Processing's detailing all materials required for one (1) week's shop loading, the Material engineer determines those P.D.'s for which 100% of the required materials are on hand. These P.D.'s are then released via a CRT in the Material Control Department and become available for fabrication on the scheduled date. This information is fed to Production engineers so that work orders can be written only for those P.D.'s released and to the Pipe Shop so that the materials and the P.D.'s to be built will coincide. As with the old system, material requisitions are then written to the Warehouse for issue t the Pipe Shop. The materials sent to the Pipe Shop will b separated by categories, such as flanges, elbows, reducers etc., for ease of machine station loading in the Pipe Shop P.D.'s that were scheduled during this time period, but no released due to a lack of material, are reviewed each week and released to the Pipe Shop when the material arrives.

The storage and issuing of finished pipe details under the system type method presented the Material Department with many handling and record keeping problems as can be seen from the brief system overview discussed below. As pipe details were fabricated in the Pipe Shop with perhaps several systems being built at one time, they were sent directly to the fabricated pipe storage yard where they we off-loaded on to other trailers depending upon the coating required; or, if no coatings were required, palletized, stored and located in a manual locator system. As coated pipe details were returned to the storage area, they too were palletized, stored at random and recorded. This resu ted in one system being stored on many pallets in many loc tions. When the installation work order was written, it w to install the entire system over a rather long period of time. Of course, it would be impractical to issue all the P.D.'s for an entire system at one time; so, what usually happened was the installing foreman would call for P.D.'s he needed them. This resulted in taking the appropriate P.D.'s from a pallet containing other P.D.'s, in effect, double handling nearly all P.D.'s The length of time the P.D.'s remained in storage often caused other problems suc as deterioration, damage, or loss.

Today, pipe details are received from the Pipe Shop as the are built and off-loaded to the various coating ares much under the old system. However, each P.D. is now pallet coded and placed into a metal container with only P.D.'s designated for that particular pallet. Since the Pipe Sho is building to a much shorter schedule due to the fewe P.D.'s required in a unit as compared to a system, P.D.'s remain in storage a relatively short time. When all P.D.' required for a pallet are received and ready for installa- tion, the metal containers are banded and only await the scheduled installation date to be issued. Obviously, this method will result in a smoother flow of fabricated parts the building areas, along with a reduced amount of handlin by the Material Department.

D) WAREHOUSE (PURCHASED) MATERIAL

Waehouse, or purchased material other than piping, is still for the most part purchased on a system, or group basis, but allocated against unit and zone areas. This material is received and stored in material family groupings by job and purchase order number.

Working with the unit and zone pre-outfitting lists, this material is palletized at the Warehouse by craft. In conjunction with the fabrication and erection schedules, this material is then delivered to the work site.

By way of summation, the total logistics of material flow to the unit and zone concept, under the process lane technique, has been embodied in our material marshalling plan. This plan essentially establishes four (4) physically designated marshalling areas. The overall effort is then monitored and coordinated so that materials from the various areas will arrive in a timely manner to form a complete material package. This coordinated effort represents a big improvement over the former “system method.”

STEEL CG's

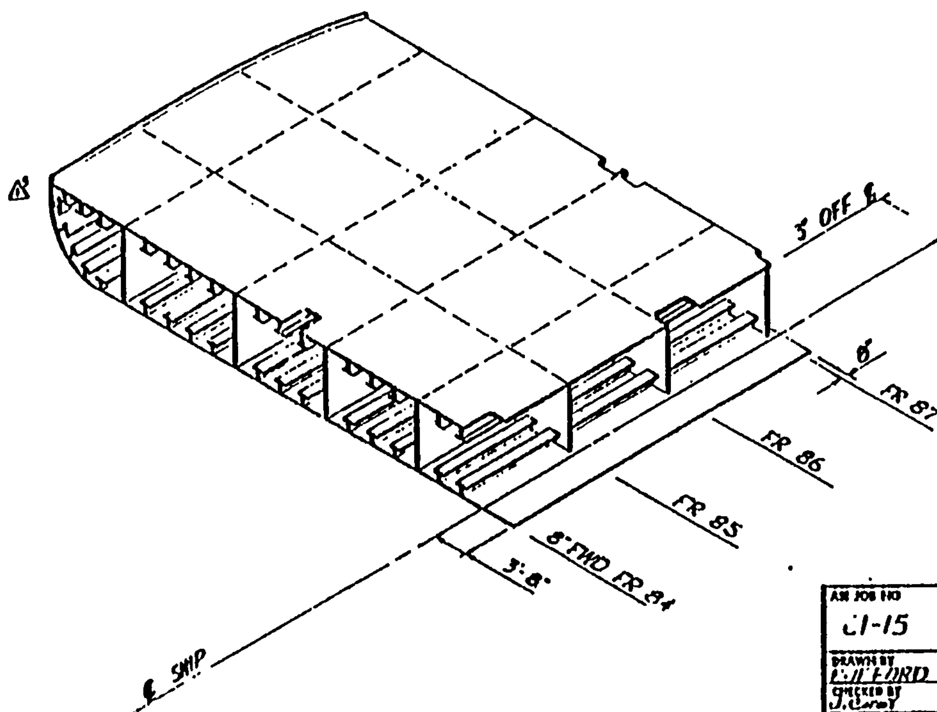
STEEL WT. = 99.69 ST
VCG : 9'-9⅝" ABV BL
LCG : 7'-4⅝" FWD FR 85
TCG : 20'-0" OFF ℄

REVISIONS

REV	DESCRIPTION

OVERALL DIMS.

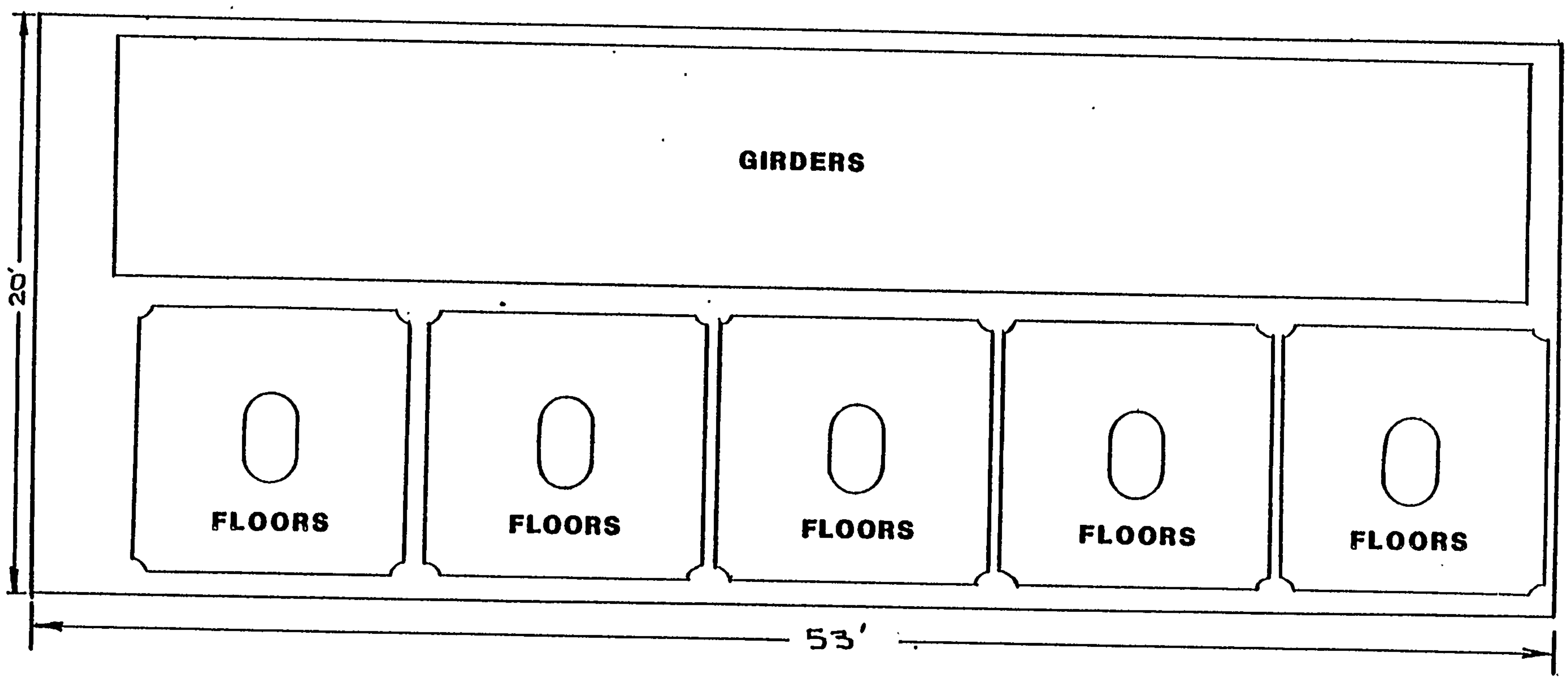
L: 36'-0"
W: 56'-7"
H@ E.J. 8'-9"

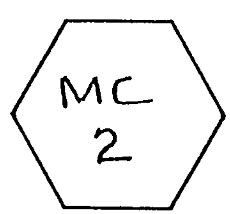


CATEGORY I

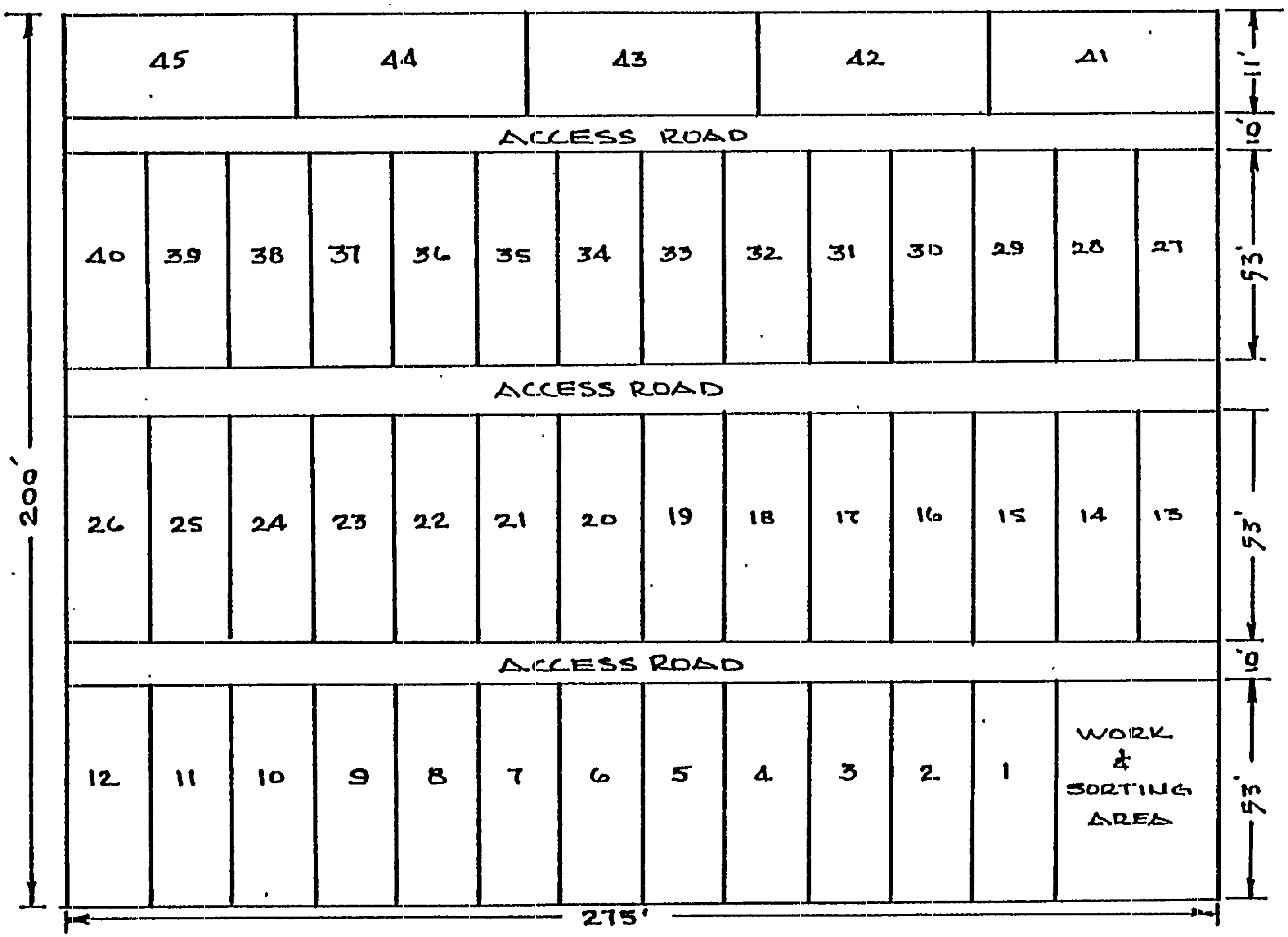
ASI JOB NO C1-15	42,000 DWT. MULTI-PRODUCTS CARRIER
DRAWN BY C. H. FORD DATE 5-21-81	AVONDALE SHIPYARDS, INC P O BOX 50280 NEW ORLEANS, LA 70150
CHECKED BY J. Carey 5-27-81	UNIT 67
APVD OPERATION SERVICES 6-3-81	
APVD	SIZE C ASI DWG NO 5-068 REV
APVD	OPERATION SERVICES

TYPICAL STORAGE GRID FOR PRE-FABRICATED STEEL (UNIT 67)





MARSHALLING AREA FOR PRE-FABRICATED STEEL



MC 3

HULL 1

PLATE CUTTING LIST

R	LN	SUHN NO	UNIT-SUB-PSU-PC	QTY	LOCATION	MATERIAL	GRADE	MATERIAL RECEIPTS DATE	TICKET	LOCATION	MATERIAL ISSUES DATE	TICKET	LOCATION
	1		1 - 1 -27 -25	1	FLR.FR.63 STBD	15/32" PL	AH-32	4-20-82	876542	17	4-26-82	862348	PLT. #16
	2		- - -										
	3		- - -										
	4		- - -										
	5		- - -										
	6		- - -										
	7		- - -										
	8		- - -										

STRUCTURAL CUTTING LIST

R	LN	SUHN NO	UNIT-SUB-PSU-PC	QTY	LOCATION	MATERIAL	GRADE						
	1	30	1 - 1 -27 -26	1	FLR.FR.63 STBD	5/8"X6"F.B.	A						
	2	31	1 - 1 -27 -27	1	FLR.FR.63 STBD	5/8"X6"F.B.	A						
	3	32	1 - 1 -27 -28	1	FLR.FR.63 STBD	5/8"X6"F.B.	A						
	4	36	1 - 1 -27 -29	2	FLR.FR.63 STBD	5/8"X6"F.B.	A						
	5	30	1 - 1 -27 -30	2	FLR.FR.63 STBD	5/8"X6"F.B.	A						
	6		- - -										
	7		- - -										
	8		- - -										
	9		- - -										
	10		- - -										
	11		- - -										
	12		- - -										
	13		- - -										
	14		- - -										
	15		- - -										

PCL-SCL 1 10/81

SIZE	DRAWN BY	JOB	TITLE	ASI DWG NO
B	B.LYNN	JOB C1-15	FLOOR FR.63 STBD	CL 1-1-27
	CHECKED BY	REVISION	(FOR CONTINUATION SEE)	SH NO 33

MC 4

HULL NO.		AVONDALE SHIPYARDS, INC. PREFAB & ASSY. SHEET	UNIT NO. 106-Lower
ASSY AREA			SHEET NO. 33 OF 36
JOB NO.	C9-215	AFT PEAK (23'0 FLAT TO BOTTOM SHELL) FR-173-AFT	DWG. NO. 11-01-03

	PIECE MARK	QUANTITY P	QUANTITY S	DESCRIPTION	TYPE OF STEEL	DWG. DETAIL	LOFT INFO.	STD. PC.MK.	REMARKS	WEIGHT	WEIGHT	
1				Shell Plating P/s								1
2												2
3	106-28-FK1-1		1	PL 1.25 x47 11/16" x 9'-11 5/8"	AB/A	11-A	210630		Form		1816	3
4												4
5	106-28-FK-1	1	1	1.25 x37 3/4" x 9'-0 3/4"			210630		Roll	1379	1379	5
6												6
7	106-28-F1-2	1	1	1.25 x100 3/4" x 17'-0 1/4"			230401		Roll + Form	7652	7652	7
8												8
9	106-28-F2-2	1	1	x93 3/4" x 17'-11 1/4			230402			7121	7121	9
10												10
11	106-28-F3-2	1	1	x85 11/16" x 7'-1 11/16"			230403 / 230402			2603	2603	11
12												12
13	106-28-FK1-2		1	1.6875 x 47 3/4" x 8'-11 3/4"			210575				2461	13
14												14
15	106-28-FK-2	1	1	x 35 13/16" x 8'-11 5/16"			210599			1859	1859	15
16												16
17	106-28-FK1-3		1	x 47 9/16 x 10'-0 5/16"			210574		Form		2235	17
18												18
19	106-28-FK-3	1	1	x 32 1/2 x 9'-11 3/4"			210600		Roll + Form	1835	1835	19
20												20
	PIECE TOTAL			SHT. REV.					TOTAL WEIGHT	22265	29461	
									UNIT NO: 106-L SHEET 33 OF 36			

HULL NO.	AVONDALE SHIPYARDS, INC. MATERIAL CONTROL RECORD SHEETS	UNIT NO.
ASSY. NO.		SHEET NO. OF
JOB NO.		DWG. NO.

	WORK ORDER No.	FOREMAN	HULL 1	HULL 2	HULL 3	
1				[illegible]	[illegible]	
2				[illegible]	[illegible]	
3			[illegible]	[illegible]	[illegible]	[illegible]
4				[illegible]	[illegible]	
5			[illegible]	[illegible]	[illegible]	[illegible]
6						[illegible]
7			[illegible]	[illegible]	[illegible]	[illegible]
8				[illegible]	[illegible]	
9		9	[illegible]	[illegible]	[illegible]	[illegible]
10	E2.7	9A	[illegible]	[illegible]	[illegible]	
11			[illegible]	[illegible]	[illegible]	[illegible]
12				[illegible]	[illegible]	
13			[illegible]	[illegible]	[illegible]	
14		LHLS	[illegible]	[illegible]		[illegible]
15			[illegible]	[illegible]	[illegible]	
16				[illegible]		
17			[illegible]	[illegible]	[illegible]	[illegible]
18						
19			[illegible]	[illegible]	[illegible]	[illegible]
20				[illegible]	[illegible]	

MC
5

UNIT OUTFITTING PALLET L/M

PRODUCTION. PLANNING

JOB. NO. C1-15 UNIT 25 PALLET NO. 025-1T

HULL 2335 "B" ZONE M PALLET REQ'D. AS PER SCHED.

UNIT DESCRIPTION: INNER BOTTOM S/S
FRAME(S) 15-29

GROUP	LINE	DESCRIPTION	DRAWING	MATERIAL RECEIVED	MATERIAL ISSUED
16		MANHOLE HATCH & SCUTTLE LIST	16-02-01B		
↓	1	MANHOLE W.T. MS-16-MH-B (2)	↓		
↓	2	↓ ↓ ↓	↓		
	3				
	4				
	5				
20		FDNS IN ENGINE ROOM (ZONE M-1)	11-12-04		
↓	6	FN-141	↓		
	7				
	8				
	9				
	10				
20		DOUBLE BOTTOM C-UNIT 25	00-025-000		
↓	11	LINE SHAFT FDN.	↓		
	12				
	13				
	14				
	15				
16		STERN TUBE L/O DRAIN TANK	45-01-03		
↓	16	TANK	↓		

REVISION

PAGE NO. 25-T-A
PRODUCTION PLANNING

MC
6

FABRICATED PRE-OUTFITTING MATERIAL

MATERIAL LIST 33

ASI 3000

DRAWING TITLE	JOB NUMBER	REQUEST NUMBER	DRAWING NUMBER
	1		11. 12. 042
TIME TO PRODUCE		CODE	DATE

PIECE MARK	QUAN.	DESCRIPTION	PURCHASE ORDER NUMBER	PURCHASE ORDER PROMISED	RECEIVED	TOTAL RECEIVED	DATE ISSUED	NUMBER	DESTINATION	QUANTITY	TOTAL ISSUED	BALANCE ON HAND	REMARKS
	(3)	①②③ FDNS. FOR INCIN. SLUDGE	475760		RSPC7	HULL ①②	3	① 442051	PLAT 17A				
		OIL TANK SHT 18			PAINTED			① 504237	PLAT 20				
		2 PCS. PER FDN.						① 606229	YANCEY				
								(SEE OUTFITTING BOOK)					
	1	SHT 8	262969		RSPC7								
	2	①① " 10					① 609808		① 661205				
	2	①① " 13					①	H 2 OREN	609810	① 661205			
	2	①① " 14					①	609811	① 661205				
	1	" 7											
	(1)	" 19					① 503865		H1 OREN				
	2	① " 6					① 358269		H6 OREN				
	3	①① " 9	SHT9	R107 PAL 53			① 609808		H2 OREN		① 661205		
	2	" 12											
	(3)	①①①			YM. 577438		(CH. ①②3)		R4 P 65 OR 66				
		FDN. FOR Air Compressor Control				H3 R107 PAL 10		① 606551	OREN H1				
		SHT. 48 PLAN '48.A PALLET # 20-064-17						① 609072	OREN H3				
								① 624923	OREN				

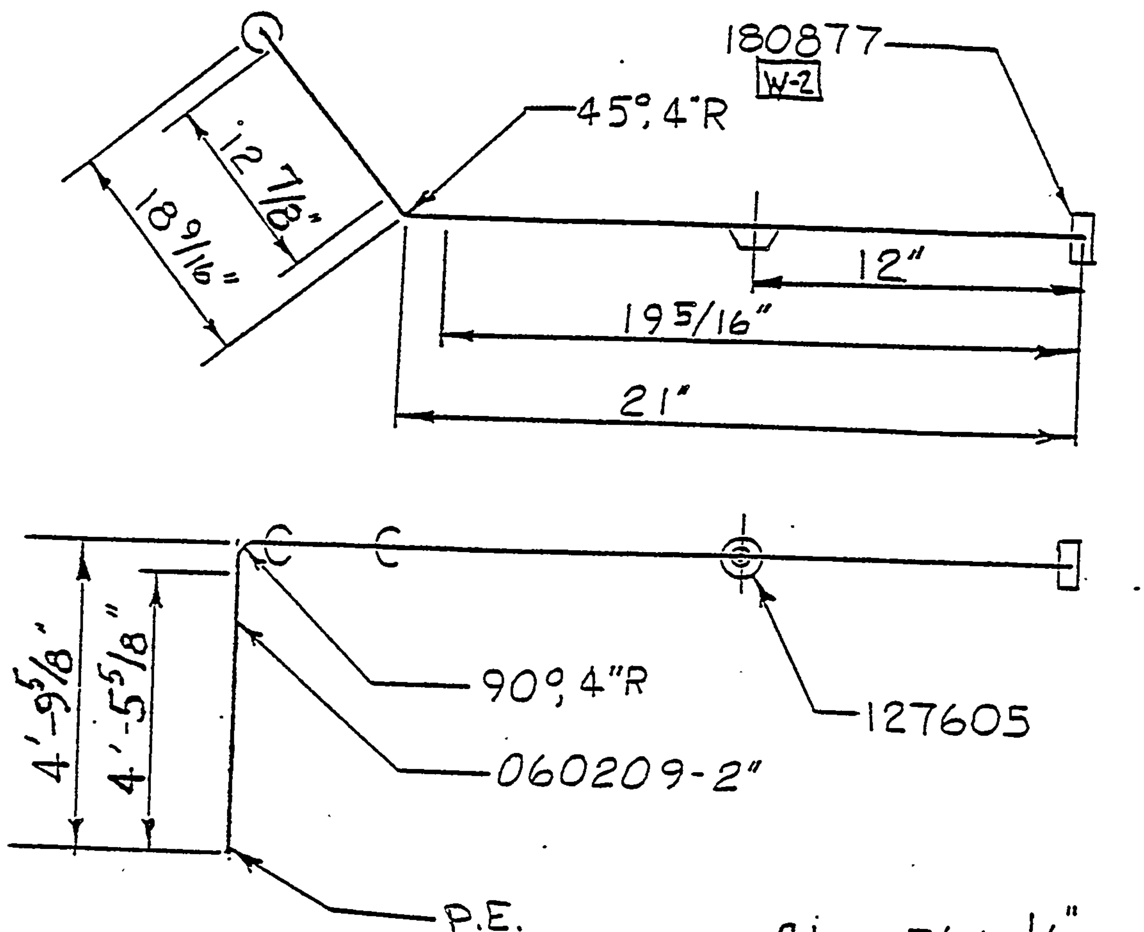
SEE YM 390275 390276 THESE TICKETS ARE POSTED IN OUTFITTING BOOK

MC 7

PIPE DETAIL SKETCH

P. O. NO.	1-2
NO.REQD.	1
LOC.	04-71-1

HOT DIP GALV.
AFTER FABRICATION



CL. = 7'-11 1/4"

0127605 COUPLET STL FORGED SW 3000 ASTM A105 VOGT SW-1211 3/4" SIZE
0060209 PIPE STL BW XS ASTM A53 2
0180877 SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 2

COST CODE	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150 TITLE: PLUMBING & INT. DK. DRNS. QTRS. "C" DK. & ABOVE - P/D	JOB NO. C8-0750 DWG NO. 48 02 142 DWN SAW REVISION

SHEET 5

MC
8

DATE 2/17/81 P.O.NO.

LIST OF MATERIAL QUANTITY (1) SHIP REQ.NO. 6247F

PC. MK.	QTY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
000180809	10	BHD & DECK PENETRATIONS STEEL WT & OT ASI MECH STD NO 11 3 IPS		
000180876	43	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 1 1/2		
000180877	56	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 2		
000180879	42	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 3		
000180881	2	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 4		
000181159	4	VENT ANTI-SIPHONIC PVC BODY MONEL SCREEN MIN VACUUM TO VENT 1" WATER MIN PRESSURE TO SEAL 1" WATER 3/4 FPT		
000181612	21	DECK DRAIN STL SOCKET WELD TATE 60-160 W/BRASS STRAINER GALV WITHOUT TRAP AND BAFFLE 2		
101000284	4	NUT STEEL GALV HVY HEX MIL-B-857A-5 ASTM A307 ANSI B18.2.2 5/8 11UNC-2B		
101011109	4	BOLT STL GALV HH MIL-B-857A-5 TY 2 GR 2 ASTM A307 GR B 5/8 11UNC-2A X 3		

DR.	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	CUSTOMER CODGEN MARINE, INC.
CKD.	TITLE PLUMBING & INT. DK. DRNS. QTRS. "C" DK. & ABOVE - L/M	JOB NO. C8-0750
APPD.		DWG.NO 46 08 141 REV. 2

CODE 0618 NO OF VESSELS 2 DATE 2/17/81 SHEET 8

MC 9

DWG. NO. 48-08-142 TITLE OF DRAWING PLBG & INT DK DRS QTRS. "C" DK & ABOVE REV. NO. ________

CE750

PC. NO.	TOTAL	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY	SKE
070111	1	1	PD15																		
090113	8	7	PD25	1	PD26																
090211	1	1	PD15																		
093609	4	2	PD11	1	PD13	1	PD32														
127605	6	1	PD1	1	PD5	1	PD6	1	PD10	1	PD14	1	PD18								
133429	1	1	PD15																		
180876	2	2	PD20																		
180877	CONT. "	1	PD1	1	PD3	1	PD4	1	PD5	1	PD6	2	PD7	1	PD8	1	PD9	1	PD10	1	PD12
180877	17	2	PD14	1	PD16	1	PD17	1	PD19	1	PD20										
180879	1	1	PD24																		

PIPE DETAIL SUMMARY - "SHOP LOAD"

MC 10

WEEKLY PIPE DETAIL SHOP LOAD

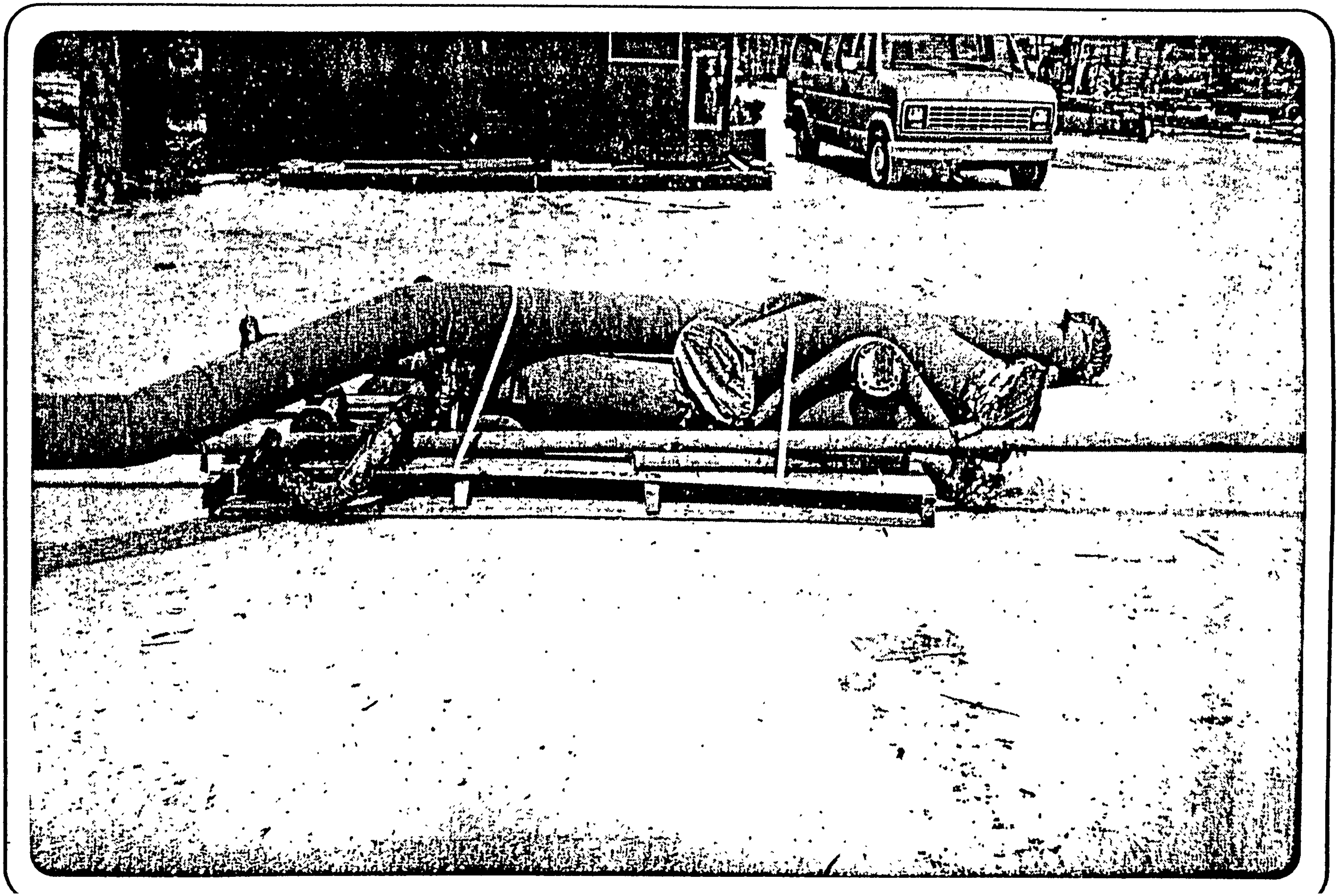
A V O N D A L E   S H I P Y A R D S,   I N C.

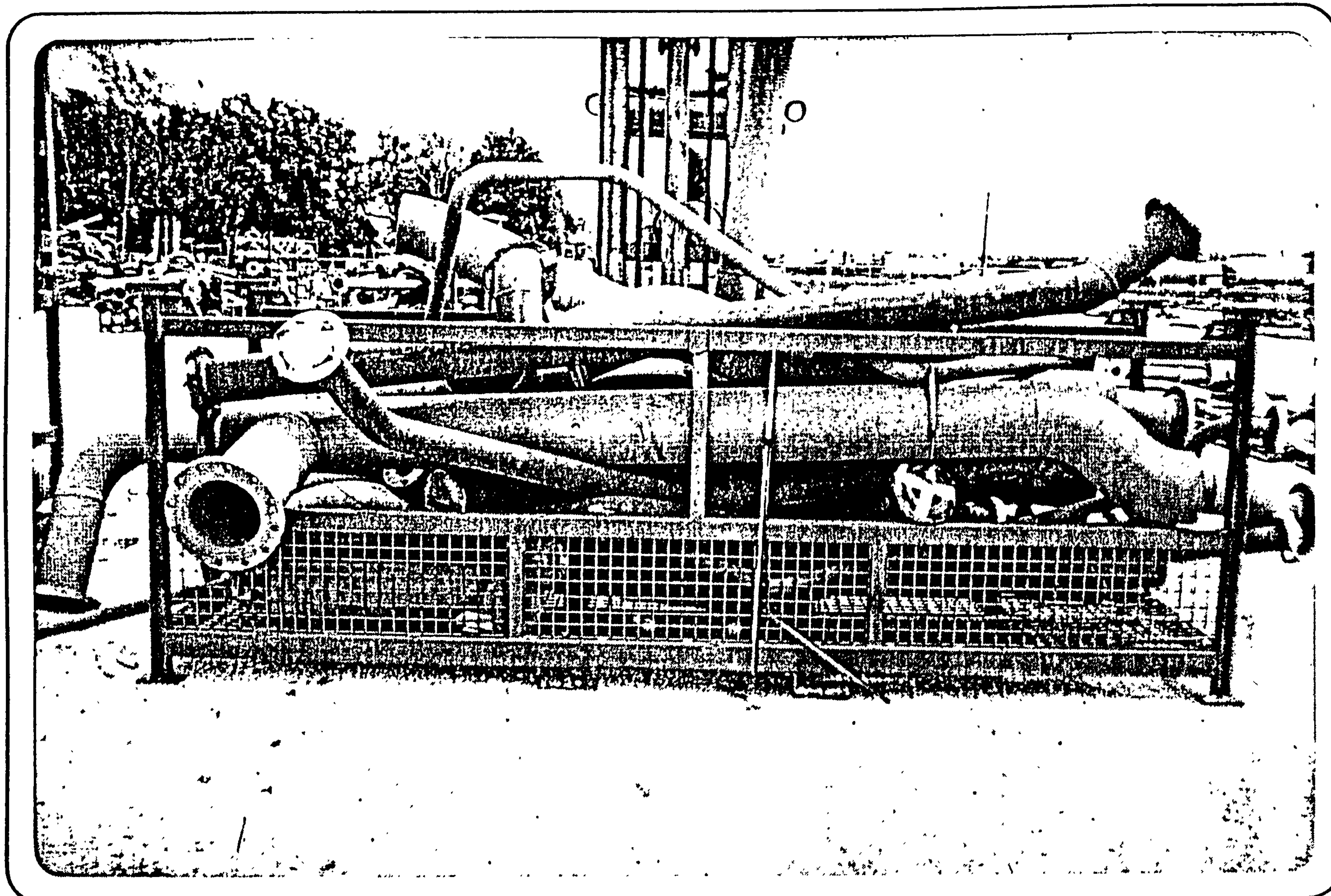
M A T E R I A L   L I S T I N G

RELEASE DATE 04/02/62

PD	PD DESCRIPTION		QUANTITY	PIECEMARK	PIECEMARK DESCRIPTION	NO REQ'D	S O NUMBER
PD165-06008047-2335	233506008047	0608	1.00000	000070110	FLANGE STL SLIP-ON 150 A	2	0000108420
PD167-06008047-2335	233506008047	0608	2.00000	000070110	FLANGE STL SLIP-ON 150 A	1	0000108370
PD024-06008047-2335	233506008047	0601	1.00000	000070113	FLANGE STL SLIP-ON 150 A	1	0000108270
PD124-06008047-2335	233506008047	0609	1.00000	000070113	FLANGE STL SLIP-ON 150 A	1	0000108530
PD166-06008047-2335	233506008047	0609	1.00000	000070113	FLANGE STL SLIP-ON 150 A	1	0000108310
PD061-06008047-2335	233506008047	0601	1.00000	000070115	FLANGE STL SLIP-ON 150 A	1	0000108390
PD071-06008047-2335	233506008047	0608	1.00000	000070115	FLANGE STL SLIP-ON 150 A	1	0000108240
PD114-06008047-2335	233506008047	0608	1.00000	000070115	FLANGE STL SLIP-ON 150 A	1	0000108650
PD016-06008047-2335	233506008047	0603	2.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108300
PD017-06008047-2335	233506008047	0603	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108600
PD020-06008047-2335	233506008047	0604	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108210
PD023-06008047-2335	233506008047	0603	2.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108430
PD118-06008047-2335	233506008047	0609	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108250
PD119-06008047-2335	233506008047	0609	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108640
PD120-06008047-2335	233506008047	0609	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108360
PD034-06008047-2335	233506008047	0612	1.00000	000070409	FLANGE STL SOCKET WELD 1	2	0000108570
PD050-06008047-2335	233506008047	0612	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108590
PD128-06008047-2335	233506008047	0609	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108480
PD129-06008047-2335	233506008047	0609	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108330
PD130-06008047-2335	233506008047	0608	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108580
PD118-06008047-2335	233506008047	0609	1.00000	000091316	ELL 90 STL BW STD SMLS AS	1	0000108250
PD119-06008047-2335	233506008047	0609	1.00000	000091316	ELL 90 STL BW STD SMLS AS	1	0000108640
PD120-06008047-2335	233506008047	0609	1.00000	000091316	ELL 90 STL BW STD SMLS AS	1	0000108360
PD016-06008047-2335	233506008047	0603	1.00000	000091416	ELL 90 STL BW XS SMLS AS	1	0000108300

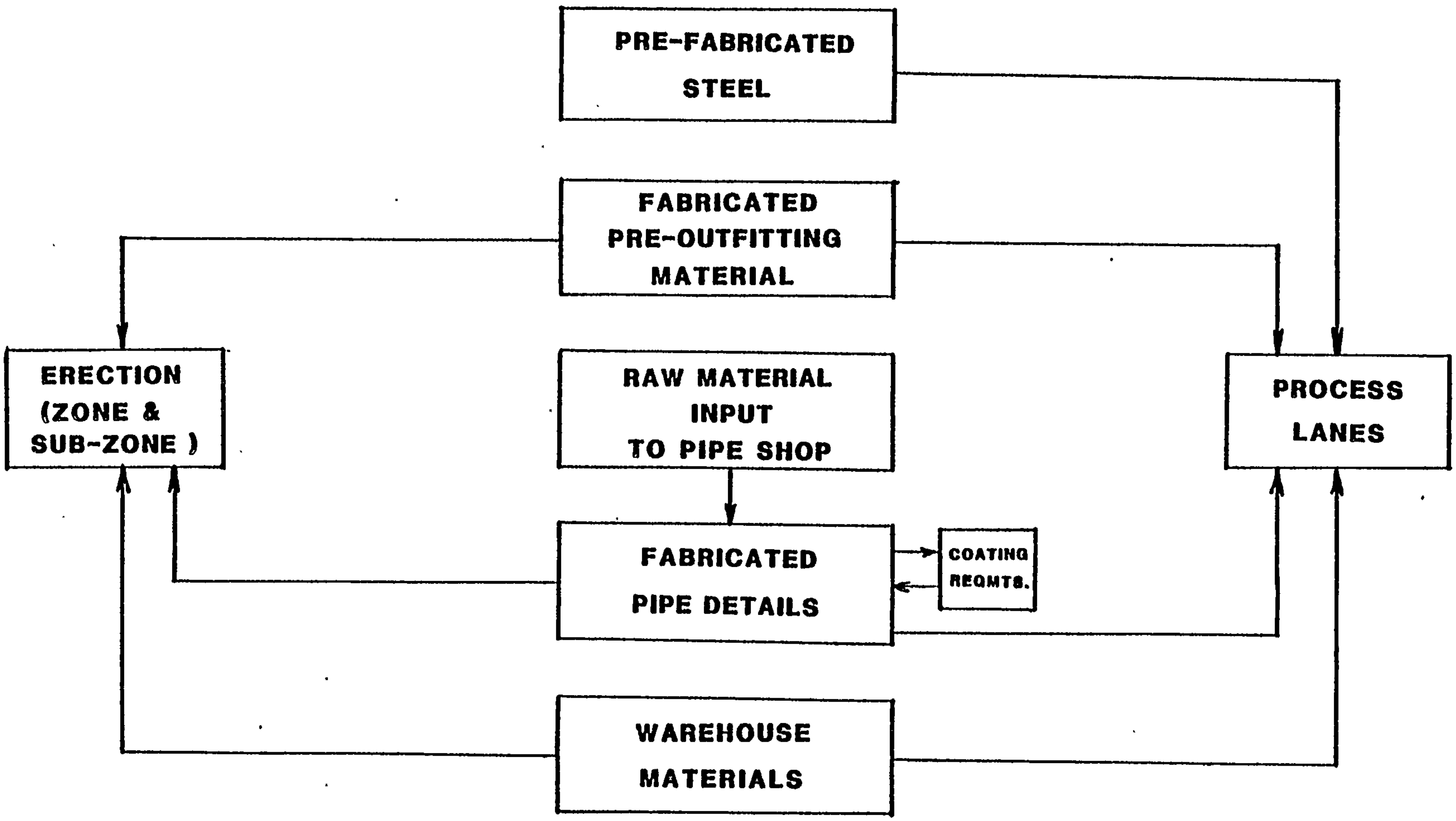
MC 11





MC 13

MARSHALLING PLAN MATERIAL FLOW



MC 14

ACCURACY CONTROL
IN THE SHIPFITTING DEPARTMENT
AVONDALE SHIPYARDS, INC.

Prepared By: J. TAYLOR

ACCURACY CONTROL IN THE SHIPFITTING DEPARTMENT

I. INTRODUCTION

A) GENERAL

The primary goal of Accuracy Control in the Shipfitting Department is the development and implementation of procedures that enhance the construction process of completed ship units so that they will, within prescribed tolerances and with a high degree of predictability, coincide with all design dimensions and details, thereby minimizing the amount of rework on units at the time of erection. Secondary goals are the development and implementation of procedures that enhance the burning process of individual pieces and the construction processes of sub-units and partial sub-units so that they will, within prescribed tolerances and with a high degree of predictability, coincide with all design dimensions and details, thereby minimizing the amount of rework in the sub-assembly, main assembly and final main assembly.

These goals are achieved through a three-fold effort:

1) Checks

2) Controls

3) Statistics

These efforts should have a dual impact: the improvement of immediate work and the improvement of future work (see Fig. 1-1). Although these are distinct and separate activities, they are so thoroughly interrelated that any one cannot be effectual without the involvement of the other two.

B) CHECKS

Checks are utilized for three primary purposes:

1) The isolation of specific problems that present a demand for controls.

2) The monitoring of construction to insure that:

a) proper controls are being utilized

b) controls are, in fact, effective

3) The monitoring of construction to assist in the min mizing of human errors.

C) CONTROLS

Controls are employed for the sole purpose of enhancing existing work practices. Control might be called the magi word in Accuracy Control, but it is, in reality, the magic word in any type of endeavor. The most necessary prerequi site for success in any venture whatsoever is a predictabl end result. It is control that makes an end result predic able, whether that control be over Personnel, Machinery, Systems, or even Yourself. A lack of control means liter- ally that something is "out of control," resulting in a ve poor degree of predictability.

D) STATISTICS

Statistics may be divided into two categories:

1) The development of statistics that are applicable t shipfitting work throughout the ship.

2) The development and maintenance of statistics appli able to a specific unit. In other words, a unit his tory.

E) COORDINATION OF ACTIVITIES

The coordination of these activities is graphically dis- played in Figures 1-2 through 1-5. Figure 1-2 indicates that without the utilization of an Accuracy Control Program a poor product is the predictable end result, both for imme diate and future work. Figure 1-3 indicates the implementa tion of checks. Checks alone cannot improve the end pro- duct. Figure 1-4 indicates the development and implementa- tion of controls in addition to checks. This results in an improved product for immediate work but develops slight potential for the improvement of future work. Figure 1-5 indicates the results that may be expected with the imple- mentation of a well coordinated Accuracy Control Department utilizing checks, controls and statistics.

The results from this are not only a good product in the immediate work nor the potential for a good product in the future work, but the potential has also been developed for improved design concepts, improved engineering concepts and improved production concepts.

The amount of time spent on each of these three distinct but interrelated activities will vary widely, contingent upon many factors such as the stage of development of the Accuracy Control Department or the complexity of the work at hand. In the early stages of the development of an Accuracy Control Department, it is likely that checks will be the single most important activity. Initially, the checks are necessary to develop a cognizance of all the problems that are at hand. As these various problems are recognized and evaluated, controls may then be developed and implemented to alleviate the problems. As the work progresses and the effect of controls becomes pronounced, the need for checks should begin to taper off until ultimately it is used primarily as a monitoring procedure. Similarly, in the early stages of development of an Accuracy Control Program, a very considerable amount of time will be utilized in the development of generally applicable statistics. As these statistics are evaluated and utilized in the development of controls, the need for statistics will also tend to taper off. The maintenance of unit histories must be a continuing effort.

II. OUTLINE OF ACCURACY CONTROL ACTIVITIES

A) CONTROLS

1) Control Lines, Control Points and Backside Marking
2) Burning Procedures
3) Uniform Shrinkage Factors
4) Construction Procedures
5) Erection Procedures
6) Construction Aids

B) CHECKS

1) Measuring Procedures
2) Mathematical Checking Systems

3) Forms For Reporting

4) Establishment Of Unit Profiles

C) UNIT HISTORIES

1) Engineering

2) Mold Loft and Numerical Control

3) Plate Shop

a) Burning

b) Panel Line

4) Structural

5) Shipfitting

6) Welding

7) Handling

8) Miscellaneous

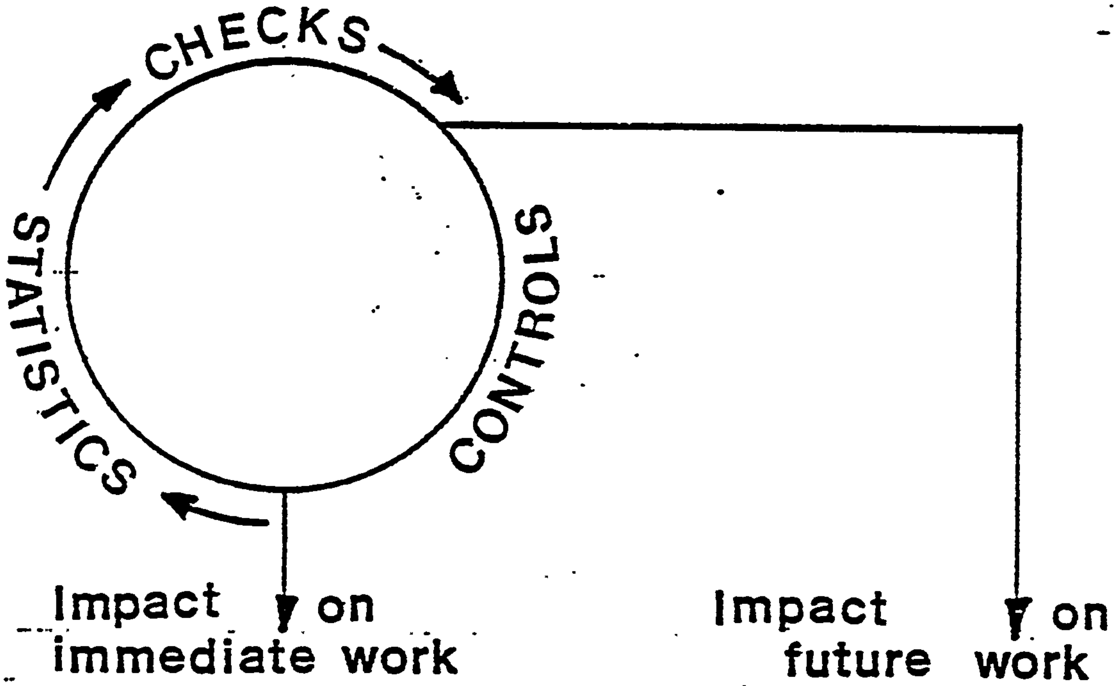

CHECKS
CONTROLS
STATISTICS
Impact on immediate work
Impact on future work

Fig. 1-1

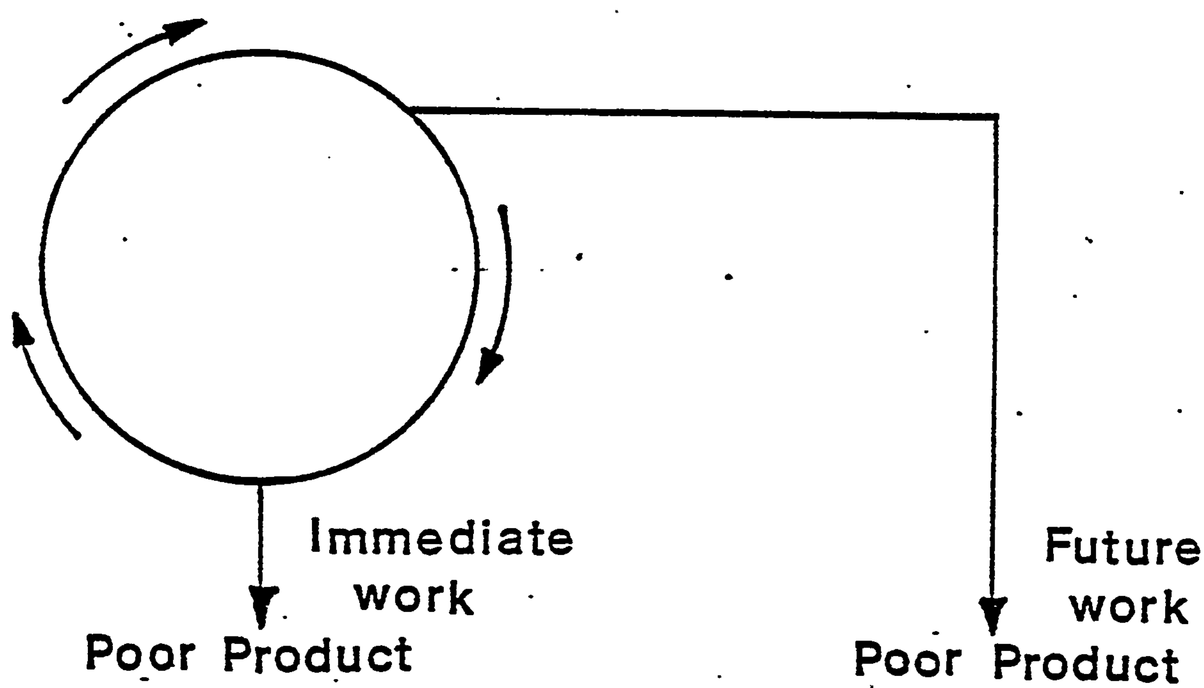

Immediate work
Poor Product
Future work
Poor Product

Fig. 1-2

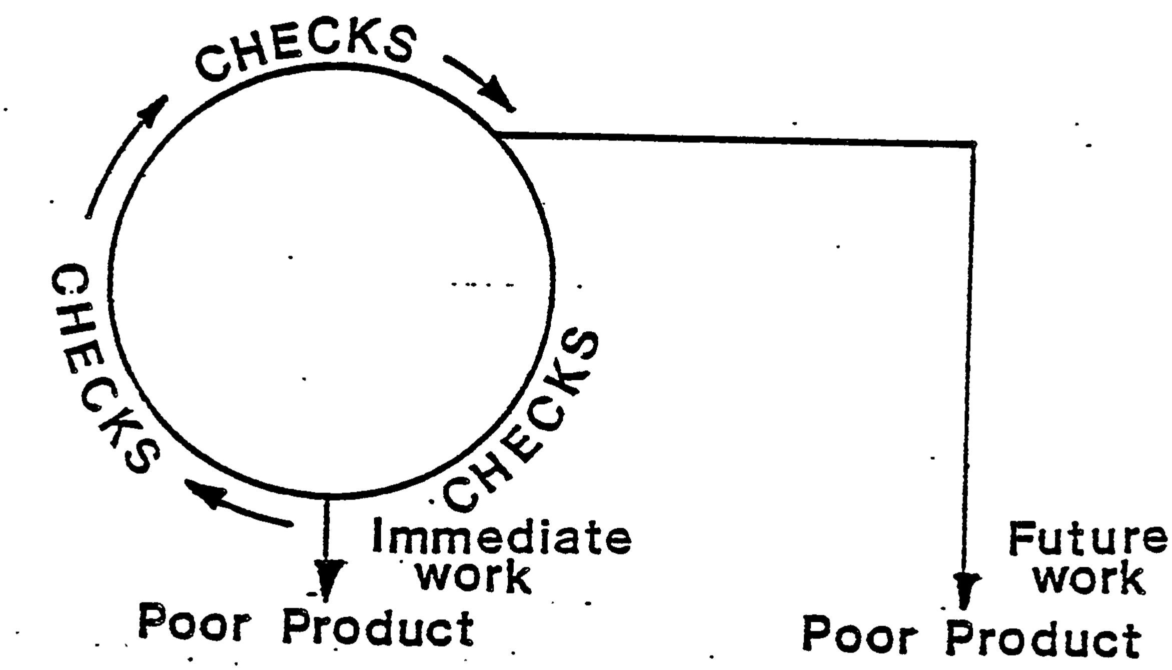

CHECKS
CHECKS
CHECKS
Immediate work
Poor Product
Future work
Poor Product

Fig. 1-3

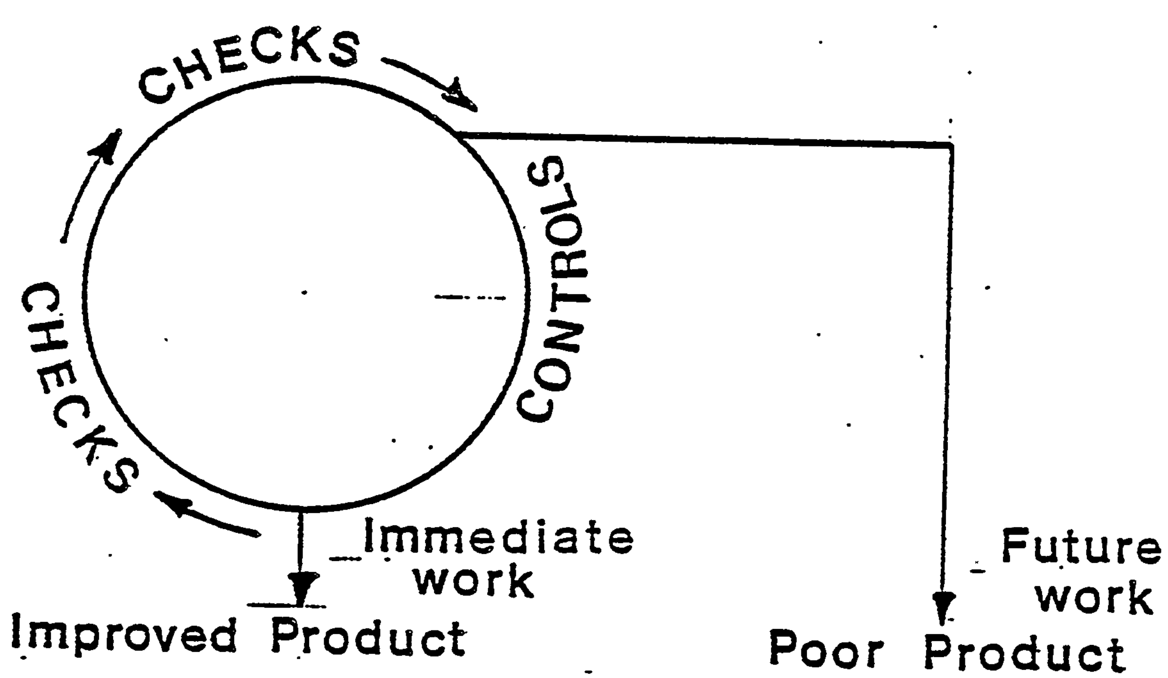

CHECKS
CHECKS
CONTROLS
Immediate work
Improved Product
Future work
Poor Product

Fig. 1-4

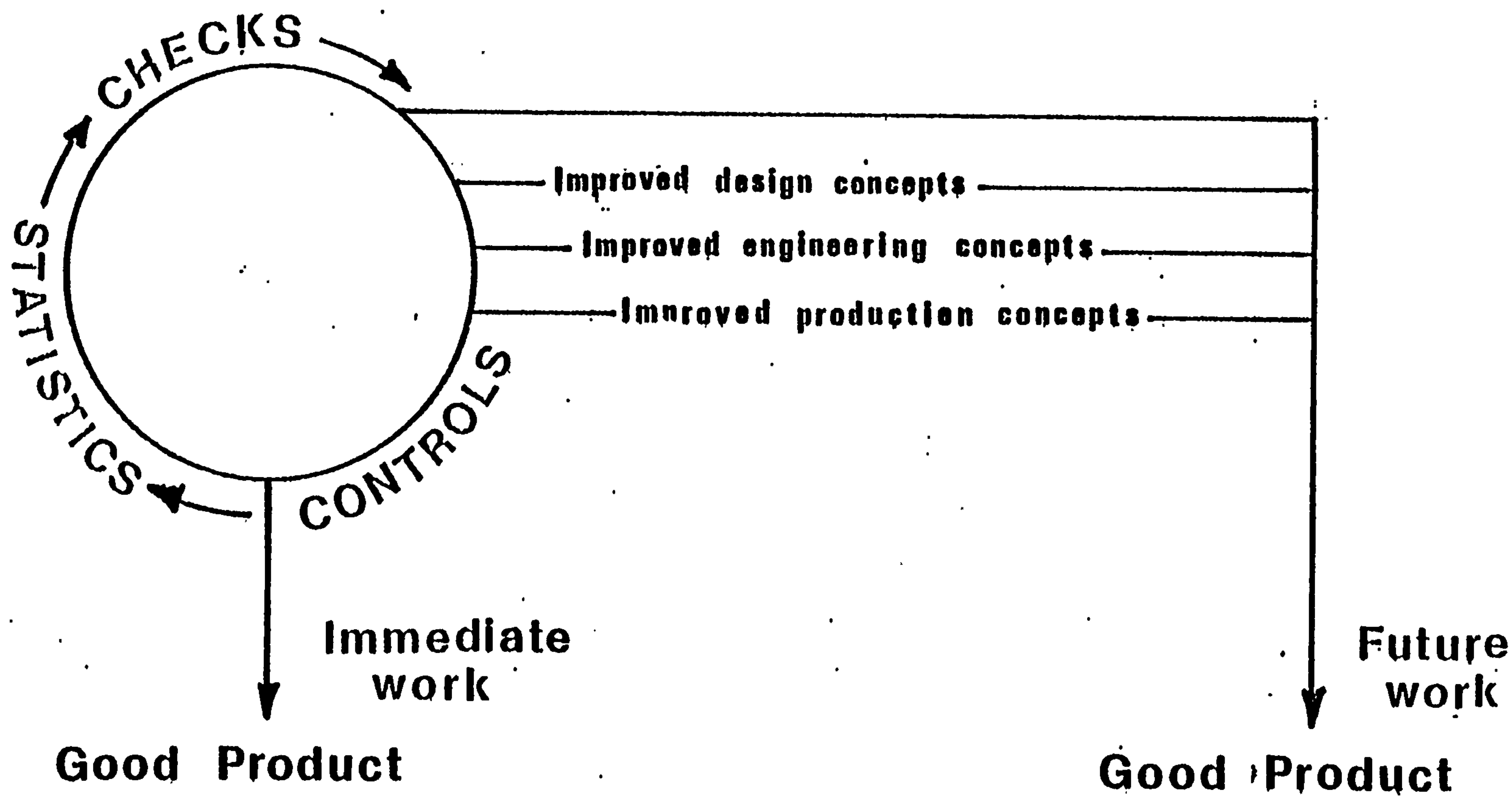

CHECKS
CONTROLS
STATISTICS
Improved design concepts
Improved engineering concepts
Imnroved production concepts
Immediate work
Good Product
Future work
Good Product

Fig. 1-5

2.0 Outline of Accuracy Control Activities

2.1 Controls

- A. Control Lines, Control Points and Backside Marking
- B. Burning Procedures
- C. Uniform Shrinkage Factors
- D. Construction Procedures
- E. Erection Procedures
- F. Contruction Aids

2.2 Checks

- A. Measuring Procedures
- B. Mathmatical Checking systems
- C. Forms for Reporting
- D. Establishment of Unit Profiles

2.3 Unit Histories

- A. Engineering
- B. Mold Loft and Numerical Control
- C. Plate Shop
  - 1. Burning
  - 2. Panel Line
- D. Structurals
- E. Shipfitting
- F. Welding
- G. Handling
- E. Miscellaneous

Fig 2-1

ACCURACY CONTROL AS AN INTERFACE OF PRODUCTION PLANNING AND SCHEDULING

AVONDALE SHIPYARDS, INC.

Prepared By: WALTER WEIDMAN

ACCURACY CONTROL AS AN INTERFACE OF PRODUCTION PLANNING

I. GENERAL

Although all activities of an Accuracy Control Program are interrelated to Production Planning and the effectiveness of such activities is positively correlated to the stage in the work process in which such activities are planned and implemented, in some areas of activities this interrelationship is much more pronounced. In the time available today, we will briefly explore some of these activities with an emphasis on the profound effect that they can have on an end product. The Accuracy Control Program at Avondale Shipyards was started early in the production of a contract to build three A.P.L. Container Ships and, to date, the activities of the department have been restricted largely to the A.P.L. Contract. All of the following have been developed while working on that contract. Three areas of activity have been selected to discuss at this time, not because they are necessarily of any greater importance than other activities but, rather, because they more graphically illustrate the advantages that can be derived from the functions of a well coordinated Accuracy Control Program.

Time does not permit a detailed analysis of these procedures. Today we will only attempt to touch on the highlights of the procedures and advantages to be secured from them with more extensive details deferred to later discussion.

II. CONSTRUCTION SEQUENCES

It is probable that the most immediate and most positive improvement that can be achieved in the work process is through the development and implementation of well conceived fitting and welding sequences. This is quite likely a valid assumption in that the complete lack of such established sequences can virtually negate all other improvements. Dozens of such construction sequences were ultimately developed for use on the A.P.L. Contract. A typical unit has been selected for minimal elaboration at this time.

Unit #7 is a fairly typical innerbottom unit such as is likely to be found on most ships of contemporary design (see Fig. 3-1). Three major areas of heat introduction, in the form of welding, present the potential for building in stresses or actually deforming this unit:

1. butt welds;

2. vertical welds, floors to girders;

3. welding of loose shell longitudinal.

Since this unit was built upside down and the tank top was delivered to the platen fully welded with all longitudinal stiffeners fitted and welded, it in no way contributed toward any deformation of the unit. The longitudinal girders were delivered to the platen with the floors immediately outboard already fitted and welded. This then necessitated fitting of all girders and attached floors to the tank top, the fitting o all floors to girders immediately inboard of them, the fitting of all loose shell longitudinal and the fitting of all shell plating to girders, floors, longitudinals and to the tank top.

Each of these areas of fitting presented a very distinct poten tial for deforming the unit. No formal construction sequence whatsoever was utilized in the building of Unit #7 of Hull 1. Figure (3-2) is a profile that was developed from that unit, shown to a scale of 1/8" - 1' - 0" athwartship and full scale vertically. A crown in excess of 5/8" developed on this unit. Other similar, but larger, units developed crowns up to 7/8".

Various attempts were made to minimize this deformation inclu- ding the building in of a reverse crown, but most of these efforts tended to be ineffective (see Fig. 3-3). Utilimately, a detailed construction sequence was developed and implemented (see Fig. 3-4).

This procedure isolated and controlled the three basic problem areas: butt welding of all shell plates, welding of all floors to girders, and welding of all loose shell longitudinals. The procedure in no way minimized the heat introduction but only permitted it to shrink the components in such a manner as to minimize the potential for deformation. The resulting unit on Hull 3 was virtually flat (see Fig. 3-5).

The deformation of such units as innerbottom Unit #7 resulted primarily from the introduction of heat, in the form of welding, at the shell plate side of the unit while the tank to of the unit was totally restrained by prior fitting and welding. This resulted in horizontal movement in excess of 5/16 of an inch on the shell plate side of the unit. Since th tank top side of the unit was restrained and not permitted to move, the crowning of the unit was the unavoidable result. This result is both predictable and calculatable as is shown o accompanying calculations which will be elaborated on in detai in later discussions.

The entire construction sequence was developed to permit a uniform movement of the components of the unit, thereby precluding the possibility of deformation.

III. CONTROL LINES, CONTROL POINTS AND BACKSIDE MARKING

Early in the production phase of the A.P.L. Contract, it became evident that accurately located control lines on a unit would be advantageous in both the building and erection of the units. Figure (3-6) shows the layout of control lines on a typical tank top unit. The buttock is used for setting the unit athwartship and the frame line is used for setting the unit longitudinally. For this procedure to be practical, these lines must be located with unvarying accuracy. To enhance the potential for a high degree of accuracy, future contracts will incorporate these lines into the Engineering Drawings and Panel Line Sketches that are used for building flats, decks, bulkheads, etc.

IV. CONSTRUCTION AIDS

Many tools may be developed to assist the Shipfitting Department in completing accurately built units, but perhaps the one of the greatest practical value is the erection joint tape batten. These battens indicate proper position of all structurals at erection joints. Where utilized properly and in conjunction with other procedures, it is possible to locate such structural within a tolerance of one quarter inch or less. This procedure has proven itself so effective on the A.P.L. Contract that on future contracts battens will be developed at all erection joints.

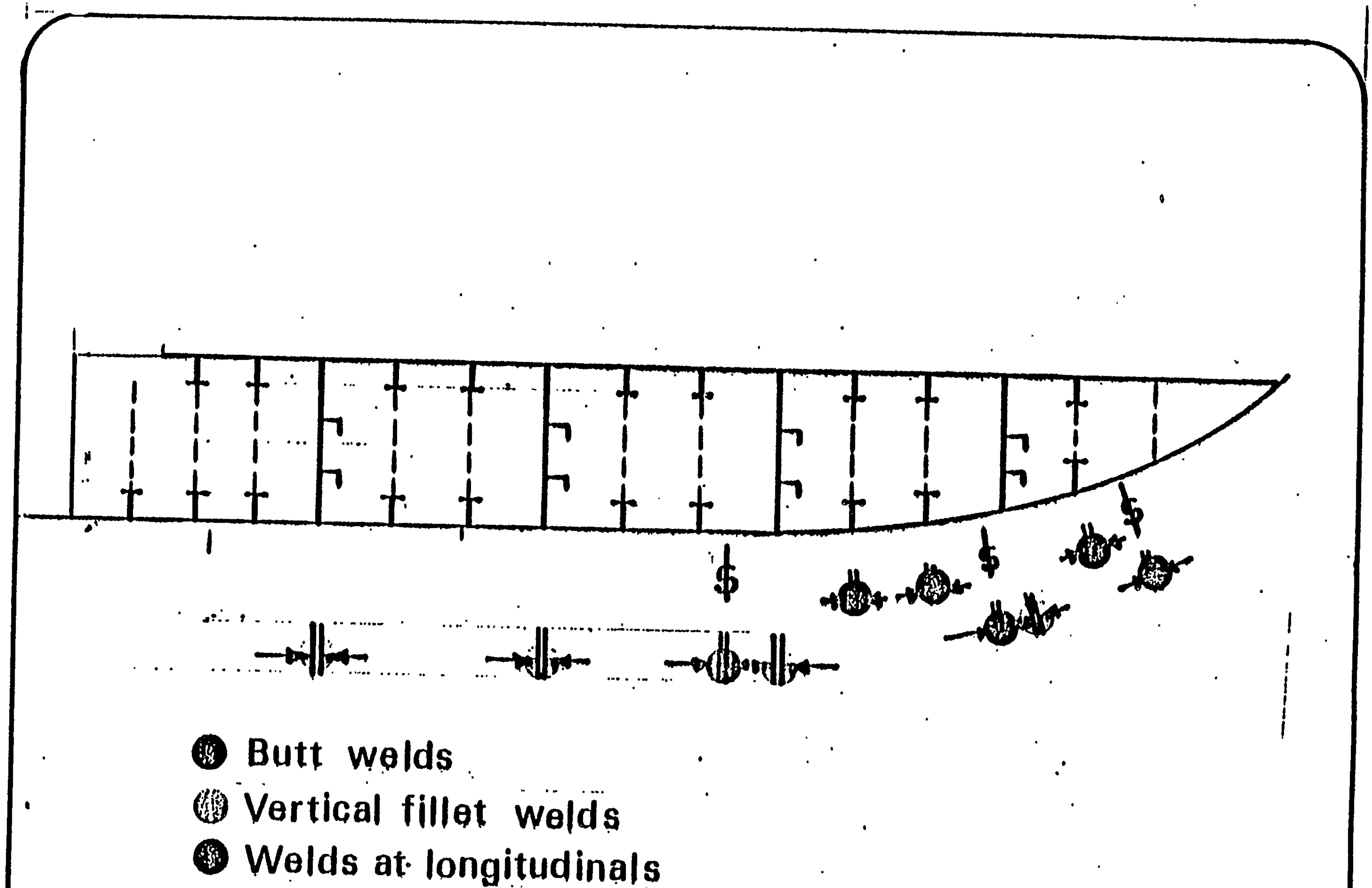


Fig. 3-1

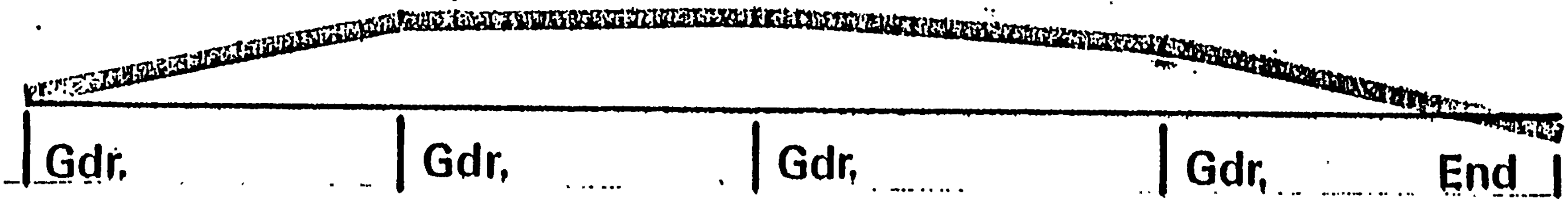


Fig. 3-2
Hull 1

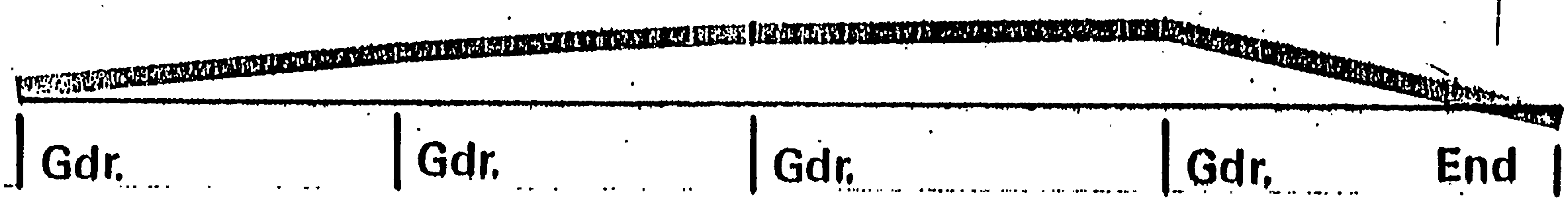


Fig. 3-3
Hull 2

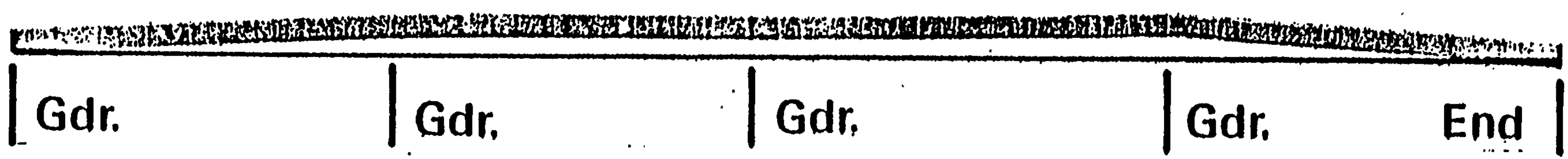


Fig. 3-4
Hull 3

Main Assembly Construction Sequence

1. Lay down tanks top panels on platen.
2. Hang girders to which floors have been previously fitted and welded.
3. Fit girders to talk top. (2′ -0″ fwd. and aft. of each frame should left free of tacks)
4. Level unit. (Tack to platen w/clips)
5. Fit floors to griders (Do not fit floors to tank top)
6. Weld all floors to griders, backsstepping four times.
7. Fit floors to tank top.
8. Flat weld all girders and floors to tank top.
9. Fit all stifeners, collars, brackets, clips, etc. at tank top.
10. Weld stiffeners, collars, etc., at tank top.
    Note: No piping to be installed prior to this stage of construction.
11. Hang and fit all loose shell longitudinals.
12. Weld clips or collars at shell longitudinals.
13. Hang and fit shell plate nearest to centerline of ship. (It this is a blanket, fit entire blanket, tacking to floors, girders and longitudinals)
14. Hang adjacent shell plate.
15. Weld shell plate butt.
16. Repeat procedure prescribed in item #14 for each of remaining shell plates up to extreme outboard plate.
17. Hang extreme outboard shell plate. If shell longitutials fall under this plate, fit as previously described. Otherwise fit shell plate to floors, utilizing weldinig clips. (Do not fit to floors) Do not fit to tank top at this time!
18. Weld last shell plate butt.
19. Fit shell plate to tank top.
20. Flat weld shell plate to tank top.
21. Turn unit right side up and finish fitting at shell.
22. Flat weld floors, girders and longitudinals and backgouge and weld butts
23. Check ends of all girders and longitudinals for proper alignment with adjacent units. Fair if necessary.

Fig 3-5

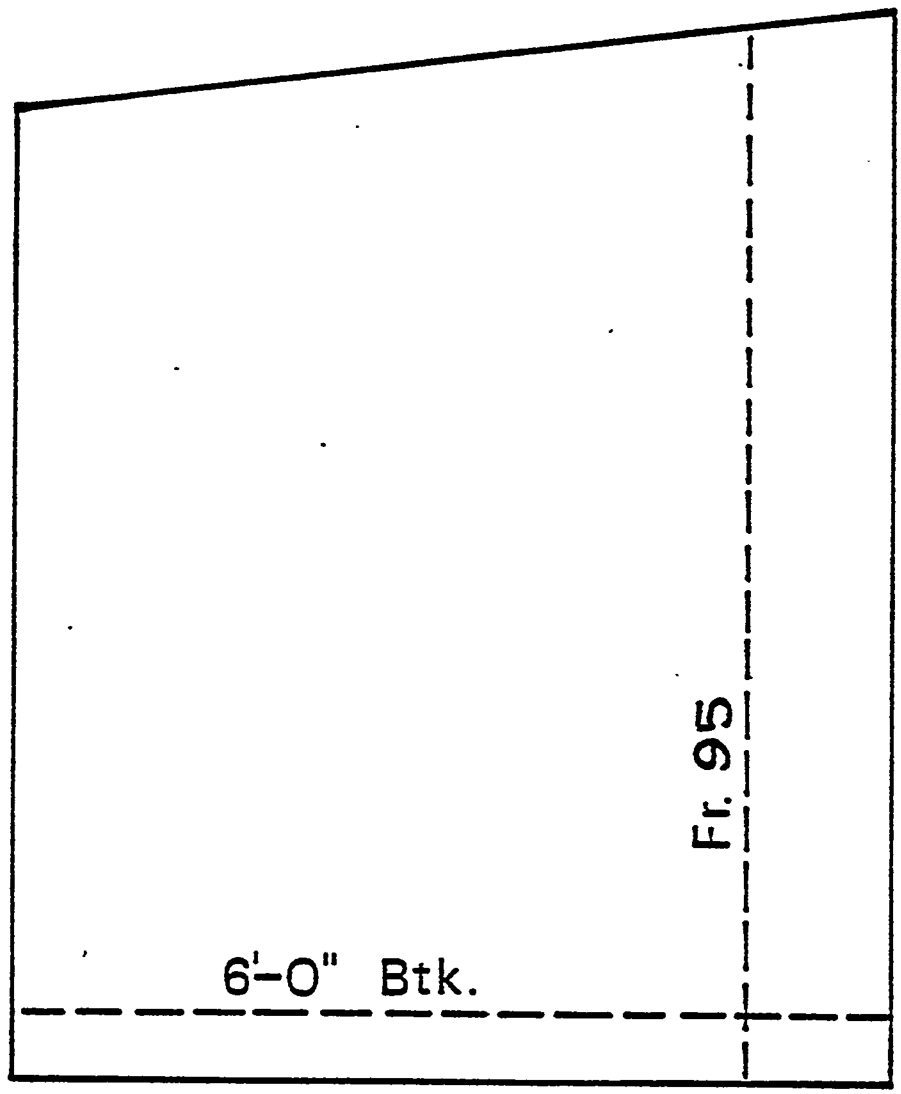


Fig. 3-6
Control lines on typical innerbottom unit

DISTORTIONS OF UNITS
PRODUCTION PLANNING AND SCHEDULING
AVONDALE SHIPYARDS, INC.

Prepared By: WALTER WEIDMAN

DISTORTIONS OF UNITS

For the simplicity of discussion, we analyzed the unit in the form of a simple beam (see Fig. 4-1 and 4-2). Using a standard W36 x 194 beam, we derived the following comparison: the distortion from welding can be compared to simple beam action when the beam is loaded with a uniformly distributed load.

From the AISC Handbook on simple beams with uniformly distributed loads:

$$\Delta_{max} = \frac{5wl^4}{84EI}$$

Where: Δ_{max} = maximum deflection in the vertical direction

w = load in kips/inch

l = length of the beam in inches

E = modulus of elasticity (30 x 106 PSI)

I = moment of inertia in inches to the fourth.

If w = .5 k/in and l = 480″ and I = 12,100 in^4 for a standard W36 x 194 shape, then:

$$\Delta_{max} = \frac{5(.5k/in)(1000\ lb/k)(480\ in)^4}{(384)(30 \times 10^6\ lb/in^2)(12,100\ in^4)}$$

$$\Delta_{max} = 0.9521\ in = 15/16''$$

We can easily measure the horizontal deflection, but the vertical deflection is more difficult to determine and is very important. To determine the vertical deflection that would occur as a result of the horizontal deflection, we need to derive some more formulas.

Horizontal deflection" Δ_H" caused by a force "P" can be described by the following formula:

$$\text{EQ.I} \quad \Delta_H = \frac{Pl}{AE}$$

Where: Δ_H = horizontal movement of the shell

P = the force in the shell

A = cross sectional area of the plate

l = length (varies with the size and amount of tack welds)

E = modulus of elasticity.

Since stress "σ" = P/A

then EQ. I becomes

EQII $\Delta_H = \sigma \frac{l}{E}$

but $\sigma = \frac{Mc}{I}$

Where: M = moment

c = distance to the neutral axis

so: EQIII $\Delta_H = \frac{Mcl}{EI}$ by substitution

Since $M = \frac{wl^2}{8}$

EQIV $\Delta_H = \frac{wl^3c}{8EI}$ also by substitution

To obtain the vertical deflection "Δ_V" in terms of the horizontal deflection "Δ_H," multiply both sides of the following equation:

$$\Delta_V = \Delta_{max} = \frac{5wl^4}{384\ EI}$$

By equation IV

$$(\Delta_V)\ \frac{wl^3c}{8EI} = \frac{5wl^4}{384\ EI}\ (\Delta_H)$$

$$\Delta_V = \Delta_H \frac{(0.104)l}{c}$$

To prove this equation we substituted the values we used in the Δ max equation into our equation IV.

$$\Delta_H = \frac{wl^3c}{8EI}$$

When: $w = .5k/in$

$c = 17.61$ in (steel handbook)

$1 = 480''$

$E = 30 \times 10^6$ PSI

$I = 12{,}100 \text{ in}^4$

$$\Delta_H = \frac{(.5k/in)(1000\ lb/k)(480\ in)^3(17.61\ in)}{8(30 \times 10^6\ lb/in^2)(12{,}100\ in^4)}$$

$$\Delta_H = 0.3353 \text{ inches}$$

$$\Delta_V = \Delta_H \frac{(0.104)l}{c}$$

$$\Delta_V = (0.3353\ in)\frac{0.104\ (480\ in)}{(17.61\ in)}$$

$$\Delta_V = 0.9505 \text{ in} = 15/16''$$

This compares with our earlier results of 15/16″ in the equation for Δ_{max}.

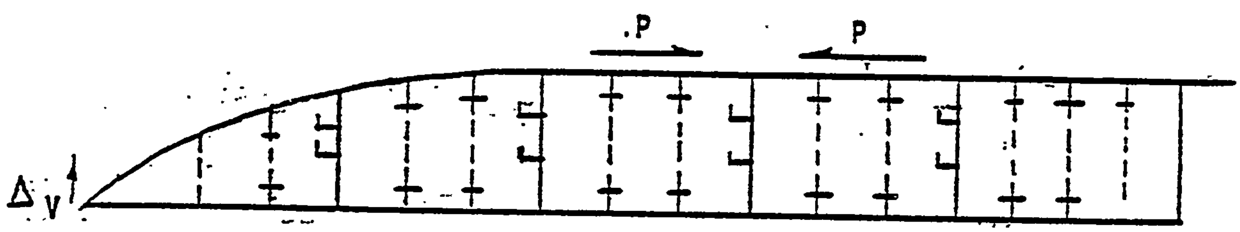


FIG. 4-1
TYPICAL INNERBOTTOM

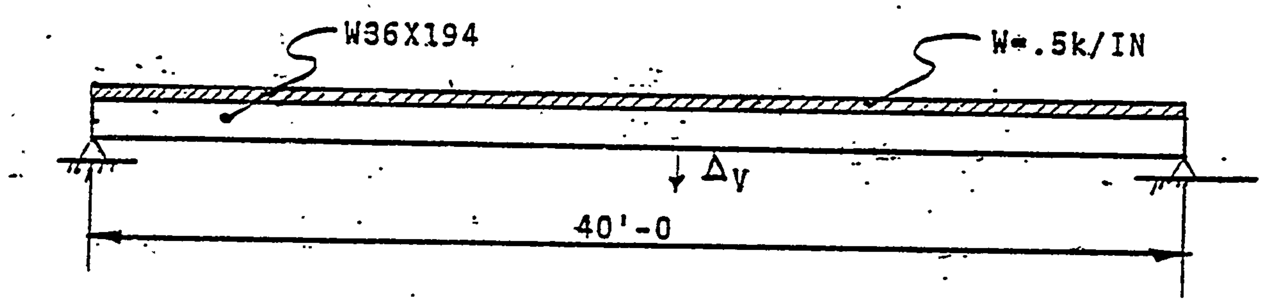


FIG. 4-2
SIMPLE BEAM

DETAILS OF OUTFIT PLANNING AND SCHEDULING

SEMINAR ON HULL SCHEDULING METHODS
AS OUTLINED BY PROCESS LANES PROCEDURES
AVONDALE SHIPYARDS, INC.

Prepared By: DOUGLAS SMITH

LONG TERM SCHEDULES

I. INTRODUCTION

The training began in October, 1981, with an indoctrination of the pinciples of process lanes as described in Phase I of the process lanes theory. Upon completion of the indoctrination, the training turned toward the development of long term schedules.

The schedules and the system of methods used to produce them is yet another spoke in the wheel that will be a total production system. The theory behind the schedules is very simple. They are based on the actual production efforts and the facilities used in the production effort. The next step was to apply this theory to the principles of process lanes applicable to Avondale Shipyards.

The goals set forth by the schedules are realistic because they are based on facilities available and a calculated period of time to accomplish each task required for proper and accurate completion of all units.

The first step is unit breakdown and categorization. Process lanes require the units of a vessel to be divided into categories based on their size, shape, weight and method of construction. Categorization of hull components is required primarily by the Production Planning Department and later by the shop planners. This will assist them in basic and detailed planning and scheduling and establishing material flow. Categorization also allows us to determine where partial sub-unit and subunits will be fabricated and help determine time required for construction. To accomplish this, the hull has been divided into six (6) basic types. They are as follows:

A) TYPE I - FLAT PANEL UNIT

These units are comprised of panel line components and assembled on a flat surface as the base of the unit; however, it is not limited to strictly panel line components. This flat surface can be a deck, innerbottom, bulkhead, and sometimes a flat shell plate. This category is comprised of relatively simple units with short construction time required. Weight would be approximately 140 tons. About 50% of total hull weight falls in this category. (Graph No. HLS-1)

B) TYPE II - CURVED SHELL UNITS

These units are assembled on curved shell, knuckled longi dinal bulkhead, or innerbottoms in a fixed jig or a pin jig. Such units would be outboard with tanks or outboard sections of shell plate for engine room flats and fore peak. Weight is 75 tons. (Graph No. HLS-2)

C) TYPE III - SUPERSTRUCTURE TYPE UNIT

These are usually built on a deck or engine room flat as base of the unit. These units stay in main assembly for longer periods of time due to the large amounts of pre-outfitting in this area of the ship. (Graph No. HLS-3)

D) TYPE IV - LARGE AND HEAVY MODULAR UNITS

These units are large and very heavy with a long assembly and outfitting period. They require much piece-meal and close tolerance fitting, such as fore peak with bow thrus and bulb, aft peak with rudder post and stern frame castings, and engine room double bottom with main engine foundation. (Graph No. HLS-4)

E) TYPE V - MACHINERY SPACE DOUBLE BOTTOM

These units are usually built with tank tops as the base the unit, and they require a long period of time of main assembly. Pre-outfitting requires more time in this area the ship (due to enormous amounts of pipe). Shell platin is usually piece-mealed, requiring more time for fitting welding. (Graph No. HLS-5)

F) TYPE VI - SPECIAL WELDMENTS

These are specialty units, such as rudders, skegs, anchor pockets, bilge keels, Coamings, box girders, and bulwarks. (Graph No. HLS-6)

II. ISOMETRIC UNIT ARRANGEMENT (GRAPH NOS. HLS-7, HLS-8, HLS-9, HLS-10

After all units have been placed in the final category list, building locations have been determined, the breakdown of unit starts. Each unit is divided into the following categories:

- Sub-Assembly;
- Partial Sub-Assembly;
- Panel Line;
- Items that are piece-meal, such as Shell Plate and Structural Members;
- Final Erection Items, such as Trunks, Brackets, and Web Frame Stubs.

The category of unit determines the building location of components, and schedules for each work center determine critical points at each assembly area.

III. RECAP SHEETS

Using key plans and unit arrangement drawings, we group all like units in the same categories. We then put all like units into stages of construction such as grand assembly, main assembly, and sub-assembly. We then use the key plans to attain welding lengths, fitting lengths, and size of each unit. Once the above steps are taken, you have to look at the units and determine how many men you can put on one (1) section and work efficiently. From the formula we determine the number of assembly days for both welding and fitting. Once the fitting and welding assembly days are known, the outfitting time needed at each stage of construction is obtained from the Outfitting Section of Production Planning. Knowing the capacity of our shot house, we also incorporate the days needed for blasting and painting of each unit. Operation Services furnishes us with the weight of the units, which is added to the recap sheet. We then take the total welding lengths and divide them by the total manhours to come up with the efficiency of manhours per foot. With the completion of the category recap sheet, we have established the following information:

the number of units by type per category,

total weight of units per category,

- total welding length of units per category,
- total manhours of units per category,
- efficiency of units per category.

IV. ASSEMBLY PLATFORM LAYOUTS

I would like to explain to you how our Assembly Platform 20 laid out and the unit assembly flow associated with it.

A) PLATEN NO. 20 - CATEGORY 1 UNITS

The Assembly Platform is designed primarily for the produc tion of flat panel units. The production effort on it is divided into four stages.

1) First Sub-Assembly

At this stage, most typically two or three web frames the floors and girder are fitted and welded to the bas panel of the unit which was produced at the panel line The area has been divided into a gridwork of twelve (1: unit platforms that are 48' x 52'. It is recommended that each grid be clearly distinguished by flat bars colored with paint. They are known by the name S1, S2, S3, etc. Upon completion of the work at the sub-assem stage, the units are moved to the pre-outfitting stage

2) Pre-Outfitting

Outfitting work is accomplished in this-area while the unit is open. It also reduces substantially high posi tion work and, thus, increases efficiency. There is a gridwork of eight (8) platforms, which also should be clearly identified. Upon completion of outfitting, th sub-units are sent to the main assembly stage. The exceptions would be centerline main decks and similar type units which are finished at this stage.

3) Main Assembly Stage

Here, sub-units are combined to make cubic units. Thi is where scaffolding work, as necessary, is accomp- lished. A total of six (6) platforms have been dedica for use by this stage. Upon completion, the unit will sent to the final assembly stage.

4) Final Assembly Stage

Most typically, the connection work of outfitting, inspection, and weld completion is accomplished it this stage. Upon completion, the unit is sent to blast and paint. (Graph - Platen 20 Lay Out)

V. LONG TERM ASSEMBLY SCHEDULE DEVELOPMENT

Following is an explanation of the development method of long term assembly schedules.

The following documents are required:

- Master Yard Schedule
- Erection Schedule
- Key Plan
- Unit Recap Sheets
- Unit Arrangement
- Platform Arrangements

First of all, the date that each unit is in its last day of construction is determined by the erection schedule and considering outfitting time and blast and paint time. This date for each unit is then transferred to the appropriate assembly stage chart. Using Category 1 as an example, the grand assembly schedule, which is the last assembly stage for Category 1, is the first schedule for which these critical "dates are determined. When all the dates for each unit that goes to grand assembly are transferred to that chart, the first schedule can be prepared. The units are then level loaded, considering the information in the unit recap sheets and the platform arrangement appropriate to the grand assembly construction stage.

After the grand assembly schedule is completed, ensuing schedules - final assembly, main assembly, pre-outfitting, and sub-assembly and panel line - are made, each one depending upon the critical dates established by the previous construction stage schedule.

Then, from the panel line schedule forward in time, we refined loading and dates to insure critical dates are not in conflict and that work areas are not overloaded, adjusting the panel line schedule so as to accommodate the refinement of the various schedules.

An important point in accomplishing level loading is keeping mind the capacities of work areas at each stage and backing in time, where necessary, to meet critical dates without ove loading those work capacities. Also important to level load is the grouping and loading of similar work groups together. When the work is arranged in this manner, because the work groups are similar, the construction time periods are similar These two points, capacities and similar construction periods permit the smooth flow of material and the improvement in co struction efficiencies. This is the principle of not mixing Pintos and Continentals on the same conveyor line or process lane.

As these same scheduling principles are applied to each indiv dual category, the resulting sum is a level loaded construct schedule for the duration of the contract.

Bear in mind that these schedules are not meant to be an abso lute final product. They are long term assembly schedules ar will be continually updated and refined as efficiencies chang and as new contracts are taken into account. They are per- fectly adequate at this stage for preparation of Unit Control manuals, templates and for the scheduling of purchasing mater ials.

Planning for a process lanes system should provide realistic schedules at each stage of construction, resulting in a smoot and even flow of materials required for each subsequent stage of construction, against which can be measured the efficiency of that particular stage. Without a level loaded and realist schedule, efficiency or cost can never be accurately predicte or controlled.

VI. LONG TERM FABRICATION SCHEDULE

As explained earlier, we have studied and decided which plate would be best suited to support each stage of construction using the process lane theory. I've explained our assembly platen for Category 1 units. Now, I'll briefly cover our fabrication platen for Category 1 units. In this case we mus use the sub-assembly schedule from Platen No. 20 so that the partial sub-assemblies can be completed before the critical dates needed on Platen No. 20. The platen choosen was divide into two (2) fabrication lines:

- Line 1 - Longitudinal bulkhead webs, side shell webs, transverse bulkhead, and horizontal girders.

- Line 2 - Floors, girders, and small pieces.

We have dedicated each of our platens for support of specific categories. Our main objective is to have the same people perform the same work at the same location.

VII. LONG TERM BENDING SCHEDULE

To insure proper material flow to develop detailed shop schedules from raw materials to a finished product, there are certain factors required at each work center.

For bending schedules, the factors are:

- Need Dates: Using sub-assembly schedules and main assembly schedules, you determine the date material is needed.
- Total number of plates and structural that require bending: Using shell expansion drawings and Mold Loft bending criteria, plates are classified as to the bending process.
- Total number of plates and structural that require line heating: Using shell expansion drawings, Mold Loft bending criteria.
- Total number of plates & structural that require forming: Using shell expansion drawings, Mold Loft bending criteria and need dates for forming jigs.
- Length and thickness of plates: To determine work center or alternate work centers.
- Capacity of rolls and frame bender: Largest-smallest T.
- Production out-put at each work center: Capacity of rolling, frame bender, line heating and press.

VIII PRE-FABRICATION SCHEDULE

The pre-fabrication schedule should be made for each type cutting machine or work area, such as structural and flat ba pre-fabrication area.

Therefore, in preparing the pre-fabrication schedule, the following should be included:

- Exactograph - for straight skin plates
- N.C. (3 axis) - for curved shell plates and internal plate
- N.C. (2 axis) - for internal plates
- Servograph - for small pieces
- Shearing - for small pieces
- Structural Cutting Area
- Flat Bar Cutting Area

The pre-fabrication schedules are made up from three schedule - the panel line schedules, fabrication schedule, and the bending schedule.

We used these three schedules and back off the correct amount of days it will take for cutting, marking, punching, and stacking of material for the next stage.

Example:

- The skin plates are taken off the panel line schedule and cut on the exactograph machine, where we will allow two da for cutting and five days in the work queue where we assemble all plates and check to make sure all plates are there and ready to go to the panel line.
- The longitudinal are taken off the panel line schedule, where we allow five days for cutting, marking, punching an five days in work queue and then send to panel line where they are fabricated.
- The internals are taken off the fabrication schedule for t N.C. (2 axis) burning machine. We allow five days for cutting and five days in a work queue and send to Platen No 16 for fabrication.

- The curved shells and structural are taken off the bending schedule for the N.C. (3 axis) burning machine. We allow five days for cutting and five days in the work queue, then send to, the bending roller and/or line heating, and the frame bender for structural.

There are some cases where we will not be level loaded. For example, on superstructure units, the plates will not go to the panel line. The material will be sent to Platen No. 10 to be assembled, but we will make adjustments on our monthly schedule to level load the exactograph. (Graph - Examples of Pre-Fab Schedules)

IX. SCHEDULING MECHANISM AND NETWORK (GRAPH NO. HLS-11)

The next topic of discussion deals with our scheduling mechanism and network and how each stage schedule is retained, using a longitudinal bulkhead Category 1 chart as an example.

The first thing we do is break down all units into sub-units. These longitudinal bulkhead units are broken down into three sub-units which consist of:

- Longitudinal Bulkhead
- Transverse Bulkhead
- Upper Deck

After we have the unit broken down into these three sub-units, we then take each individual sub-unit and break it down into into pieces. For example:

A) LONGITUDINAL BULKHEAD, which is a sub-unit that consists of:

1) Skin for Longitudinal Bulkhead

2) Longitudinal for Longitudinal Bulkhead

3) Internal Members, such as Web Frames

B) TRANSVERSE BULKHEAD is a sub-unit that consists of:

1) Skin of Transverse Bulkhead

2) Longitudinal for Transverse Bulkhead

3) Internal Members, such as Horizontal Girders

C) UPPER DECK, which consists of:

1) Skin Plate for Upper Deck

2) Longitudinal and Headers for Upper Deck

After we have each sub-unit broken down, we then schedule ea individual piece. The reason for scheduling each individual piece at a certain time is to allow a constant flow of mater through each stage, so that each piece can meet at the prope stage at the proper time where they can be fabricated and become a sub-unit and, finally, a unit.

You will notice on the scheduling and mechanism and netw chart everything is keyed on the erection date. The unit ha to be complete prior to that date; from there, we have the final outfitting stage. In this stage, all work on the unit must be completed prior to the erection. We allow five days this stage. Prior to outfitting is grand assembly, where we install the brackets and the trunk to the longitudinal bulk-head. We allow two days. Prior to grand assembly is blast paint, where the unit is sent through the shot blast and painted. Prior to blast and paint is the final assembly sta where all the welding, fitting, and outfitting of all the pr ious stages are to be completed so the unit can be inspected and accepted prior to blast and paint. We allow seven days this operation. Prior to final assembly is the main assembl stage where we join the upper deck to the longitudinal bulkh and transverse bulkhead. We allow five days at this stage. Prior to main assembly is the pre-outfitting stage where we outfit the sub-units with piping, ladders, etc. Prior to th pre-outfitting stage is sub-assembly stage where we join the transverse bulkhead to the longitudinal bulkhead. You will notice on the scheduling mechanism and network chart that th longitudinal bulkhead and transverse bulkhead are made up of the same three pieces and are scheduled exactly alike, but y will also notice the transverse bulkhead is scheduled one we prior to starting the longitudinal bulkhead. The reason for this is so the transverse bulkhead will be complete the same week that the longitudinal bulkhead starts sub-assembly, whe they can be joined together.

You will also notice that the upper deck starts approximatel five weeks after the transverse bulkhead, the reason being tl upper deck does not have to go through the sub-assembly step. It will meet the transverse bulkhead and the longitudinal bu head at the main assembly stage where both will become a unit

In pre-fabrication, prior to sub-assembly, on the longitudinal bulkhead and transverse bulkhead is the panel line where we install the stiffeners to the skin plates. We allow four days on all panels to be fabricated at the panel line.

Prior to the panel line is a work queue area for the skin plates and longitudinal. We allow five days to make sure all material is available for the panel line. On the internals we allow ten days. On skin plates, prior to the work queue, is the pre-fabrication where the skin plates are cut on the exactograph. We allow two days for cutting.

On longitudinal we allow five days for punching, marking, and cutting. Prior to the work queue on the internals, we have fabrication where we fabricate the girders and web frames. We allow ten days. Prior to fabrication on internals, we have another work queue which we schedule for five days to gather all material for fabrication. Prior to the work queue-is pre-fabrication for the internals where the cutting is done.

You will notice at the bottom of the scheduling mechanism and network chart it will take sixty-six days to complete one longitudinal bulkhead Category 1 unit.

Now you understand why the UCM books are separated by sub-units and also the sub-unit divided into three parts (skin plates, longitudinal, and internal members), due to the different pre-fabrication start dates.

X. MONTHLY PRODUCTION VOLUME

The schedules shown to you here today were developed, based on the current Master Yard Schedule and the Erection Schedule.

As a result of these schedules, a Master Yard Schedule II was devised containing additional information. I would now like to explain the information contained in it.

- The shipbuilding program is indicated showing:

    Keel Laying Date

    Launch Date

    Delivery Date

- The monthly assembly and erection weight is also indicated.

- The accumulative erection and assembly weight curves are shown. The assembly weight is also inscribed by use of a bar graph.

The assembly weights were calculated from the completion of main assembly. There is also some difference in monthly weig due to the fact that some months contain five weeks.

Based on this schedule, we can expect monthly assembly weight of 3,500 tons from November, 1982 to April, 1983. We can als see that new contracts are required from June or July, 1983; that is, if we want to keep a 3,500 ton per month production system. This particular chart was made after completion of t long term schedules. Essentially, this is the basic schedule from which all other schedules are derived, because it is bas on the production policy decided on by top shipyard managemen

In addition, this chart is also valuable for the following functions:

- Marketing: Indicates when new construction contracts are required and how much volume is necessary.
- Material: Roughly, when and how much material should arrive in the shipyard.
- Engineering: How many and at what time drawings should be accomplished.

XI. EFFICIENCY CONTROL

The work volume of each stage of operation has an efficiency based in terms of feet per hour or manhours per ton. This ba is determined by past production history of the most efficien numbers of men to perform an operation and the time required days to complete an operation. This equates to a standard wo day for each stage, which gives the-base for monitoring and controlling efficiency.

We see that each stage of construction is considered in such detail that it provides the production operation with weights welding lengths, and manhours required for each stage of oper tion and, when combined, shows total hull progress and effi- ciency.

In the process of monitoring progress and controlling efficiency, each production stage must be controlled. It is important to note that in planning stage development, the planning stages are inter-rrelated. and that each stage is developed to compliment critical dates for the previous stage, thus indicating criteria for level loading each production stage.

The information that was presented here today is a concrete method of developing long term schedules and their mechanisms. I would now like to address the function or purpose of each type of schedule.

First of all, there are basically three types of schedules:

- The Master Yard Schedule
- Long Term Schedule
- Short Term Schedule (such as monthly schedules)

A) THE MASTER YARD SCHEDULE

The Master Yard Schedule is the long term scheme of the assembly based on the ship construction program.

For example - the usage of the building ways, drydock, etc. and the hull construction work schedule. The Master Schedule not only sets forth the assembly stage operation, but also the shipyard operation policy. Therefore, this schedule is fundamental in establishing each production stage schedule in the shipyard. The following items are indicated on the Master Yard Schedule.

1) Ship construction program for each contracted vessel:

   a) Keel Laying

   b) Launching

   c) Delivery

2) Erection and assembly weight per month.

3) Accumulative erection and assembly weight curves by vessel.

The function of the Master Yard Schedule is to give management the following:

an understanding of the necessary manhours and require assembly area,

ability to make adjustments to the assembly platform capabilities,

ability to adjust manpower to suit hull construction schedules.

B) LONG TERM ASSEMBLY

Assembly platforms are being specialized to correspond w the unit categorization. For example:

1) The Fabrication Platform

a) Specialized platforms for common partial sub-units.

b) Specialized platforms for non-common partial sub-un

c) Special weldment platform.

2) The Assembly Platform

a) Specialized platforms for flat panel units.

b) Curved shell units.

c) Three dimensional units.

d) Superstructure.

The long term assembly scheme is made for each specialize platform based on its usage which was dictated by unit categorization and the category recap sheets.

The purpose or function of the long term assembly schedul is as follows:

Smooth relationship between prior and subsequent produc tion stages. It is very important that the relationsh that fabrication, for example, has with pre-fabricatio and assembly be as smooth as possible.

- Level load the work volume at each assembly stage. The work volume for units, sub-units, partial sub-units and pieces should be established at this time. The necessary number of manhours can then be calculated. The work centers are level loaded, based on the standard work day found on the category recap sheet.

- Make adjustments to the manhour scheme calculated for the purchasing of steel material and arrival designations.

c) <u>SHORT TERM SCHEDULE (MONTHLY - WEEKLY)</u>

The production activities are accomplished based upon the long term schedules. The short term schedules are issued on a regular basis considering the following points:

- gives an understanding of the work progress status for prior and subsequent stages,

  indicates exceptions to normal routine working methods of items.

With the long term schedules now established, each shop planner can then prepare a short term schedule based on the capacities of each machine and work area.

The objectives of the shop planner and short term schedules are:

1) <u>Material Control</u>

   a) Preparation of necessary material.

   b) To know previous stage, conditions, or status.

2) <u>Process Control</u>

   a) To maintain schedule by knowing

      - status of material,
      - status of units,
      - scheme of manning flow,
      - scheme of platforms flow.

3) <u>Accuracy, Safety, and Manufacturing Method Control</u>

   a) Strive to achieve an accurate unit.

   b) Reduce cost with safety.

4) Efficiency Control - Control Chart

a) Collect data from work centers to control volume da collected is:

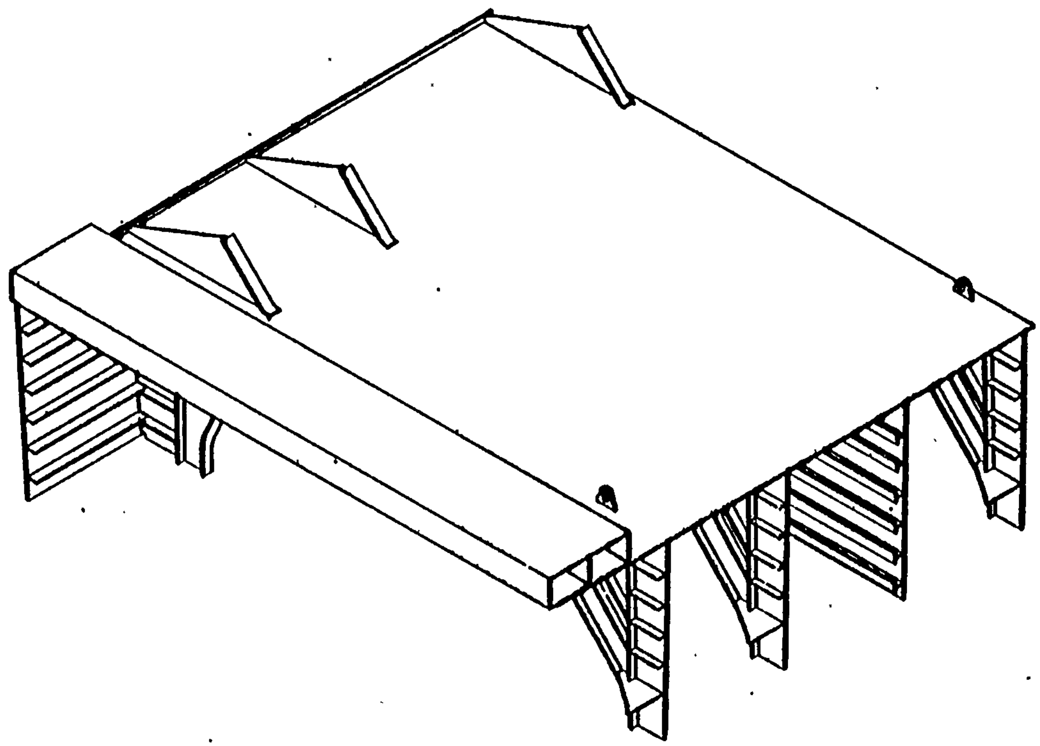
- weight,
- welding/fitting lengths,
- consumed manhours.

Proper loading and use of these schedules should provide steady flow of material and a constant-work load through shipyard.

XII. CONCLUSION

Process lanes is no more than an orderly and timely method o doing our work. It was no easy task to change the thinking minds of the old time shipbuilders. With the implementation the process lane system, we here at Avondale are committed t the goal of being more competitive in the shipbuilding indus

SEQUENCE NO. 14 A
CATEGORY NO.1 UNIT
TYP INBD LONG'L BHD WING TANK
TRANSPORT POSITION

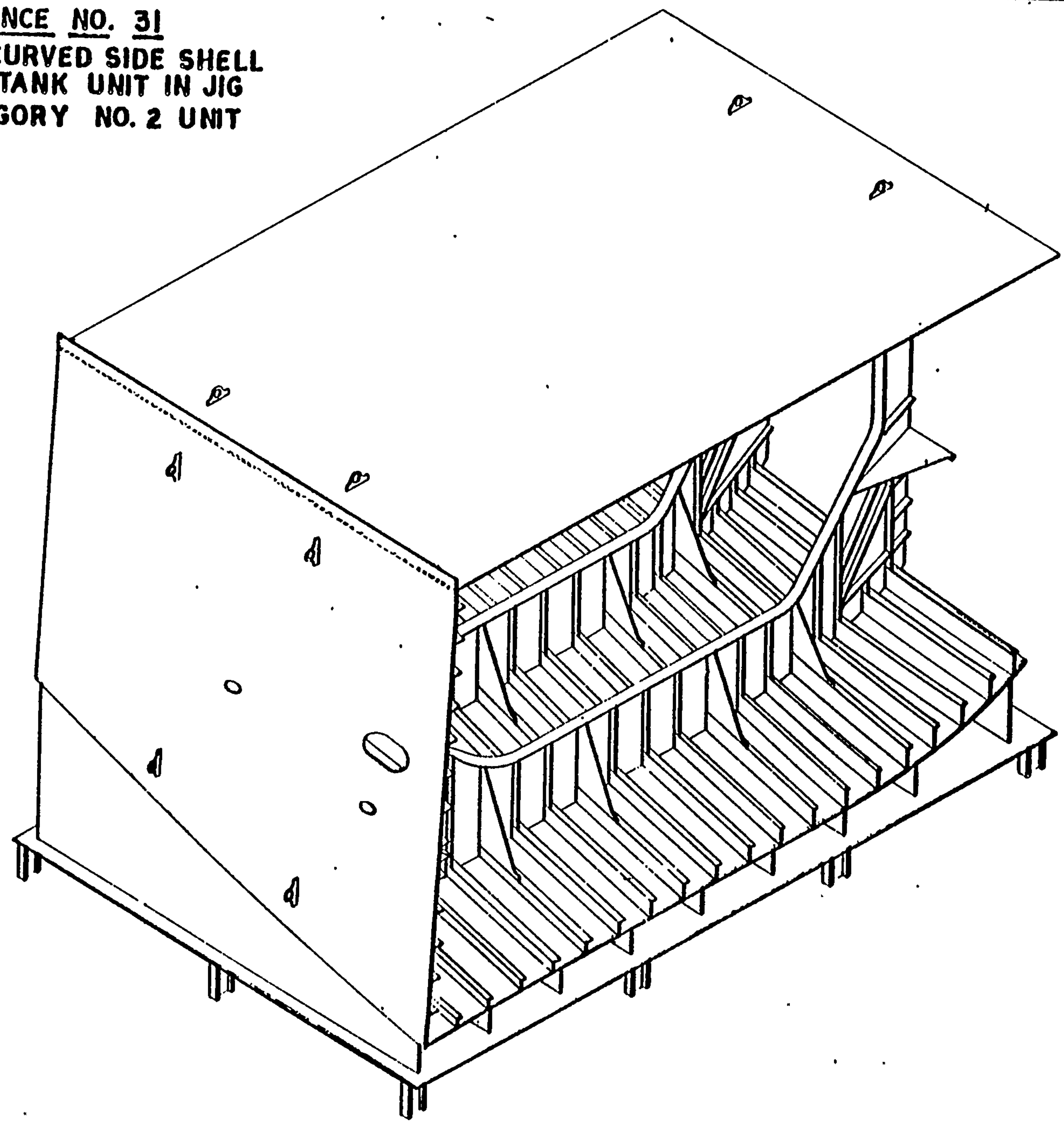


OPERATION SERVICES

GRAPH NO. HLS-1

SEQUENCE NO. 31

TYP CURVED SIDE SHELL
WING TANK UNIT IN JIG
CATEGORY NO. 2 UNIT

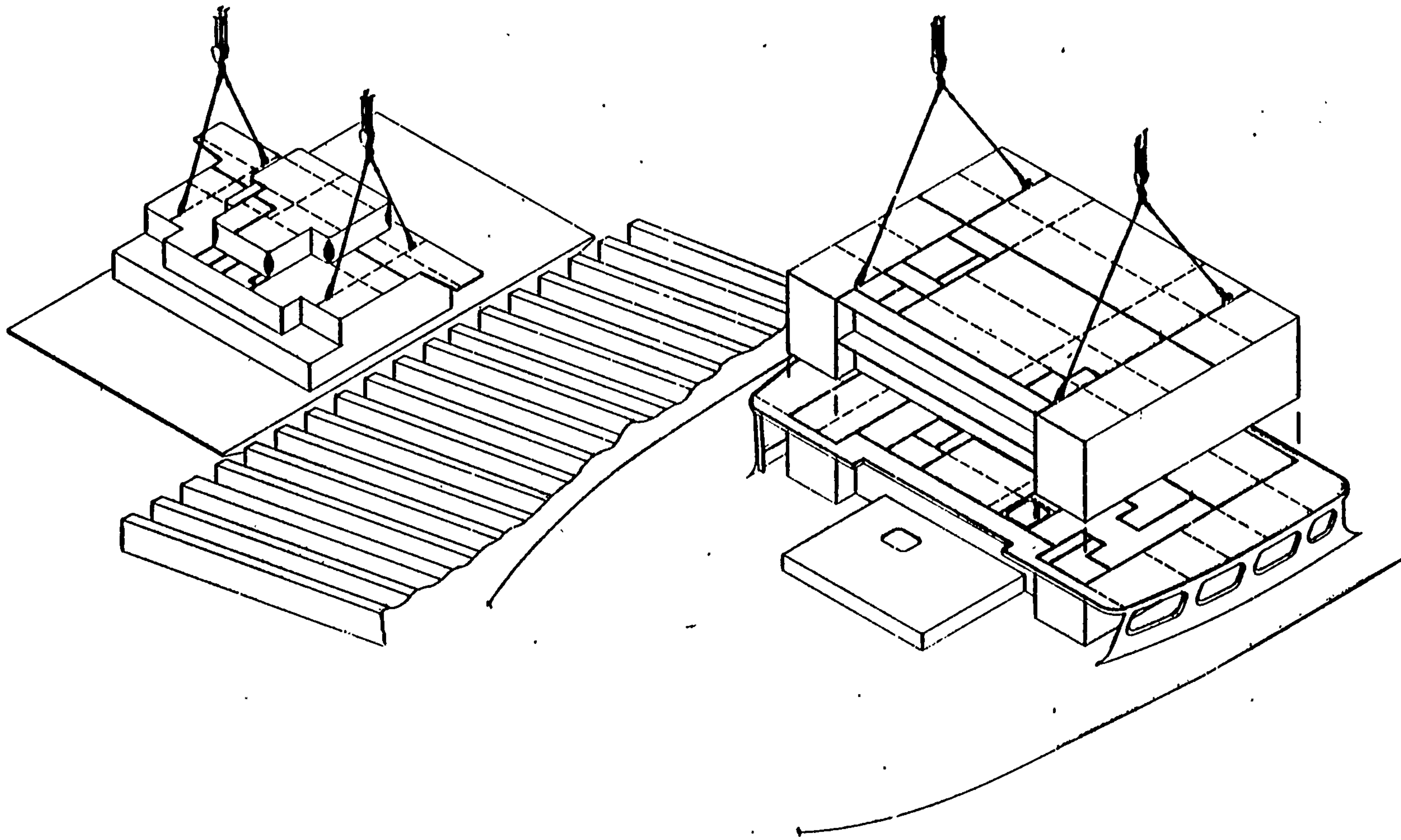


OPERATION SERVICE

SEQUENCE NO. 32

CATEGORY NO. 3 UNIT

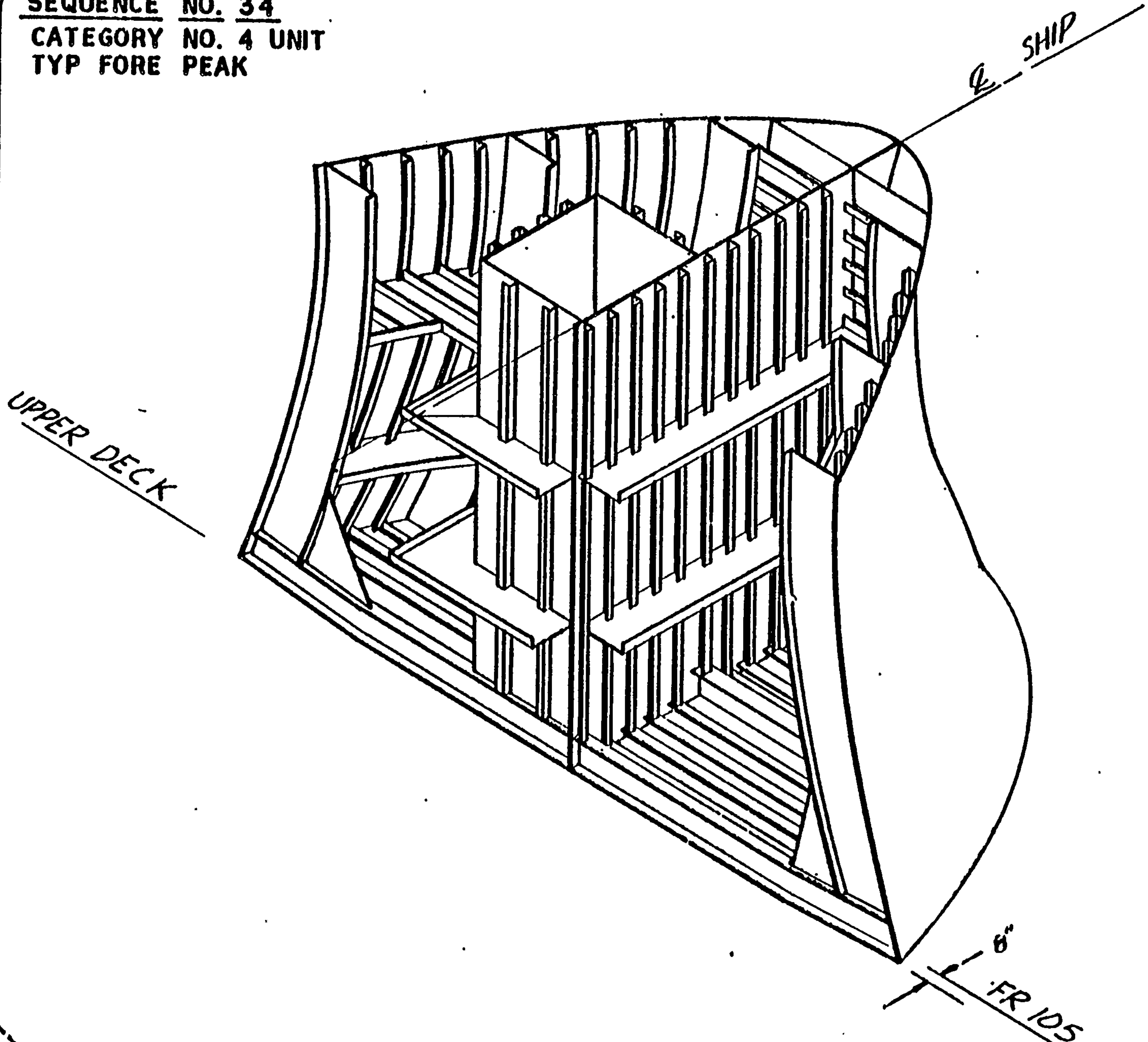
COMPLETED SUPERSTRUCTURE



OPERATION SERVICES

GRAPH NO. HLS-3

SEQUENCE NO. 34
CATEGORY NO. 4 UNIT
TYP FORE PEAK

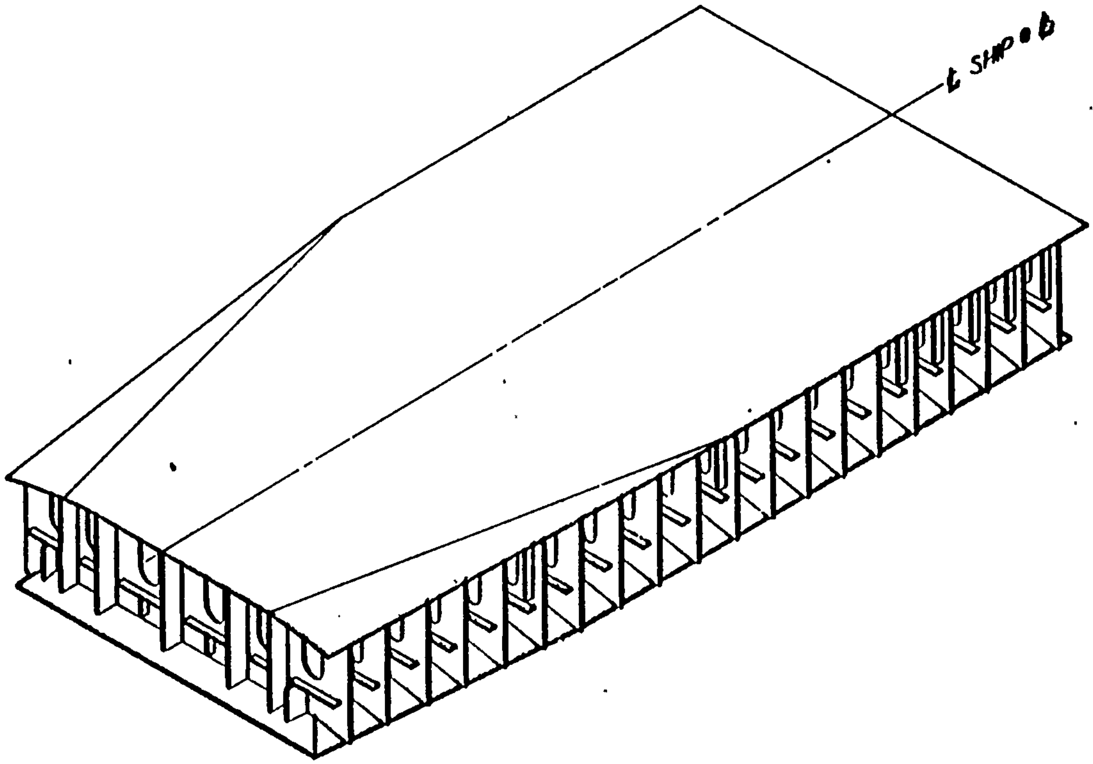


OPERATION SERVICE

SEQUENCE NO. 35

CATEGORY NO. 5 UNIT

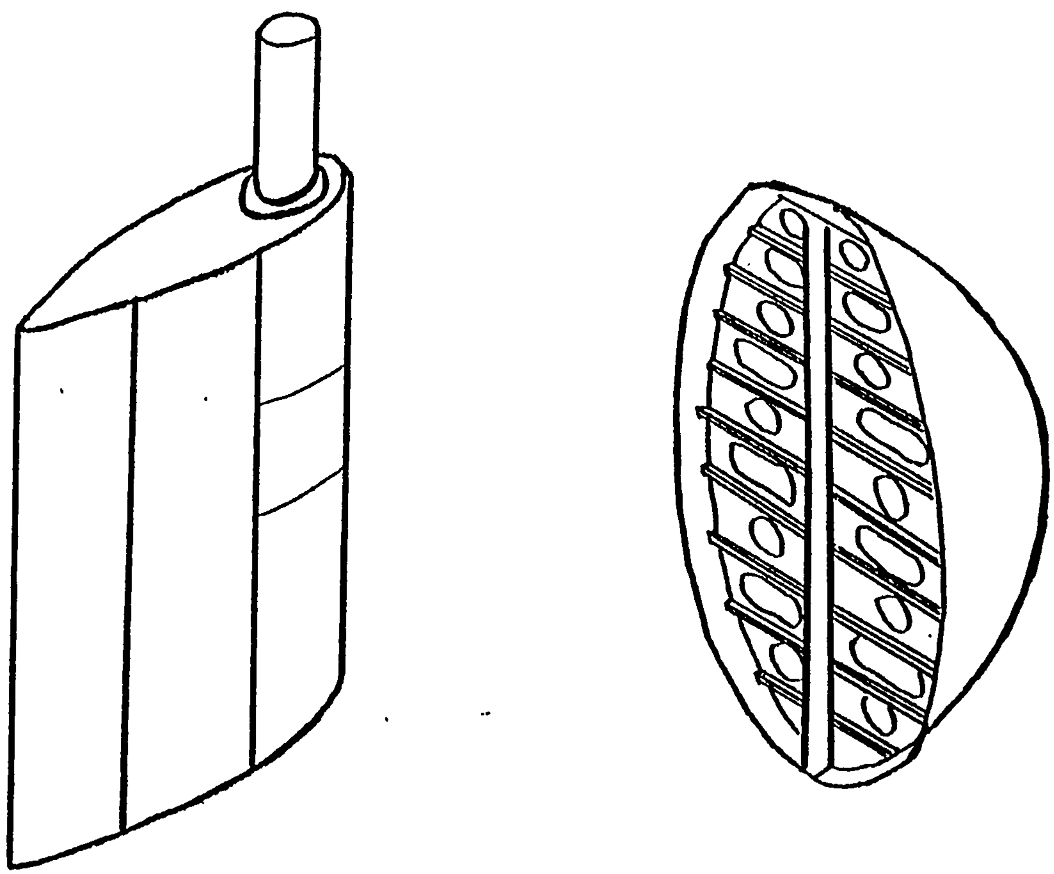
TYP ENG RM DBL BOTTOM

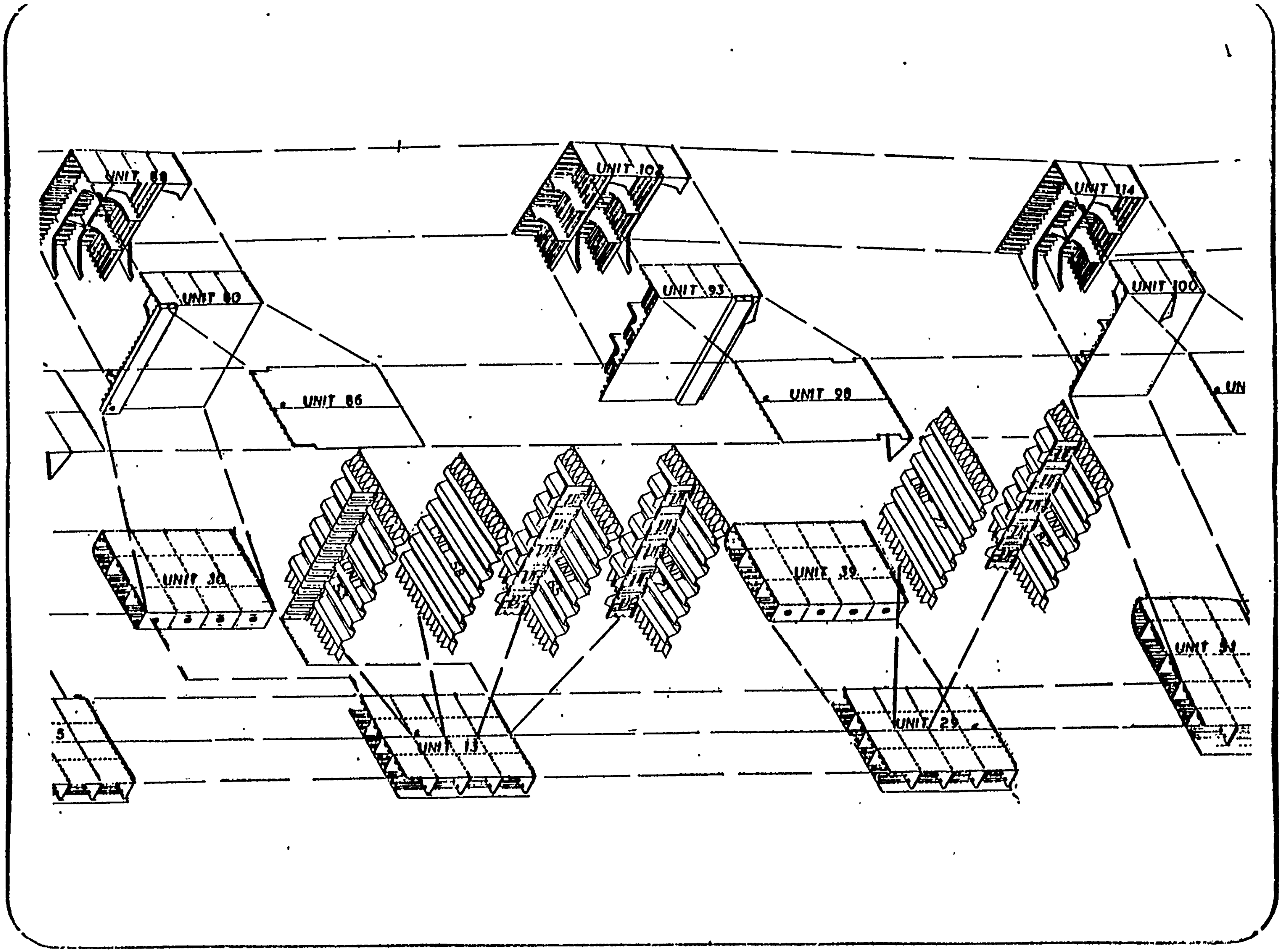


OPERATION SERVICE

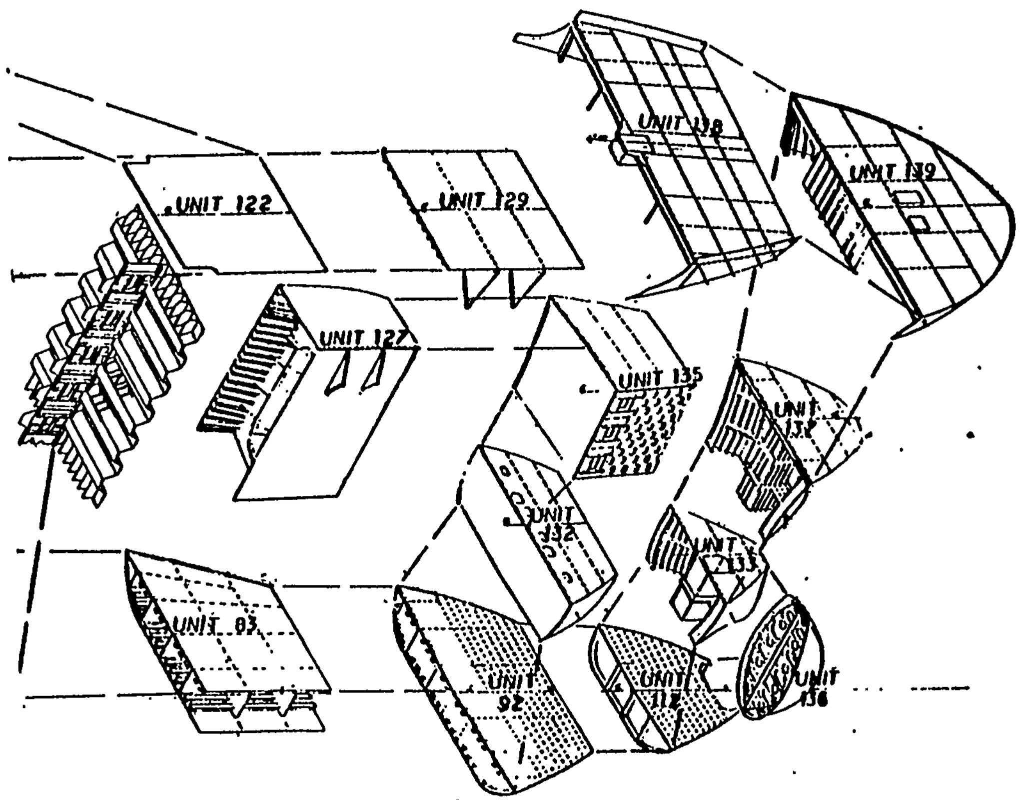
CATEGORY NO. 6

RUDDER AND BULBOUS BOW

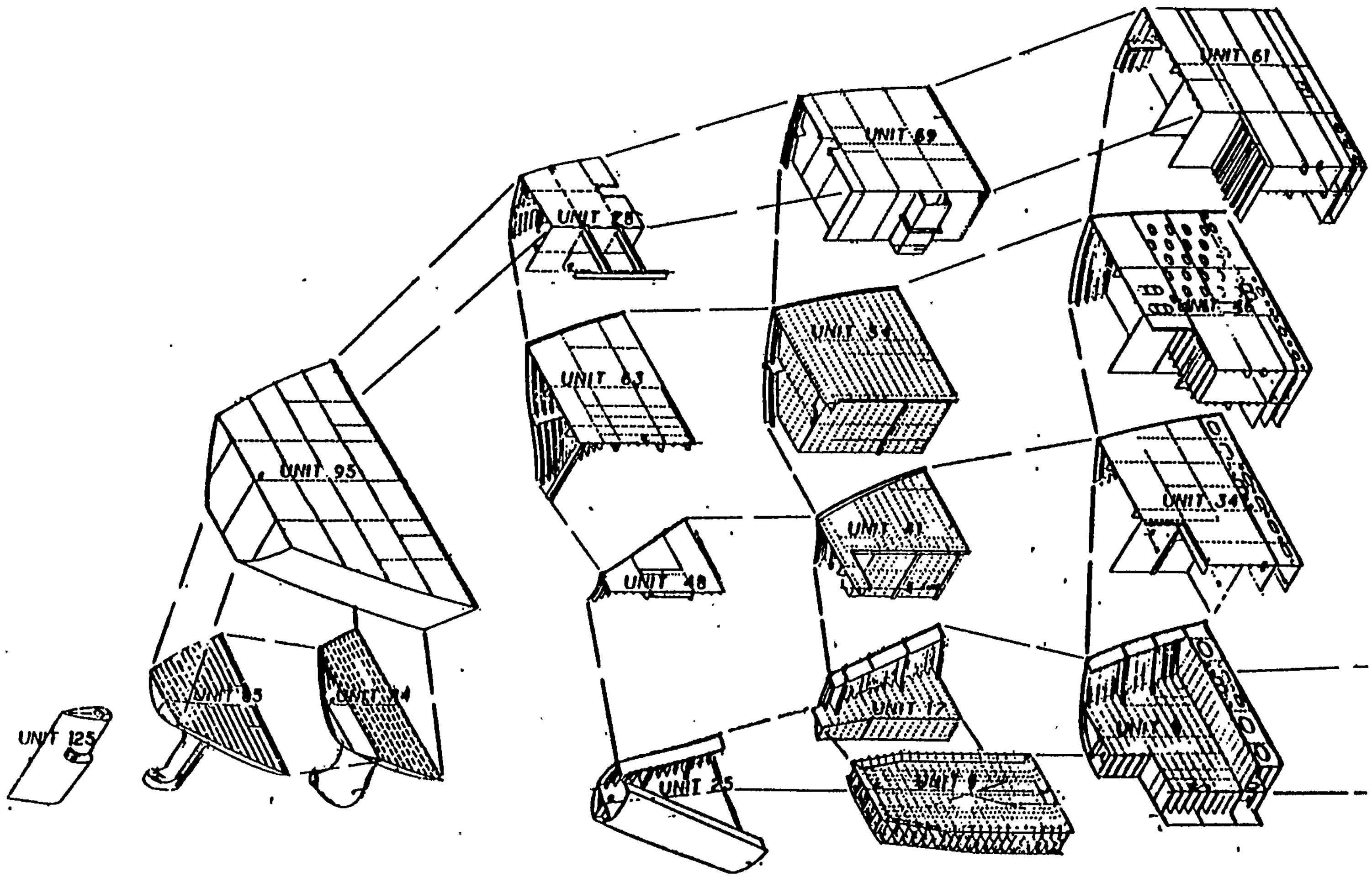




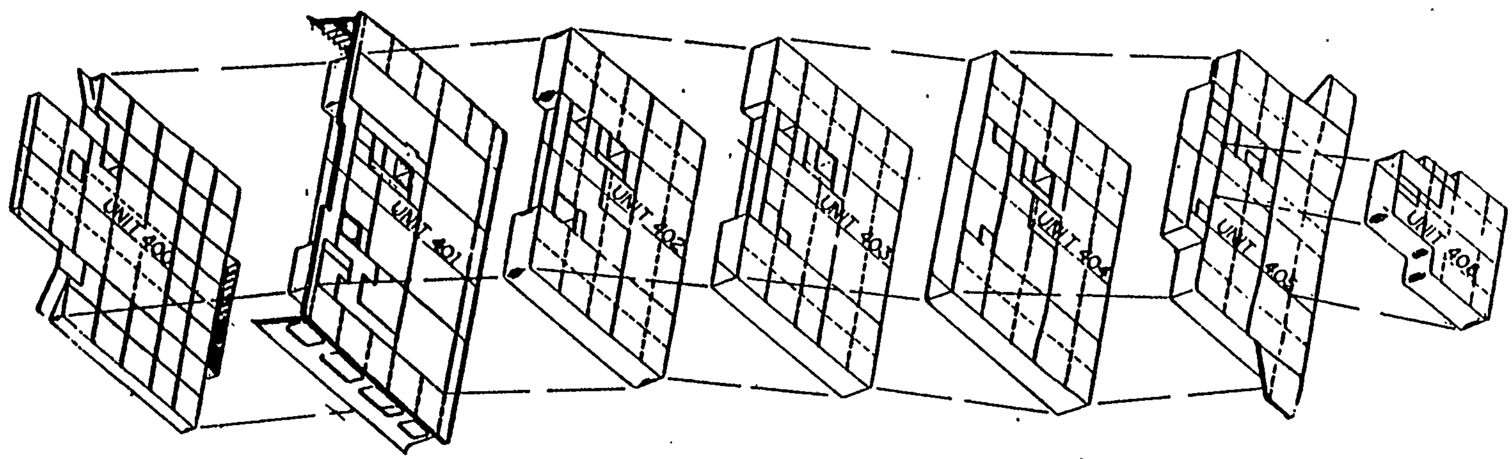
GRAPH NO.HLS-7



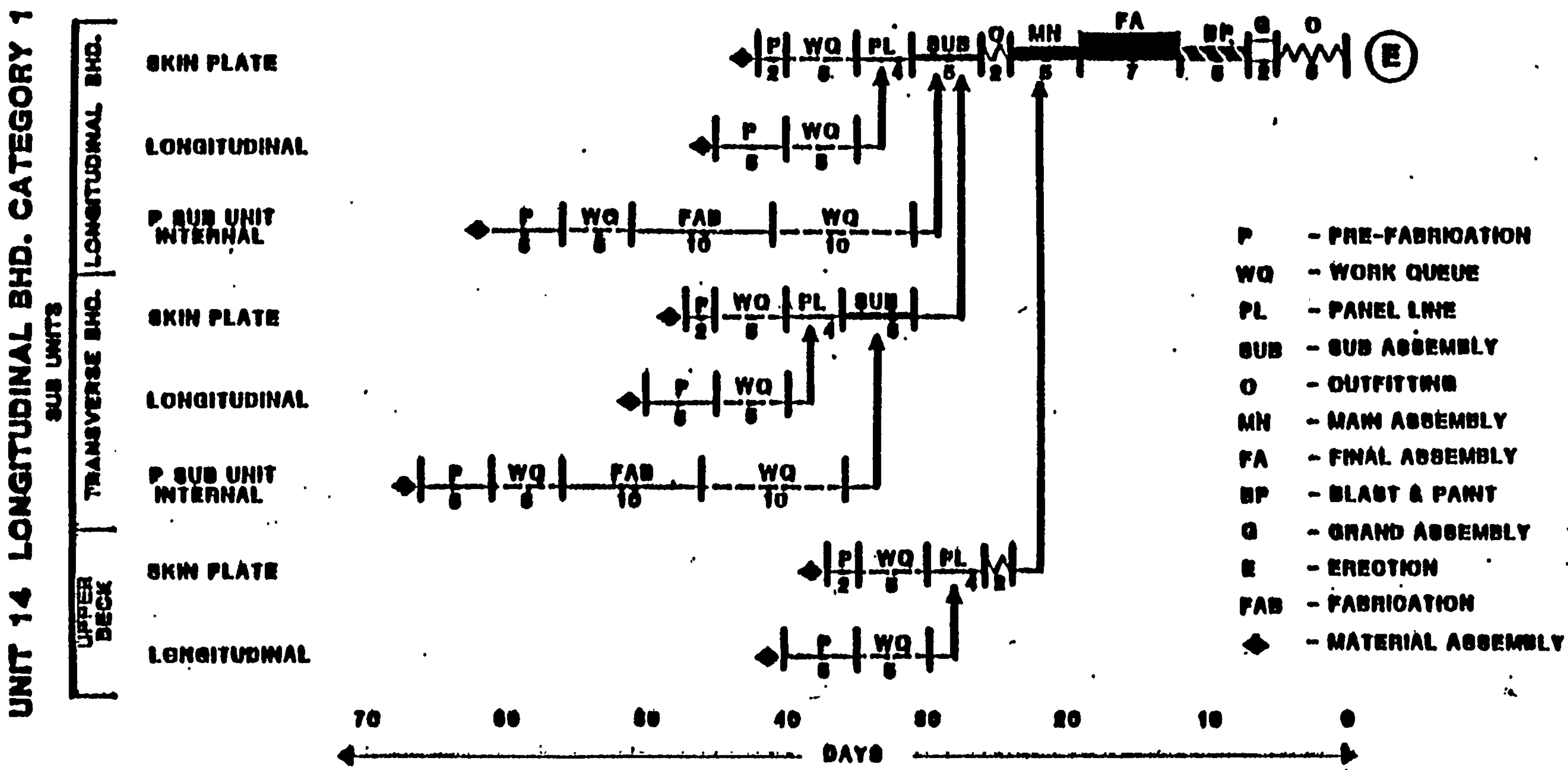
UNIT 122
UNIT 129
UNIT 138
UNIT 139
UNIT 127
UNIT 135
UNIT
UNIT 132
UNIT 133
UNIT 83
UNIT 92
UNIT 112
UNIT 136



GRAPH NO.HLS-9


UNIT 400
UNIT 401
UNIT 402
UNIT 403
UNIT 404
UNIT 405
UNIT 406

SCHEDULING MECHANISM AND NETWORK



GRAPH NO HLS-11

OUTFIT PLANNING AND SCHEDULING

ZONE OUTFITTING
PLANNING AND SCHEDULING

I. GENERAL APPROACH TO ZONE OUTFIT PLANNING AND SCHEDULING

For many years American shipyards have been building steel bulls and deck houses and filling these structures with all manner of simple and complex outfitting items numbering in the thousands and tens of thousands.

This amounted to a philosophy dominated by hull construction.

Prior to the advent of the IHI technology transfer introduction at Avondale, this was more or less our driving philosopby.

The efforts that were made to improve the fitting out costs were usually the result of a few individual efforts and the learning curves that developed in multi-ship contracts through trial and error.

The advent of recognized shipbuilding technology introduced by the Maritime Administration's National Shipbuilding Research Program, through the Ship Production Committee of SNAME, spot-lighted the highly organized methods of both building the hull and outfitting the vessel.

Upon first review, the methods appeared simple; however, when an attractive piece of the process was selected and tried by itself, it resulted in disappointment. Over the past five years several shipyards have bad this experience, not only with IHI techniques but with some of the European methods, also.

Avondale's approach to the problem was to try and recognize that what we were about to undertake would be a four or five year project, which would slowly develop over a long period of time and would require a program of patience and training.

Like planting seeds in the ground, we are experiencing similar developments shown here in Graph No. 1 ZO:

- Planting
- Germination
- Growing
- Harvesting

To carry the comparison a little further, Graph No. 2 ZO brings out the analogy in greater detail.

A) TO PLANT

- the ground must be prepared;
- the corporate managers must be able to keep the idea fresh.

B) TO GERMINATE

- the temperature, rainfall, drainage and climate must b acceptable;
- the shipyard management must provide the proper enviro ment, continued emphasis on performance, the eliminati of negativism and establishing realistic objectives.

C) TO GROW

- the proper amount of nutrients and constant checking f debilitating influences (insects, diseases, etc.);
- the proper amount of feedback using realistic schedule and the constant encouragement of those ideas, activities, and people that are productive.

D) TO HARVEST

- pick and enjoy;
- prosper and be competitive.

The zone outfitting effort was started at Avondale on Februa 4, 1980, with the formation of what was called an "Expert Group" made up of the elements shown in Graph No. 3 Z0.

II. THE PLANNING AND SCHEDULING IN ZONE OUTFITTING IS AIMED PRIMARILY AT:

- maximizing the pre-fitting of components of all systems i zones of the onboard divisions and into the sub zones of hull units;
- maximizing the assembling of components of systems in the zones of onboard divisions into the sub zones of machiner and pipe package units;

- minimizing the effort of outfitting after hull erection;

- orienting steel fitting and foundation work, especially in overhead work from a difficult "position to an easier position assisted by gravity rather than opposing gravity;

- transferring work environments from closed, narrow, unsafe and high locations to open, spacious, low and safe loctions, and also to facilitate transportation of material accessibility.

III. IN PRINCIPLE, THERE ARE THREE ASPECTS TO ZONE OUTFITTING PRACTICED AT AVONDALE AS A RESULT OF IMPLEMENTING THE NEW TYPE SHIPBUILDING TECHNOLOGY. THIS IS ILLUSTRATED IN GRAPH NO. 4 ZO.

- Package Unit Pre-Outfitting
- On Unit Outfitting
- On Board Outfitting

A) PACKAGE UNIT PRE-OUTFITTING

Basically, components are assembled into package units as long as their independence can be preserved with rigidity and stability without the help of intensive temporary re-enforcements or supports. You can readily see the increasing number of package units that have been developed on succeeding contracts due to the influence of IHI technology. This is illustrated in Graph No. 4 ZO.

Types of package units are grouped as follows:

1) Machinery Package Units

An assembly of machinery, combined with adjacent components such as the foundation, pipe pieces, valves, gratings, ladders, supports, etc. An example of this would be a salt water service pump unit shown in Graph No. 5 ZO.

2) Zone Package Units

An assembly of pipe pieces, pipe racks, combined with valves, access ladders, gratings, etc. A good example of zone package units are the main deck pipe racks of a

Product Carrier, shown in Graph No. 6 ZO. This graph, taken from the model, shows how these pipe racks will *look* when completed. We also refer to zone package units as pipe package units.

B) ON UNIT OUTFITTING

The primary objective of on unit outfitting is, of course, to complete the outfitting on ceilings and in doublebottoms before hull unit erection.

A unit involves various types of outfitting tradesmen working in a small volume; therefore, it by itself tends to create an unbalance in the work schedule.

One recommended solution to this problem is *to* allocate the multi-trade type of worker per unit and create a new trade worker called an assembler.

The fitting and welding on ceilings are undertaken with the unit upside down while the fitting and welding on floors are implemented after the unit is turned. One example of on unit outfitting is shown in Graph No. 7 ZO and in Graph No. a ZO.

C) ON BOARD OUTFITTING

On-board outfitting on first sight sounds like the conventional type of outfitting. However, this work is designed to be as minimum as possible and is limited to the following:

- outfitting items or package units too heavy or big to load onto the unit prior to erection;
- fragile components and water vulnerable componets that are impractical to be fitted on unit such as joiner panels, insulation, etc., items subject *to* damage from handling and weather;
- connection components between package units and hull units, such as pipe make-up pieces, cable, etc.

On board outfitting is planned and scheduled zone by zone, sub zone by sub zone.

An example of this type of outfitting is shown in Graph No. 9 zo. This view is taken of the No. 1 A.P.L. engine room area. What you are seeing here is a group of pre-packaged machinery units.

IV. THE PROCEDURE FOR OUTFIT PLANNING AND SCHEDULING

We start planning and scheduling by using the same seven section document we used this morning in describing bull planning, this document with the long name Job Description at Each Stage in New Hull and Outfitting Engineering Procedure at ASI."

Outfit planning commences at about the same time as the Hull Planning Group has established the preliminary unit definition. In Graph No. 10 ZO, Section No. 1, and Graph No. 11 ZO, Section No. 2, we can see that there are many items preliminarily resolved by the contract date.

The illustration in the previous graphs and in Graph No. 12 ZO, Section No. 3, shown here demonstrates this to be a considerable list.

Paramount to answering the questions where, when, and how, are the items listed under other required data shown in Graph No. 12 ZO, Section No. 3, namely:

identification of construction methods;

- preliminary unit definition;

establish outfitting zones for Purchasing;

study and preliminary assignment of package units, on unit and on board material.

Once construction methods are established and preliminary unit definition and sequencing is decided on, outfit planning and scheduling can begin at once.

The document entitled "Advanced Purchasing Zones" is shown here in Graph No. 13 ZO and is one of the standard planning and scheduling tools used by ASI. This document is sent to the Engineering and Purchasing Departments prior to contract signing.

Please note that all of the material listed in the "Engineering Hull and Outfitting Job Stage Description" is advance ordered by this method, using this document immediately after contract signing and before the "go" meeting.

Long lead time material is ordered at this time by component and by diagrammatic system. The ordering takes place long before working drawings are completed.

This allows a lead time not always enjoyed in American shipbuilding contracts. For these advanced orders, material lists are produced for each zone and each sub zone that you see on the document. Please notice the fabrication and component dates specifically standardized and denoted in the advanced purchasing zone schedule.

Using this system, it now becomes possible to determine delivery dates and order long lead time items more quickly than with conventional methods.

In other words, the advanced ordered material list is system oriented, which benefits the Estimating Department and, also, is zone oriented in a way that facilitates early material procurement tied to proper need dates.

When the advanced ordered material lists are prepared, the required dates for each purchasing zone and sub zone are readily defined for the Material Purchasing Department.

- All the advanced outfitting materials placed on order are based on lead times by referring to the advanced purchasin zone schedule.

- All the material for outfitting, which is purchased after the composite and working drawings are completed, is place on order with the required dates shown on the later developed pallet list schedule. A relationship between materia lists and required dates is shown here in Graph No. 14 20. A standard schedule for material procurement is shown here in Graph No. 15 20. This schedule is divided into given time frames for each Avondale responsible event you see on the chart. The added days are the delivery times.

Early in the pre-contract phase of the schedule, an integrate study is made by Engineering and Production Planning to determine the best possible combination of machinery components th can be developed into package units.

Shown here in Graph No. 16 Z0, Graph No. 17 Z0, and Graph No. 18 Z0, you can see a few package units that have been constructed and are about ready for transporting to the installation area. In Graph No. 19 Z0 we have a picture of a model representing a package unit that will be constructed for the engine room bilge and ballast pump system for the Exxon Produ Carrier program.

The Engineering Department has made organization changes in this area, notably formation of an established fully integrat package unit design group. This group does all design and engineering work for package unit foundations, walkways, pipe and all other components of the package unit.

There will be further discussion about this department in more detail at our seminar session tomorrow, which will deal with the engineering integration phase of the job planning effort.

Graph No. 20 ZO, Section No. 4, shows the next series of steps after contract.

Shortly thereafter and before the “go” meeting, the drawing schedule from Engineering is issued to Production Planning for scheduled dating of each drawing. This dating follows the same basic zone and sub zone scheduling process as the one used for material ordering in the advanced purchasing zone schedule. However, refinements in sequencing are cranked in using the hull sequence and erection schedule. The drawing schedule now shows each drawing as a reflection of the unit definition and construction methods mentioned earlier.

The outfit pallet schedule shown here in Graph No. 21 ZO is now composed, dated, and delivered to Engineering by the Production Planning Department. This particular pallet schedule is for on unit work. The pallet schedule at this stage is of a preliminary nature, but is used as a basis for dating material going to the various stages of machinery and pipe packages, on unit outfitting, and outfitting on board. The pallet system at Avondale will be discussed in more detail following this presentation.

The bsic unit erection sequences previously discussed in this morning’s hull seminar, along with the preliminary outfit milestone schedule, is also produced and issued by the “go” meeting.

An illustration of the milestone schedule and another illustration of the pallet schedule documents are shown here in Graph No. 22 ZO (Milestone Schedule) and Graph No. 23 ZO (Pallet Schedule). These are cut out portions of the entire document shown in your handout. The pallet schedule you see here is made for on board outfitting. There is also one for machinery package units and pipe rack package units.

These schedules will be discussed further in the “Details of Outfit Planning and Scheduling” later in the seminar. However, the main purpose of the pallet and milestone schedule is to define the dates of installing fabrication work, various components, various fittings, piping, testing, painting, and to plot these dates in an integrated manner with the erection dates of the hull units. Additionally, all this is anchored to the major milestone dates of keel, bore stern tube, launch, trials, and delivery.

Referring back to Graph No. 20 ZO, Section 4, you will notice that within three (3) months after the “go” meeting, the final decisions have been made on the application of package units and pipe rack units.

Also in line with these final decisions, the machinery compo-
nents for on unit outfitting, as opposed to on board outfit-
ting, have also been resolved.

In conjunction with all of this, the milestone schedule has r
been sent out for review to the top levels of management.

We come now to the Key Plan meeting, which we call the "K" meeting, shown in Graph No. 24 ZO, Section No. 5.

By the "K" meeting, which occurs some four (4) months followi
the "go" meeting, the approved outfit milestone schedule is issued as a cast-in-concrete document to all responsible parties and departments in the shipyard organization.

Distributed also, along with the milestone schedule, is the finally approved pallet schedule which sets all the dates for all the major outfitting material to be delivered to each sta
of construction in the entire ship manufacturing process. Graph No. 25 ZO, Section No. 6, shows the next series of proc
dures and leads into the "ML" or Mold Loft meeting.

After the "K" meeting, outfit drawings start being developed
a unit-by-unit basis, and the bills of material for construction land manufacturing stages begin to be identified pallet
pallet.

It is as though the Production Planning Department supplies t
Engineering a number of empty buckets, each with a stage code and a date. In turn, Engineering then begins to fill the buc
kets with selected materials for the appropriate stage.

A series of meetings between Production planners and Engineering draftsmen and section leaders has now been in operation since the "go" meeting. These have been the meetings where Production Planning, Production Engineering, Engineering draftsmen and section leaders have, by concensus, been decidi
the appropriate stages where all the outfitting material and components should be installed, that is to say, in sub assembly, main assembly, before turning, after turning, before bla
and paint, after blast and paint, or on board. These are the meanings of the stage codes that you saw on the pallet schedule. Beginning with the "K" meeting, these feedback forums now take place on a scheduled basis every week, with Producti
personnel now entering the process on a regular basis.

Methods of fabrication, assembly, and installation are discussed in greater detail. Unit drawings are reviewed and changes initiated.

From this interchange of thought processes emerges the most productive methods that can be utilized using the yard facilities, equipment, and manpower. The drawings produced now become a reflection of this process.

The Mold Loft meeting, shown in Graph No. 25 KZO, Section No. 7, as the “ML” meeting, is purely for verification that the Mold Loft has all the necessary information to start producing their drawings for the hull UCM book.

Two months after “ML” or eleven months after contract signing, Engineering starts delivering the unit outfit drawings to Production on a unit-by-unit basis.

For example, the first drawings to be sent are those of fittings and pipe pieces requiring fabrication for installation in the initial partial sub-assembly stages of hull construction and for the first units appearing in the fabrication and sub-assembly schedule.

Work orders are issued and fabrication begins for all fittings and pipe pieces. On the next contract we expect to cut the delivery time of outfitting drawings to Production from the eleven (11) months mentioned here to ten (10) months and eventually to the nine (9) months shown for hull drawings.

V. SCHEDULING FOR ZONE OUTFITTING

One of "Murphy’s Laws” states, “Anything left to itself goes from bad to worse.”

This applies to hull construction and zone outfitting. Therefore, the scheduling in detail of the outfitting effort becomes extremely important.

Scheduling in zone outfitting is basically done from a long term and short term basis.

The long term schedule is used for summation forecasts and a check to insure that execution and level loading is realistic and falls within budget parameters.

The short term schedule is used for the detailed execution of the work that is set forth in the long term schedule. The short term schedule is generally made and monitored by the shop planners and is structured to reflect work loads to craft foremen over weekly periods.

In Graph No. 26 ZO, we can visually see the overall tree str ture of schedules now being developed at Avondale. We can a see who is involved in schedule creation, and more important who becomes responsible for the checking of schedule progres

This, in turn, breaks down all work effort into detail sche- dules for execution. Participation effort in making these schedules originates all the way from front line foremen and mechanics to middle and upper management.

It is extremely important that schedules be:

- <u>REALISTIC</u> That is to say safely within the facility and personnel maximum loading capability.

- <u>RECOGNIZED</u> This means they are official documents of top management and can only be changed by top authority.

- <u>RESOLUTE</u> This indicates they are regarded by all employees as steady and determined work guides

In Graph No. 27 20 is an illustration of some of the overall types of schedules made and their distribution in vessel con- struction at ASI.

Schedules are very much like road maps. Everyone knows exact where they are going and how to get there without one until they get lost. That is when they refer to the document that they should have been referring to from the start.

It is this mental attitude that has to change if "product wor brakdown structure" is to be implemented to its fullest effi- ciency.

The designed layout for the schedule format is an individual thing in each yard and depends on types of computer facilitie printing methods, and traditional forms that personnel are us to seeing.

To dwell on this would accomplish no purpose in this seminar. So, for now, we will leave the subjects of general planning a scheduling and review some of the other methods of the techno ogy that have had an influence on productivity and on various changes that must take place,

We have, in the Planning Department, established in a very crude manner an overall goal for ship production performance.

Shown here in Graph No. 28 ZO is a tentative formula that establishes one of the broad goals we are hoping to accomplis

You will note the factor of accomplishment is equal to the percent complete at launch in outfitting, divided by the building time in months.

The percent complete at launch is composed of only those items that have to do with outfitting craft work.

No hull or superstructure percentages are counted into these outfitting numbers. However, the length of time to build the hull and launch it are totally dependent upon hull performance.

We have established a target of fifteen (15) points or a 90% completion of outfitting items by launch. In using this formula it must be undrstood that all hull requirements must be completed 100% as scheduled.

On this graph, also, you can see some of the performance numbers that have resulted so far from previous contracts. These are from contracts implemented by the technology to varying degrees.

The problem with this type of projection is that it does not rely on specific parameters. The outfitting parameters in this case are manhour percentages of their final or projected budget costs. This could be a variable. Also, the hull could launch in less time and not be 100%. This would also be another variable.

To reduce these variables we are now adopting the “product work breakdown” method of outfitting weights. An example of these parameters are shown here in Graph No. 29 ZO.

Everything from steel plate to waste cans on the ship has a given weight. This weight is a necessary piece of information needed in any case by the Design Group, as very often a contract will assess penalty points if a ship is built in excess of specific weight tolerances.

Each Engineering Department at ASI now is responsible for calculating and recording all the individual weights of their particular section. With this information in hand, we should then be able to come up with particular weights by craft grouping and also include lineal and square footage for those crafts not accountable by weight.

By using these parameters as a gauge of physical progress, total outfitting accomplishment can readily be determined on a rough basis.

In addition to the overall physical progress, another benefit accrues from the use of the weight system.

Each pallet now can be given a predetermined weight value. Using" these weight values against the appropriate cost standards rough budget forecasts can also be achieved from shop fabrication to outfitting installation.

A concentrated effort was made to investigate and decide the framework of information flow and the particular changes tha would be necessary in order for zone outfitting to be succes sful and effective. The expert group previously mentioned convened for three months determining this.

It was agreed upon during this stage that some of the fundam tals in material tracking and cost accounting codes would ne changing. Along with these observations, certain aspects of the shipyard organization would need to be changed, modified, and new procedures injected.

Shown in Graph No. 30 Z0 is a list of the basic changes reco mended by the IHI team. Bear in mind that all established organizations have generally developed by the add-on process because of special influences:

- growth of the business

  new-fields of endeavor

  weathervane Influence

  (organization changes to accommodate problems or special projects. NOTE: "Very often these changes occur and the organization is set into place. However, when the proble has disappeared, the problem organization is not always re-structured or totally eliminated.")

The organization changes we talk about here, however, basically to accommodate a new field of endeavor in process manufacturing. Their objectives have the same target, namel to:

  control material and labor;

  control manufacturing costs.

One of our problems experienced at ASI, in trying to underst all of this, developed out of cultural and business differen and out of the language problems.

Let me state here for the record that it is absolutely essential that all the parties be able to understand and speak a common language, whoever they may be. I might also add that the members of IHI were very patient with us in all of this.

It is also paramount that consultants be members of the upper echelon of their shipyard management.

We can now briefly review these changes and what these changes meant as far as our shipyard was concerned. Shown here in Graph No. 31 ZO is a general presentation of the over-change

A) RE-ORGANIZE ENGINEERING FUNCTIONS

This will be addressed during the seminar tomorrow on "Engineering Integration and Interface."

Briefly, however, all processes of engineering at ASI had previously been system by system.

In order to apply zone outfitting, the Engineering Department had to be transformed from system by system to zone by zone, after the system diagrams and guidance drawings, such as machinery arrangements and general arrangements, were completed. That is to say, the composite drawings and working drawings are prepared zone by zone, together with the material lists we now call pallets which contain all components for work packages.

B) RE-ORGANIZE PRODUCTION PLANNING AND PRODUCTION ENGINEERING

Previous to the start of the IHI technology techniques, the Production Planning Department at Avondale functioned almost independently of Engineering and the Advanced Program Department.

Although there was a valient attempt at pre-outfitting by Production Planning, without the precise recognition of top management the pre-outfitting was a "cry in the wilderness."

Production Engineering was known as "the group upstairs," and while there was good communication between the two departments, the common link seemed to be missing.

Production Engineering issued all their work orders by entire systems. This led to work orders being in the field sometimes for months. More damaging, however, it meant that much material had a good chance to be misplaced as the vessels moved from the building ways to the wet dock.

It was recommended to organize the Production Planning ar Production Engineering together into a Hull Group and an Outfitting Group. The Outfitting Group, then, would be sub-organized into the same three zone groups as Engine- ering. This, basically, is how we are now tentatively be formed.

Production Planning is now responsible to establish the milestone dates such as keel laying, launching, delivery, erection dates for hull units, etc. through joint meeting with all departments concerned.

It is also responsible for setting and preparing the sche dules showing the start dates and completion dates for al grouped materials, called pallets, and other activities without material, such as machinery testing and compartme scheduling on the basis of the milestone schedule.

It is also responsible for level load forecasting of the manpower and resources of the shipyard.

The Production Engineering Department now has the respons bility to estimate the manhours for each material pallet also all activities without pallet materials which are utilized by Production.

Production Engineering is also responsible for evaluating the actual performance by comparing the estimated manhour and actual manhours based on the pertinent parameters, su as weight, length, square footage, reported to them by th Production Department.

More of these changes will be discussed during our semina tomorrow morning.

c) RE-ORGANIZE PRODUCTION WORK GROUPS

Avondale's Production Department has, over the past numbe of years, followed the traditional methods of outfitting pursued by most American yards, i.e. system by system.

This brought with it the various craft trades, each tryin to do their assigned work load after the hull was devel- oped. This method, of course most of now realize, is not the most efficient process.

It was recommended to re-organize into the same groups as Engineering, Production Planning, and Production Engine- ering. This is shown here in Graph No. 32 20.

This type of organization which you see here is basically an IHI type organization that developed over many years. While it is ideal for their concept, it presents problems for some yards to adopt.

No. 1 - You must cross and integrate traditional craft and political boundaries.

No. 2 - Certain radical changes such as presented in the all-encompassing Hull and Outfitting Departments tend to be resisted for many reasons, some good, some bad.

We are in the process now of making our Production organization changes, but it will be several years before we can hope to reach our optimum objectives. This should not, however, detract from obtaining our most immediate goals.

Shown in Graph No. 33 ZO are the particular parts of these recommended changes that show how we are structured and how far we have yet to go, if we are to be organized along the recommended lines.

D) <u>CHANGING THE CODE SYSTEMS</u>

- The code is not only a symbolizing combination of alphanumerics which are handled by the total system from Engineering to Production, but,

- The code also acts as a tool to operate the total system smoothly and effectively by connecting software, hardware, and human ware. These changes are extensive in concept and length of time to pursue and complete.

- Therefore, more time is needed for the final adoption of all these systems. They are, however, presently being modified at ASI.

Previously at Avondale, the shipbuilding process from estimation to production was controlled system by system (the system oriented code system), namely, all drawings, all material control, all work orders, and all cost accounting' procedures were controlled by a system oriented code process.

The following changes were recommended by IHI.

In order to develop zone outfitting manufacturing, the system oriented engineering procedures must be transformed into zone oriented procedures at the state of composite drawings as follows:

- The Engineering Department fitting type drawings and material lists must be issued zone by zone/sub zone by sub zone.

- The Production Planning Department must develop and produce the zone outfitting schedules.

- The Material Control Department must prepare material pallets required for zones and deliver them to the required place, at the required stage, at the required time.

- The Production Engineering Department, then, must issu work orders for pallet, for zone, and for sub zone.

- The Production Department, then, must carry out the ou fitting work pallet by pallet, zone by zone, and sub z by sub zone, using the work instructions prepared by P duction engineers.

Therefore, an integrated code which controls the above activities is absolutely necessary and identifies in whicl zone and at which stage the materials are installed. Mor over, a classification of material piece numbers of the components and department codes are necesary to keep good communication among the various departments operating at maximum efficiency.

The changes recommended by IHI were to establish key unif codes for all materials, drawings, palletizing, and work processes.

The changes that were made in drawing designations and cla sifications will be addressed in the Engineering Interface seminar tomorrow.

However, briefly here in Graph No. 34 ZO are a few example of how the drawings were changed and the pallet codes were implemented.

Further classifications and piece marking codes are stead: being studied and recommended to management for implementa tion. Most coding changes taking place at ASI at the mome are those codes dealing without semi-automated Pipe Shop, pallet lists, and drawings.

This will be discussed further following this presentation

E) CHANGING THE SCHEDULING SYSTEM

Scheduling becomes the disciplined roads and highways to achieve the final destination or objective.

Without these roads and highways being properly maintained and used, efficient movement in production becomes impossible and all the other disciplines lose value. These changes eventually will prove to be most important and beneficial to the proper operation of the zone outfitting system and will subsequently be described later in our program.

Scheduling at Avondale was traditionally prepared more or less independently between Production and the Engineering Departments.

Several attempts were made to utilize the "Pert" type network techniques. This was discontinued for the following reasons:

- Modification occurred too frequently for this system to be believed.

- Feedback effort to implement this system was extremely labor intensive and not always reliable.

Changes that were recommended are in various stages of implementation and are generally oriented around the standard network processing system associated with "product work breakdown structures." These changes are interwoven with the process lane concept discussed earlier.

F) CHANGE THE MATERIAL CONTROL SYSTEM

Avondale's established material control system worked in a traditional manner.

Materials were purchased with an advanced material order list prepared by the Engineering Department, system by system. When the work drawing for the system was completed, screening between advanced material orders and final material orders was done. But materials issued to manufacturing shops and production shops were carried out in accordance with separate material requests. These were divided into several groups from the system material list shop by shop because the amount of material in the systems were too large a scale to manage.

Changes recommended were rather extensive and were directed at establishing a completely computerized material control system tied to a new piece coding catalog for the entire shipyard. All coding for installation was recommended to directed toward the zone concept. These are the" same thre basic zones of zone outfitting which you have seen earlier

Under these recommended systems, the activity of screening between the advance ordered materials and the final ordere items in the material list for pallets can be finished earlier than the old existing system. This execution contributes to a prepared work kit pallet of material complet in time for when the pallet is required.

In order to satisfy the above requirement, material lists for pallets must be issued in advance of the date of purchasing, manufacturing and palletizing of these materils

The drawing schedule must be made pallet by pallet on the basis of the required delivery dates of each pallet to the proper production site.

Because of the extensive nature of this particular subject and the changes being invoked in material control, it is needless to say that it will take a great deal of time and will develop piece by piece. There will be further discussion of this subject tomorrow morning.

G) CHANGE IN COMPUTER AND DATA PROCESSING

Computer and data processing usage at ASI was seldom requested to be used for rationalization and projecting scheduled job flow.

The recommendation for changes was directed at our Computer and Data Processing Department.

The head of this department will give a complete seminar on computer and data processing on September 15th and 16th of this year.

H) PIPING SYSTEMS

In all ship construction planning and scheduling there appears unique influences that seem to have a major effect on the eventual success or failure of the plan. In outfit planning and scheduling, one of the biggest of these influences in generated by piping systems.

Piping installations in shipbuilding represent a very expensive effort in material and labor. Piping is the second most coscly item in ship construction at Avondale.

As a matter of practice, up until recently, our yard bad. limited its piping detail sketches of pipe pieces to only those sizes of-pipe 2" and above. This made the Production Pipe Department responsible for field running piping under 2", generating a tendency to create our own interference problems. Much decision making by front line supervisors and middle management foremen also results in costly marking, cutting, bending, and fabrication on the ship site instead of conveniently in the shop. In Graph No. 35 20 you can see that on researching various types of vessels, it was found that pipe pieces below 2" in size represent approximately 50% of the total amount of pipe pieces in a vessel. An 1,800 unit container ship, for example, built at IHI has a total of 13,047 fabricated pipe pieces, approximately 6,950 of which are under 2".

As you can see, the amount of pipe pieces below 2" can be a considerable number. On this basis, it was decided to engineer and route most pipe pieces down to and including the 1" hydraulic pipe sizes. All pipe pieces now appear not only as sketches, but sketches that include material specifications, job orders, pallet numbers, planning routines, routing and coating or final treatment specifications. The pertinent information is translated to the shop management codes and stored in the COPICS shop management system for semi-automated pipe shop manufacturing. As a result of IHI zone outfitting techniques, piping is no longer fabricated in our yard by entire systems but by pallet, pre-outfit unit, and zone schedules.

This reduces considerably the amount of fabricated pipe pieces that generally take up inactive storage space. It also lends itself to a much more efficient shop management system with pipe pieces palletized for designated final treatment of pre-outfit and zone location.

Planning and scheduling for the Piping Department is now oriented around this system.

We can only touch on this subject piping very briefly at this seminar; however, many volumes could be generated on piping and the intricacies of pipe fabrication and installation. Several manuals have already been printed and are available.

To very quickly give you some idea of its complexity in shipbuilding planning and scheduling and why IHI pipe piece family manufacturing is necessary, the following view graphs are visuals taken from a model of the main deck cargo piping system of our Exxon contract. The next three pictures that you will see, Graph No. 36 ZO, Graph No. 37 zo, and Gra No. 38 ZO, show an overview of what the main **deck** will l like when all piping systems have been installed on this vessel.

The total steel structure to support these systems weighs approximately 246 tons. The total weight of the piping system itself, when filled with liquid, will weigh 696 to

We have planned to pre-fabricate and build this entire structure in 26 separate pipe rack units. Graph No. 39 shows, from a model, what one of these units will look like. This unit has a steel structure weight of 8 tons a a wet pipe weight of 25.5 tons.

A section of our yard has been designated as the pre-fabrication area and is abut 420 feet long and approximat 85 feet wide. This selected area has been layed out to correspond to the actual configurations of the deck of th ship.

Each pipe rack unit has been planned and scheduled to be fabricated, assembled, and installed in conjunction with hull erection schedule of the vessel, so that the last of the 26 units will be installed aboard ship about six week before launch.

The key ingredient of this entire operation will be the accuracy of the design and engineering scope, the palle-tizing and prompt delivery of the material, and the atten tion given to monitoring and measuring all efforts of material and labor productivity on short term results.

This project will commence this month and, thus far, ever thing seems in order.

VI. CONCLUSION

In closing my portion of this seminar, I would like to extend my compliments to the Maritime Administration for understanding all the problems that go into developing these projects under the National Shipbuilding Research Program.

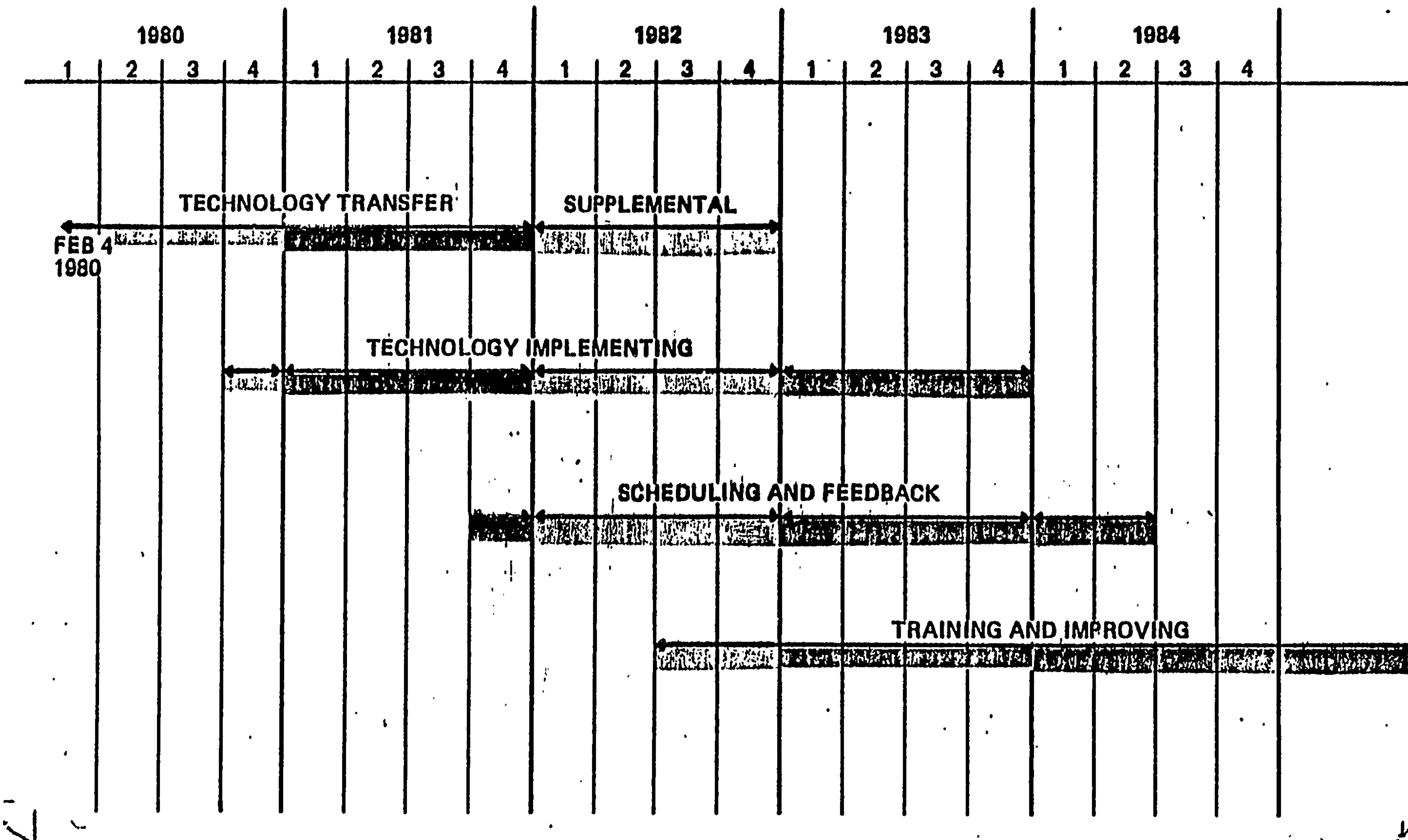
Also, I wish to compliment and bestow a few accolades on the SNAME Ship Production Committee's tireless efforts in trying to manage all these various programs, and, I would also like to thank the consulting members of IHI for the many hours and days of hard effort they put in and for their persistent patience with us at Avondale.

Last, but not least, a sincere word of appreciation to the SP-2 Panel of the SNAME Ship Production Committee for their Sicilian type tenacity in highlighting this particular technology for us all.

VIEW GRAPH FOR OUTFIT PLANNING SEMINAR

	TITLE
1-ZO	Program for Developing IHI
2-ZO	Seed Function Parallel
3-ZO	Expert Group
4-ZO	Three Aspects of Zone Outfitting
5-ZO	Salt Water Package Unit
6-ZO	Main Deck Pipe Package Unit
7-ZO	Outfitting a Unit Before Painting
8-ZO	An Outfitted and Painted Unit
9-ZO	On Board Outfitting in Progress
10-ZO	Pre-Marketing Stage - Section #1
11-ZO	Pre-Marketing Stage - Section #2
12-ZO	Pre-Marketing Stage - Section #3
13-ZO	Advanced Purchasing Zones
14-ZO	Material and Required Date Relation
15-ZO	Standard Schedule of Material Procurement
16-ZO	Building a Package Unit
17-ZO	Shipping a Package Unit
18-ZO	Lube Oil Package Unit
19-ZO	Model of Exxon Tanker Package Unit
20-ZO	Contract to "GO" Meeting - Section #4
21-ZO	On Unit Pallet Schedule
22-ZO	Milestone Schedule
23-ZO	On Board Pallet Schedule
24-ZO	"GO" to "K" Meeting - Section #5
25-ZO	"K" to "ML" Meeting - Section #6
25K-ZO	"ML" Meeting to "Keel" - Section #7
26-ZO	Tree Structure of Schedules
27-ZO	Major Schedules Issued at ASI
28-ZO	Factor of Accomplishment
29-ZO	Parameters of Progress
30-ZO	Recommended Areas of Change
31-ZO	Graph of Related Changes
32-ZO	Recommended Production Changes

Program For Development Of IHI Zone Outfitting And Scheduling



1–ZO PROGRAM FOR DEVE... PING IHI

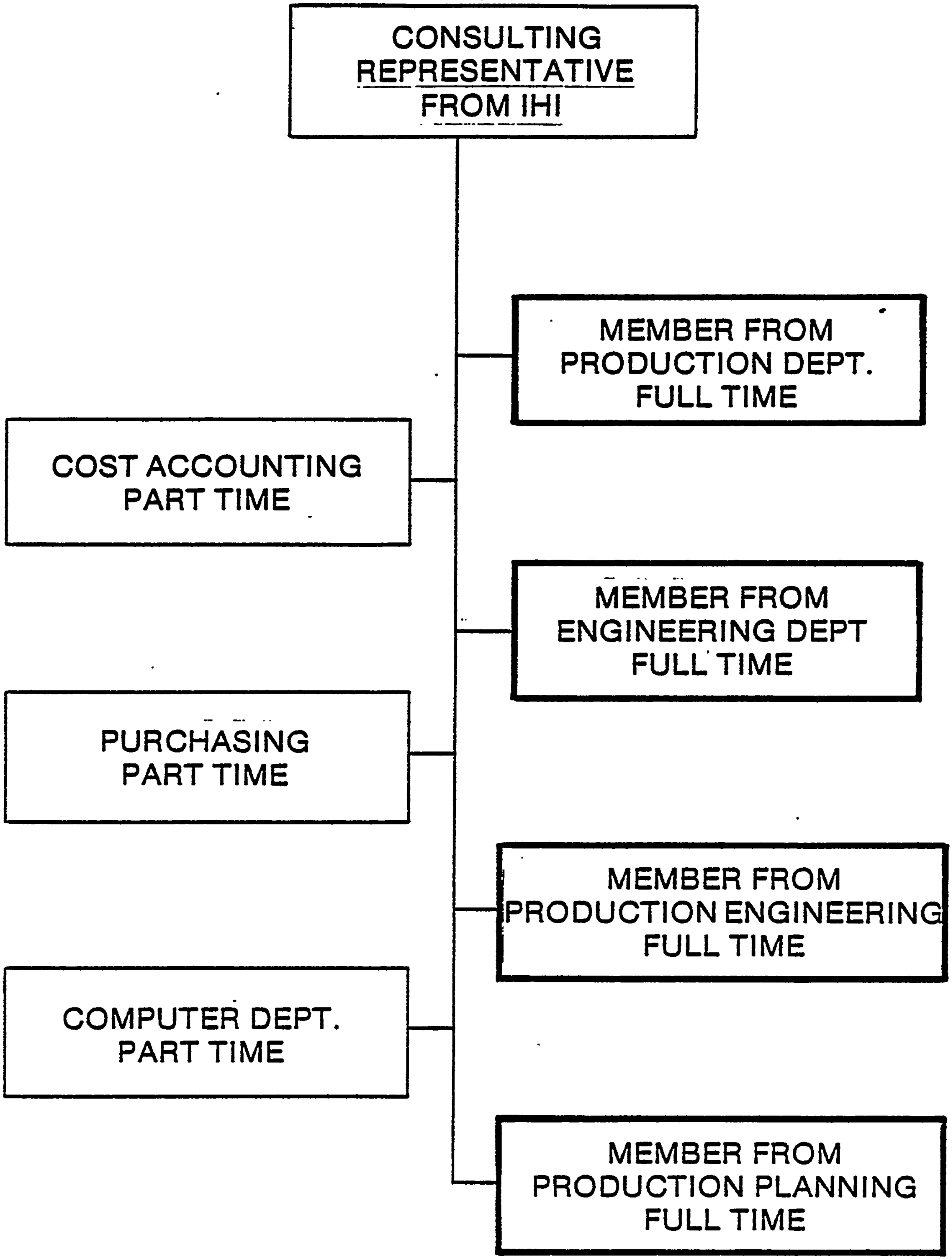
33-ZO Existing Production Organization
34-ZO Changes to Drawing and Pallet Codes
35-ZO Pipe Piece Comparison
36-ZO Overiew of Pipe Rack Model (Exxon)
37-ZO Overview fo Pipe Rack Model (Exxon)
38-ZO Overview of Pipe Rack Model (Exxon)
39-ZO 33.5 Ton Pipe Rack Unit

THE COMPARISON OF

IMPLEMENTING IHI vs/A SEED

SEED FUNCTION

HORTICULTURE EFFORT		CORPORATE EFFORT
PREPARE THE GROUND	To PLANT	CORPORATE MANAGEMENT MUST PREPARE TO RECEIVE AND KEEP THE IDEA FRESH
PROVIDE PROPER TEMP. RAINFALL DRAINAGE & CLIMATE	To GERMINATE	MANAGEMENT PROVIDES PROPER ENVIRONMENT AND EMPHASIS ON ELIMINATION OF NEGATIVISM
PROVIDE NUTRIENTS AND CONSTANT CHECKING FOR DISEASE AND INSECTS	To GROW	USING PROPER FEEDBACK AND SCHEDULES AND ENCOURAGING IDEAS - ACTIVITIES - AND PEOPLE
PICK AND ENJOY	To HARVEST	PROSPER AND REMAIN COMPETITIVE

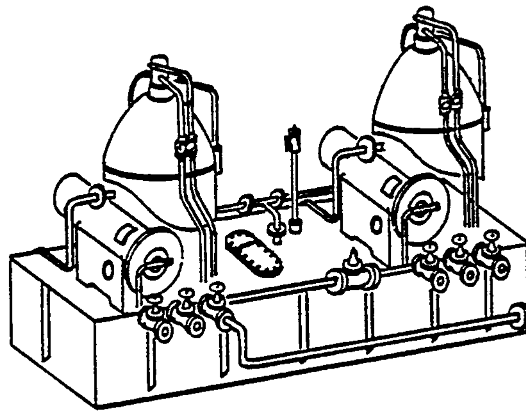


3-ZO EXPERT GROUP

THE THREE ASPECTS OF ZONE OUTFITTING

ITEM

1. PACKAGE UNIT PRE-OUTFITTING

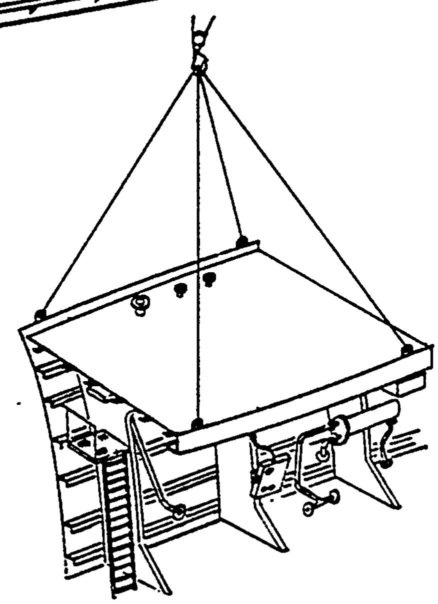


CHEMICAL CARRIER – 27

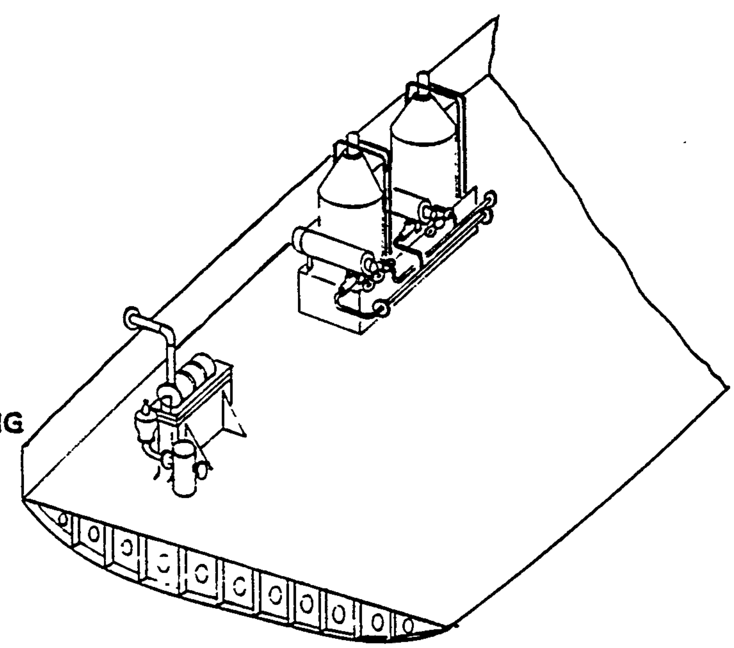
CONTAINER VESSEL – 28

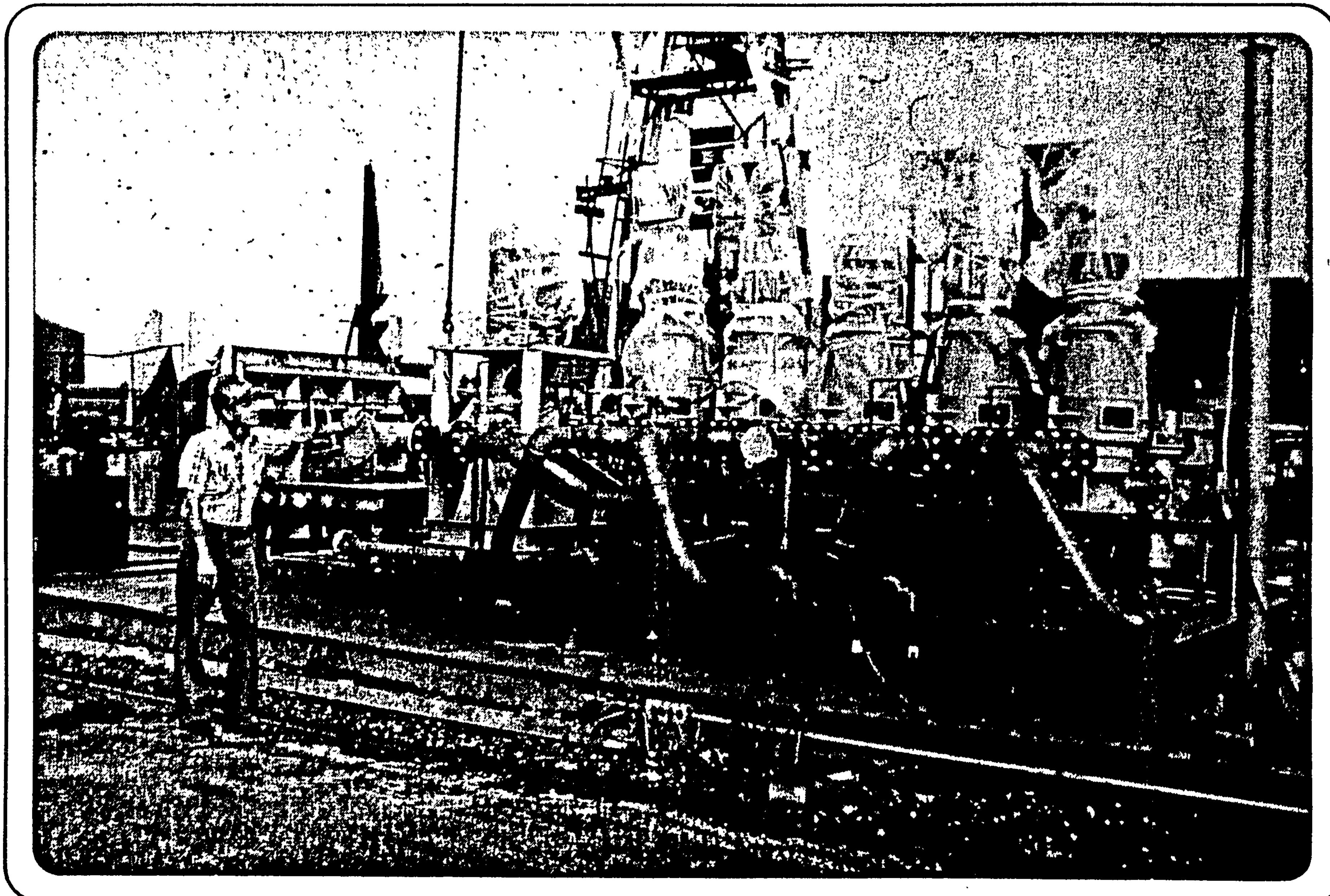
PRODUCT CARRIER – 53

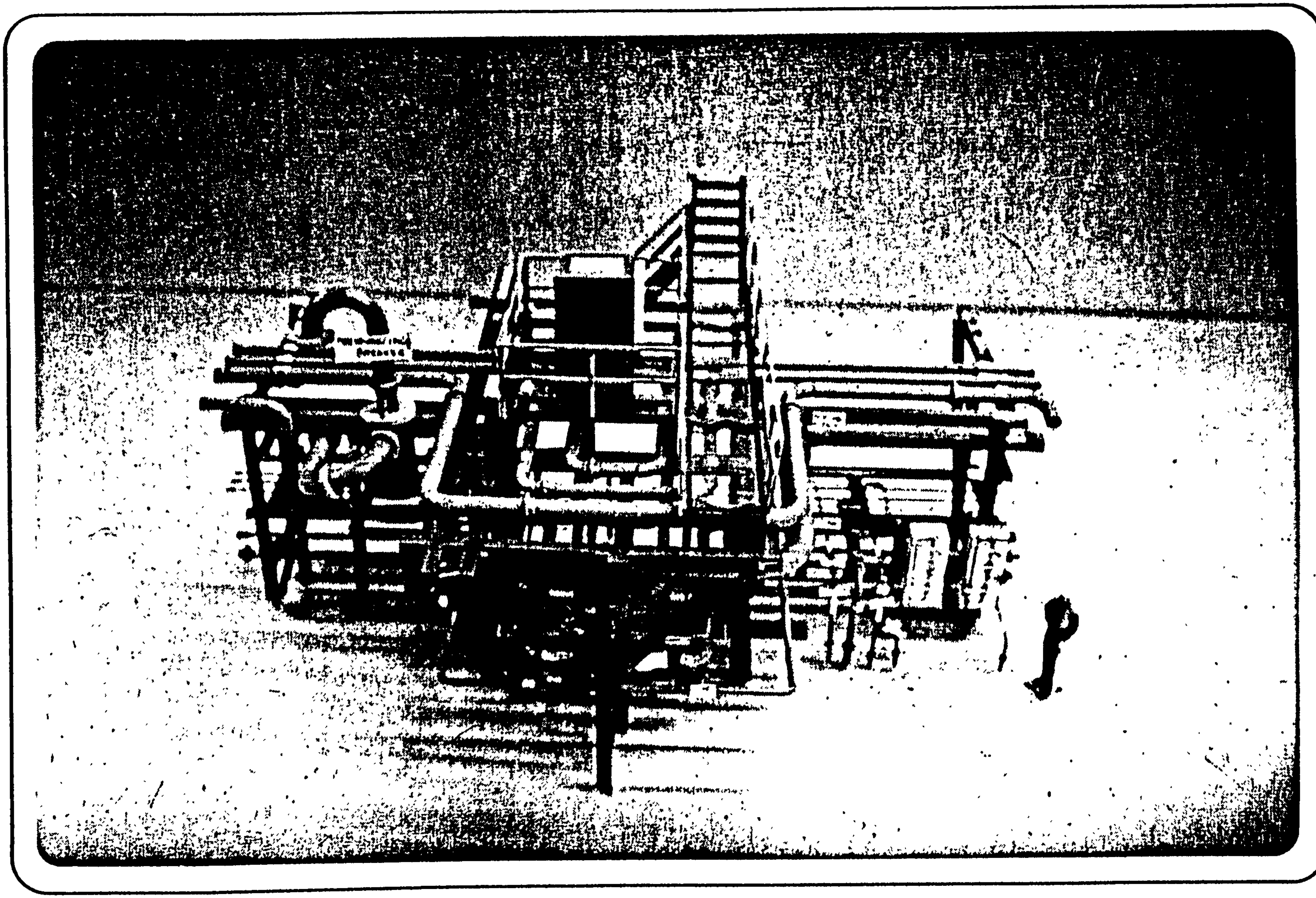
2. ON UNIT OUTFITTING



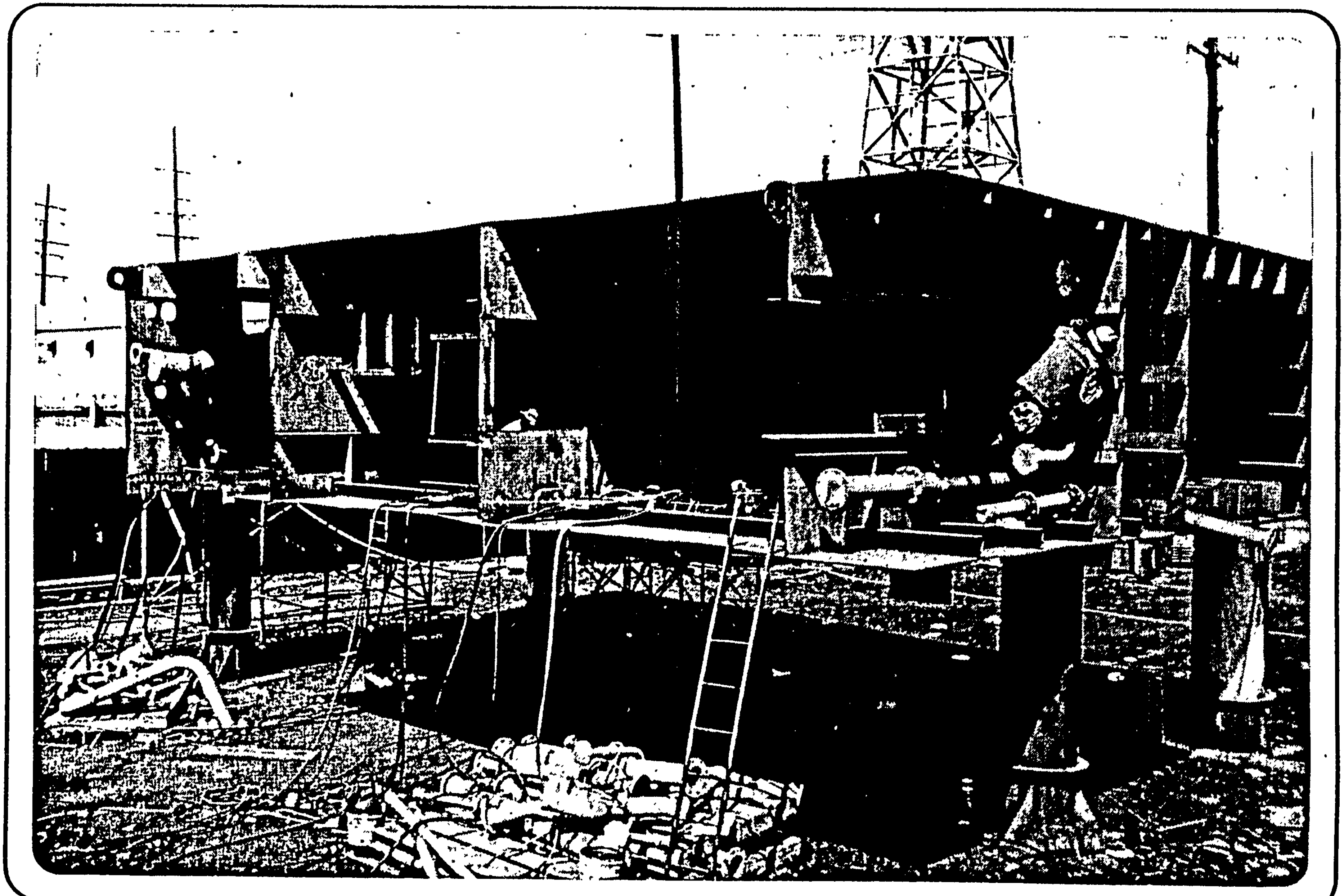
3. ON BOARD OUTFITTING

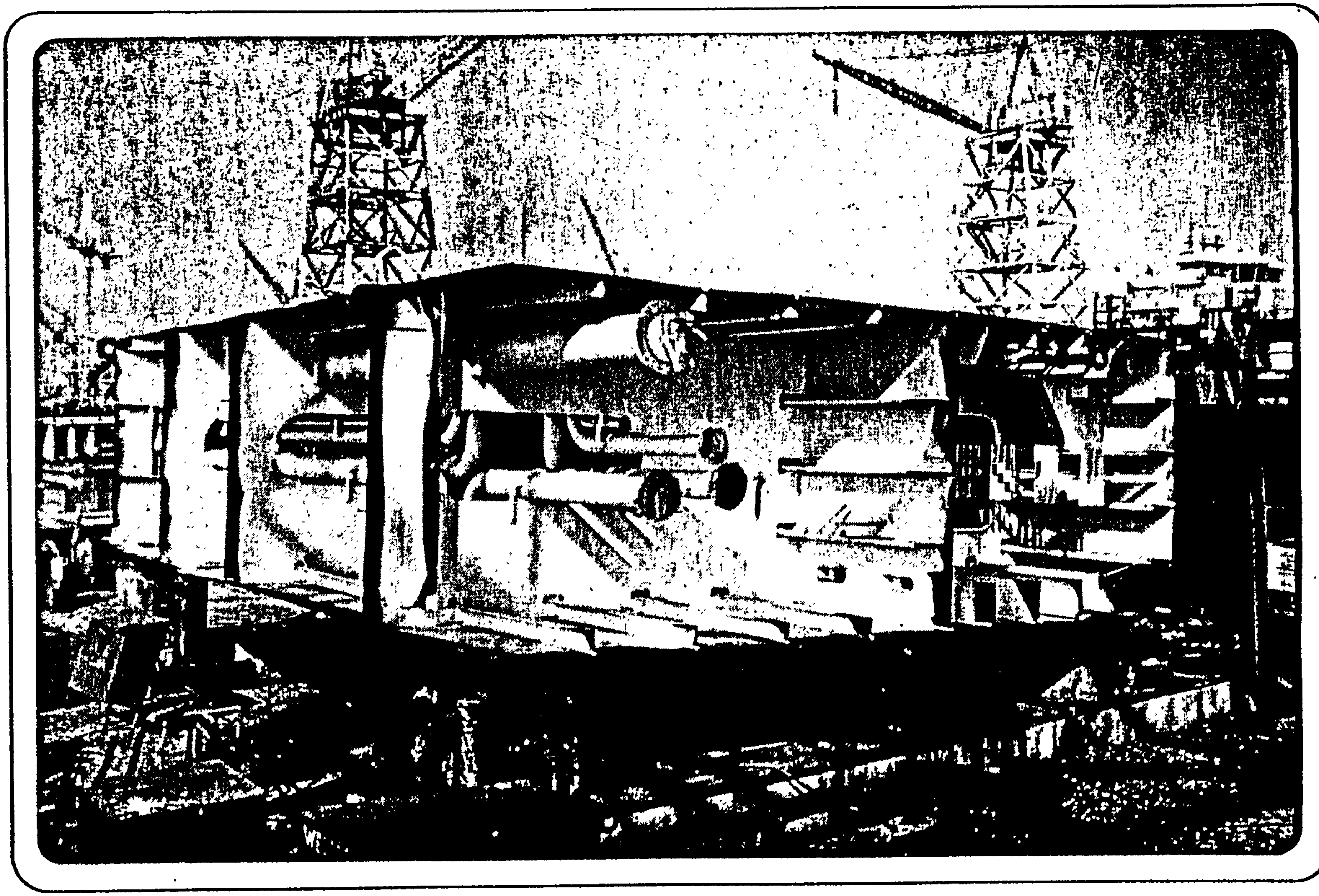




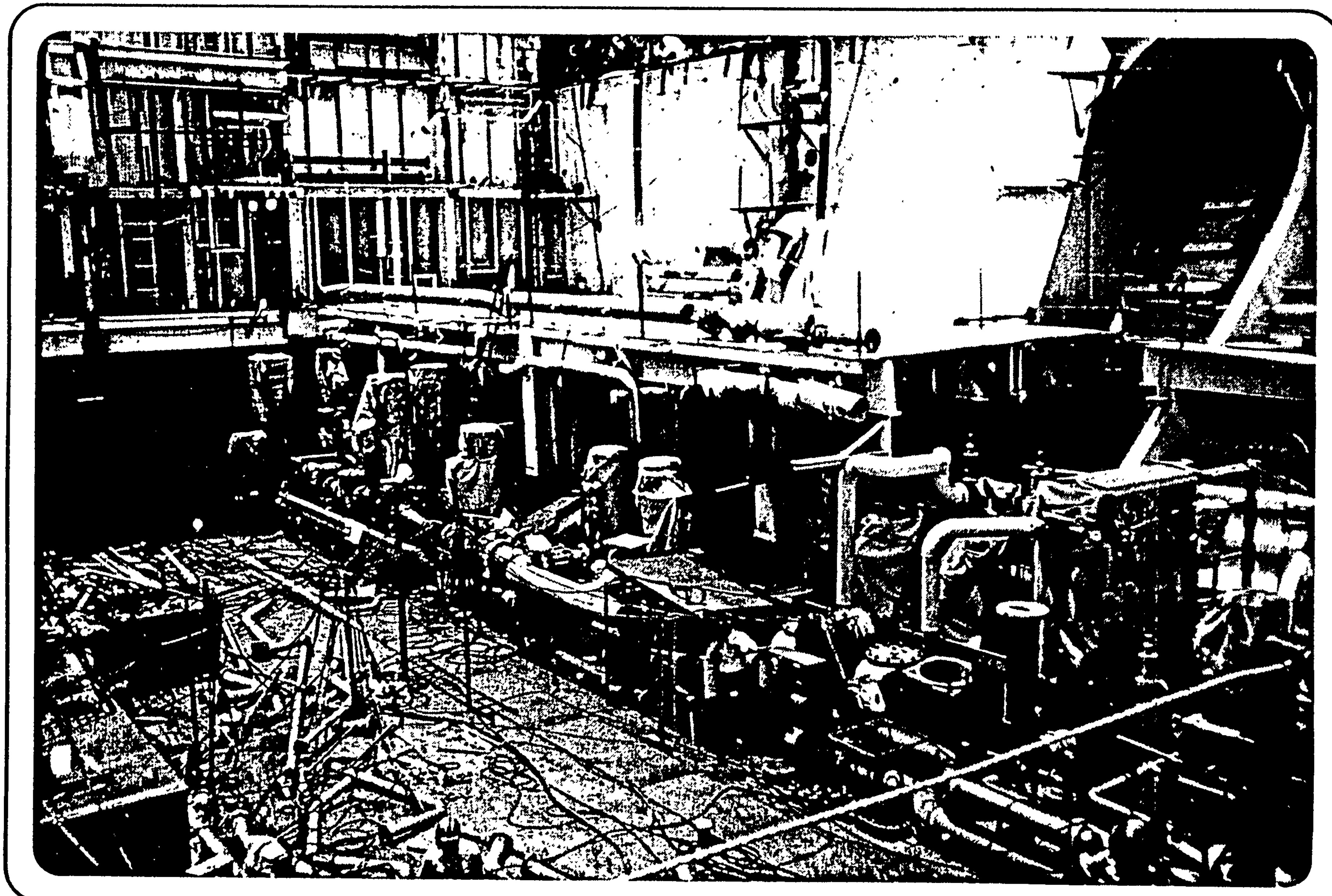


6-ZO MAIN DECK PIPE PACKAGE UNIT





8-ZO AN OUTFITTED AND PAINTED UNIT



JOB DESCRIPTION AT EACH STAGE
IN NEW HULL AND OUTFITTING
ENGINEERING PROCEDURE AT ASI

MARKETING STAGE DEFINITIONS

(A) - CONTRACT SPECIFICATION
- SHIP PROPORTIONS
- DRAWINGS
  - LINES
  - GENERAL ARRANGEMENT OF HULL AND MACHINERY
  - SUPERSTRUCTURE AND QUARTERS ARRANGEMENTS
  - MIDSHIP SECTION
  - SCANTLING SECTIONS
  - PRELIMINARY SHELL EXPANSION
  - CARGO OIL SYSTEM DIAGRAM (3)
  - INERT GAS, DEHUMIDIFICATION AND CARGO VENT DIAGRAMS (3) - 43 TANKS
  - ENGINE - RELATED AND OTHER PIPING DIAGRAMS
    - DIAG. MAIN ENGINE LUBE OIL SYSTEM
    - DIAG. MAIN ENGINE CYLINDER LUBE OIL SYSTEM
    - DIAG. LUBE OIL FILLINGS, TRANSFER AND PURIFIER SYSTEM
    - DIAG. STERN TUBE LUBE OIL SYSTEM
    - PIPING MATERIAL SCHEDULE
    - DIAG. ENGINE ROOM BILGE & BALLAST SYSTEM
    - DIAG. SEGREGATED BALLAST SYSTEM
    - DIAG. FEED AND CONDENSATE SYSTEM
    - DIAG. FIREMAIN - ENGINE ROOM
    - DIAG. FIREMAIN - ACCOMMODATIONS
    - DIAG. FIREMAIN AND FOAM SYSTEM - MAIN DECK
    - DIAG. CENTRAL FRESH WATER COOLING SYSTEM
    - DIAG. MAIN ENGINE JACKET WATER COOLING SYSTEM
    - DIAG. MAIN ENGINE PISTON COOLING WATER SYSTEM
    - DIAG. MAIN ENGINE FUEL VALVE COOLING WATER SYSTEM

JOB DESCRIPTION AT EACH STAGE

IN NEW HULL AND OUTFITTING

ENGINEERING PROCEDURE AT ASI

- DIAG. MAIN SEA WATER COOLING SYSTEM
- DIAG. AUXILIARY SEA WATER COOLING SYSTEM
- DIAG. VENTS, SOUNDING TUBES AND OVERFLOWS
- DIAG. STEAM SYSTEM
- DIAG. SHIP’S SERVICE, STARTING AND CONTROL AIR SYSTEM
- DIAG. FUEL OIL SERVICE SYSTEM
- DIAG. FUEL OIL FILLING, TRANSFER, AND PURIFICATION SYSTEM
- DIAG. DIESEL OIL SYSTEM
- DIAG. FUEL, SLUDGE AND MAIN ENGINE CLEANING SYSTEMS
- DIAG. TANK HEATING COILS

- CALCULATION OR OTHER TECHNICAL DATA

WEIGHT ESTIMATE
LONGITUDINAL STRENGTH
HYDROSTATICS
TANK CAPACITIES
BONJEANS CURVES
INTACT TRIM AND STABILITY DATA
LOADING CONDITIONS
DAMAGED STABILITY EVALUATION
WAKE SURVEY
RESISTANCE AND SELF-PROPELLED TESTS
ELECTRIC LOAD ANALYSIS
ELECTRIC ONE LINE DIAGRAM
VENT SYSTEM DEVELOPMENT AND DUCT OPENING

CONTRACT~

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

– PROCUREMENT SPECIFICATIONS

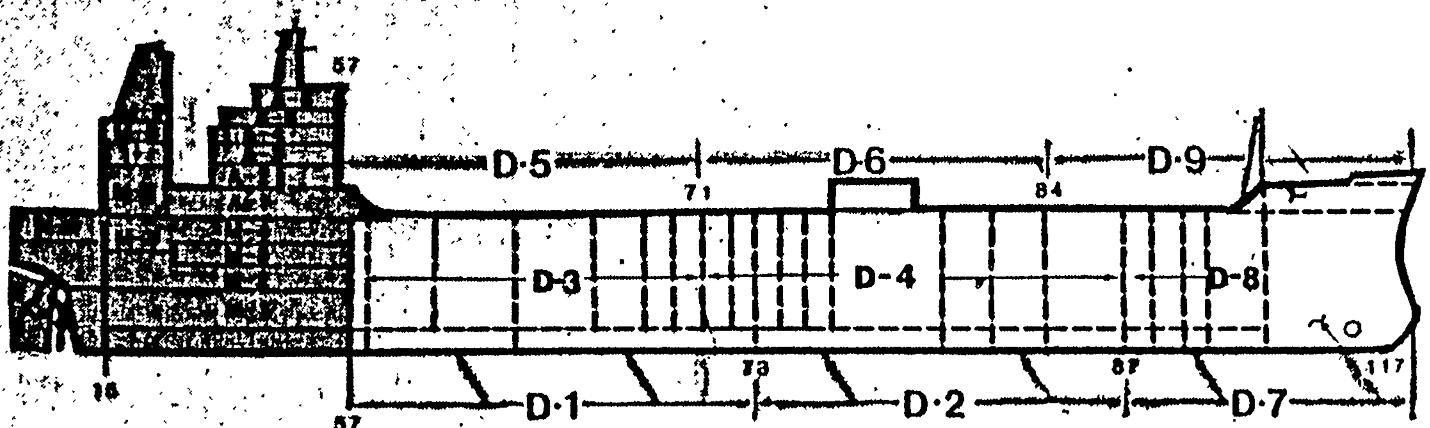
MAIN PROPULSION ENGINES
DIESEL GENERATORS
CARGO OIL PUMPS
BALLAST PUMPS
WASTE HEAT BOILER
ANCHOR WINDLASS
MOORING WINCHES
INERT GAS SYSTEM
DEHUMIDIFICATION UNITS
LUBE OIL, FUEL OIL, AND DIESEL OIL PURIFIERS
PLATE HEAT EXCHANGERS
ENGINE ROOM CONSOLE
CARGO SYSTEM CONSOLE
ELECTRIC MOTORS FOR CARGO PUMP
BOW THRUSTER
STEERING GEAR
BLENDING UNIT
AUXILIARY OIL FIRED BOILER
FUEL OIL PUMP / HEATER SETS

- OTHER REQUIRED DATA

- ✓ INITIAL REGULATORY BODY REVIEW
- ✓ PRELIMINARY UNIT DEFINITION
- ✓ IDENTIFICATION OF CONSTRUCTION METHOD
- ✓ ESTABLISH OUTFITTING ZONES FOR PURCHASING
- ✓ STUDY AND PRELIMINARY ASSIGN PACKAGE UNITS ON-BOARD AND ON UNIT MATERIAL

ADVANCED PURCHASING ZONES

OUTFITTING MATERIAL - ADVANCE PURCHASING ZONES				
	STANDARD TIME		DATES	
ZONE	FAB MAT'L REQ	PURCH'D MAT'L REQ	FAB MAT'L REQ	PURCH'D MAT'L REQ
D-4, D-5, D-6 D-1, D-2, D-3	K−4 MONTHS	K−2 MONTHS	5-14-82 HULL 1	7-14-82 HULL 1
M	K−3	K−2	6-14-82 HULL 1	7-14-82 HULL 1
A	K	K+2	9-14-82 HULL 1	11-14-82 HULL 1
D-7, D-8, D-9	K+1	K+3	10-14-82 HULL 1	12-14-82 HULL 1
ELECTRICAL	K−4	K+1	5-14-82 HULL 1	10-14-82 HULL 1

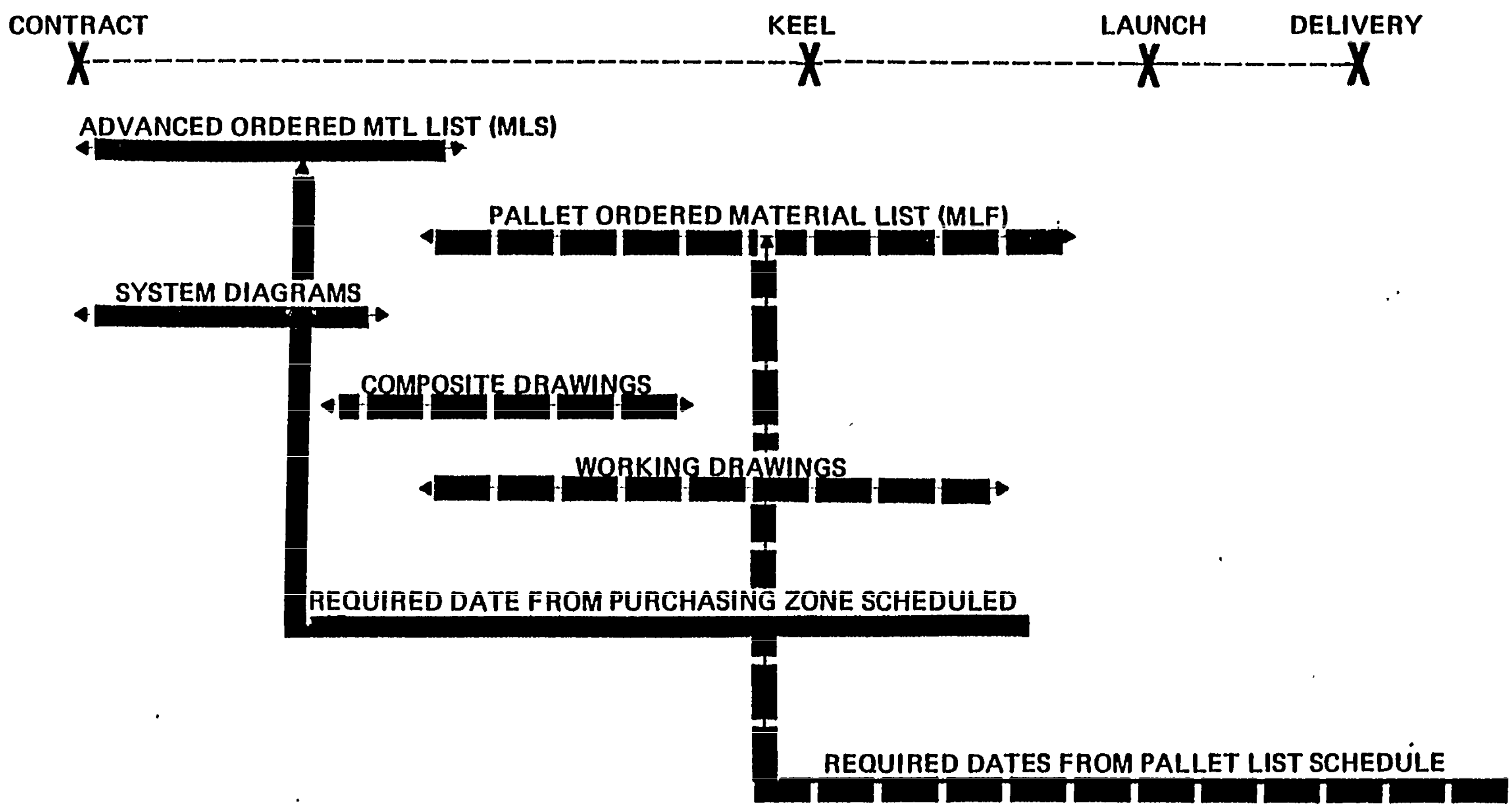


NO. 1
KEEL LAUNCH DELIVERY
9-14-82 5-14-83 10-15-83

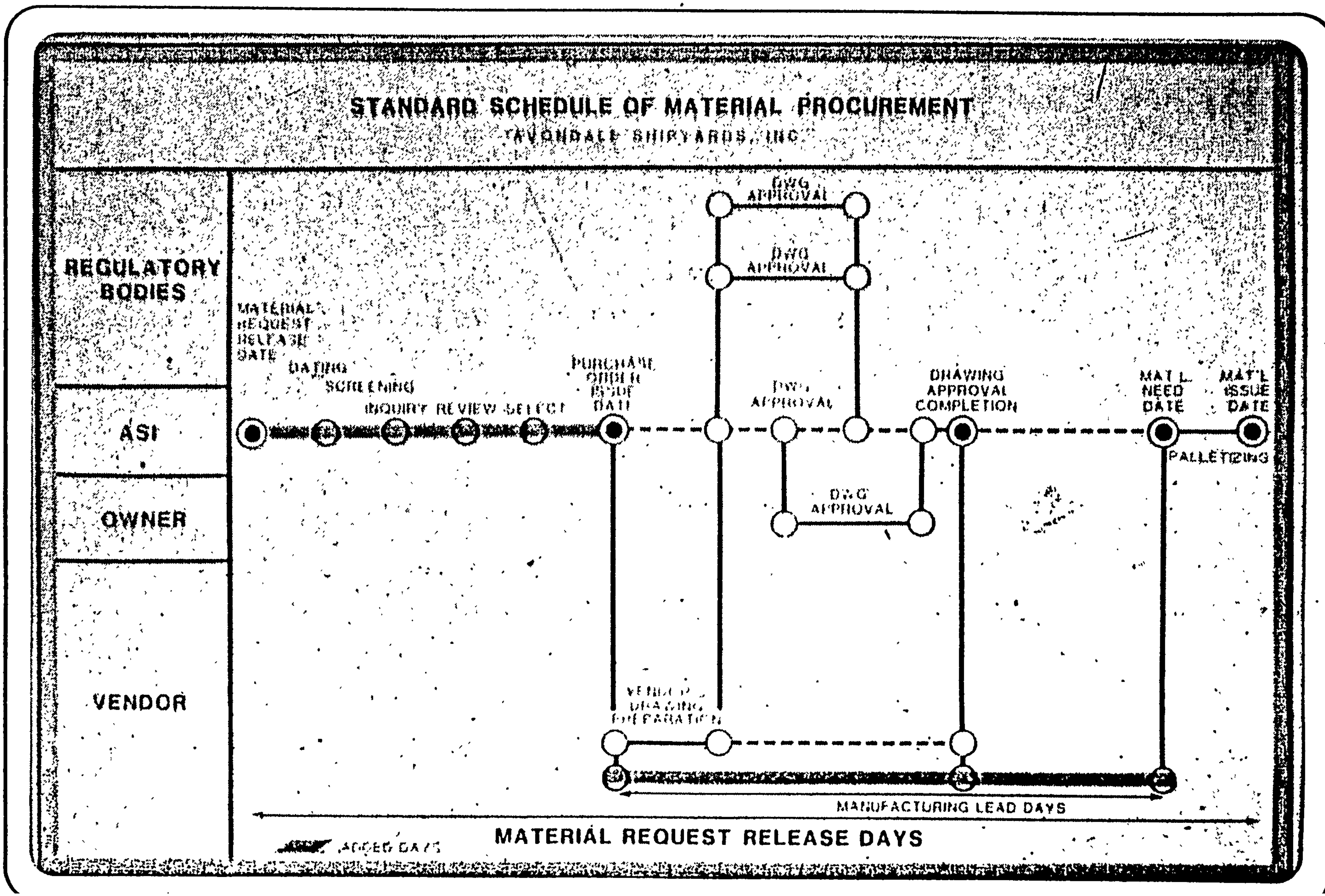
LEGEND
ZONE "M" MACHINERY SPACE
ZONE "A" ACCOMODATIONS
ZONE "D" DECK & HOLDS

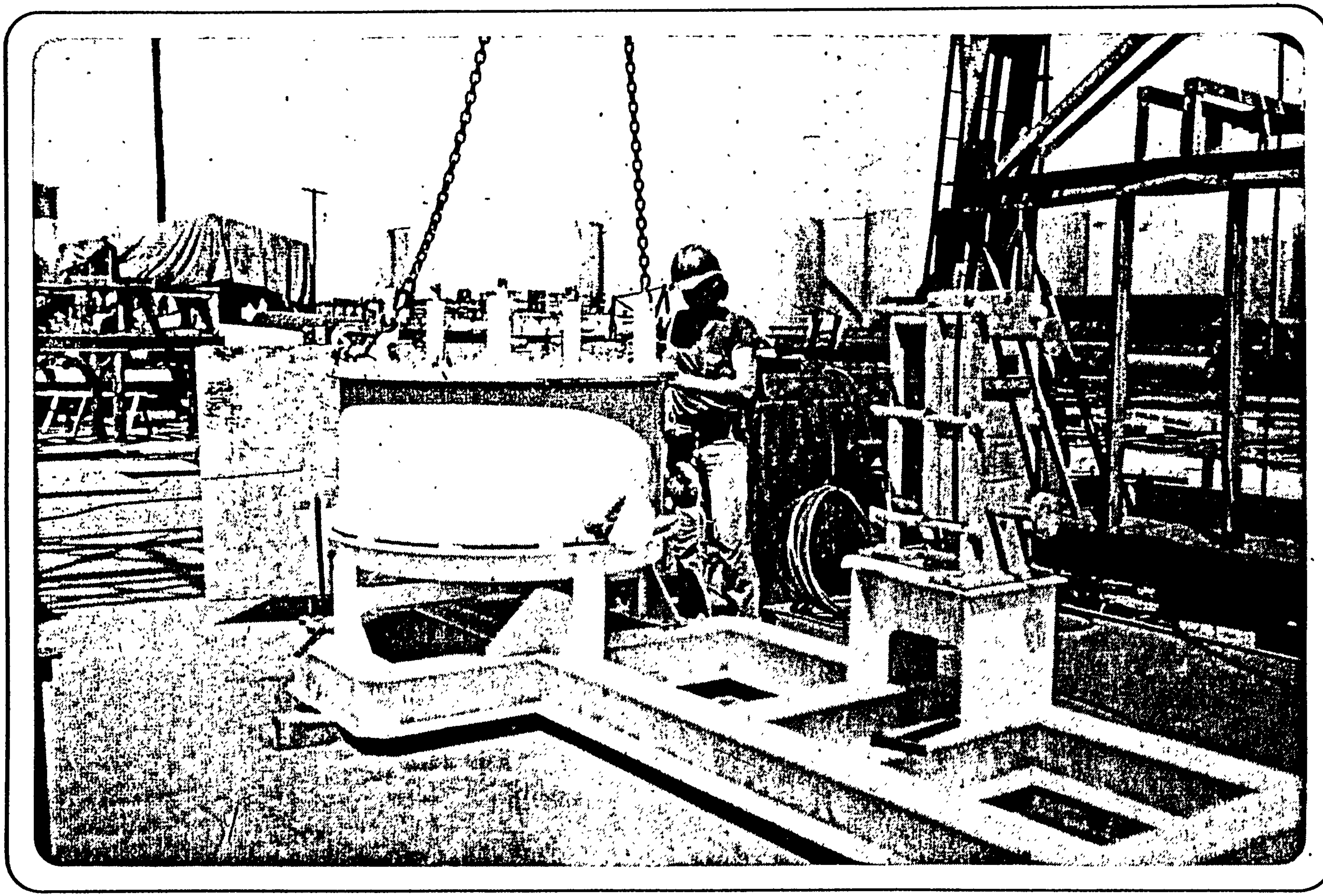
LENGTH 635 6'
BREADTH MLD. 106 0'
DEPTH 60 0'

RELATIONSHIP BETWEEN MATERIAL LISTS AND REQUIRED DATES



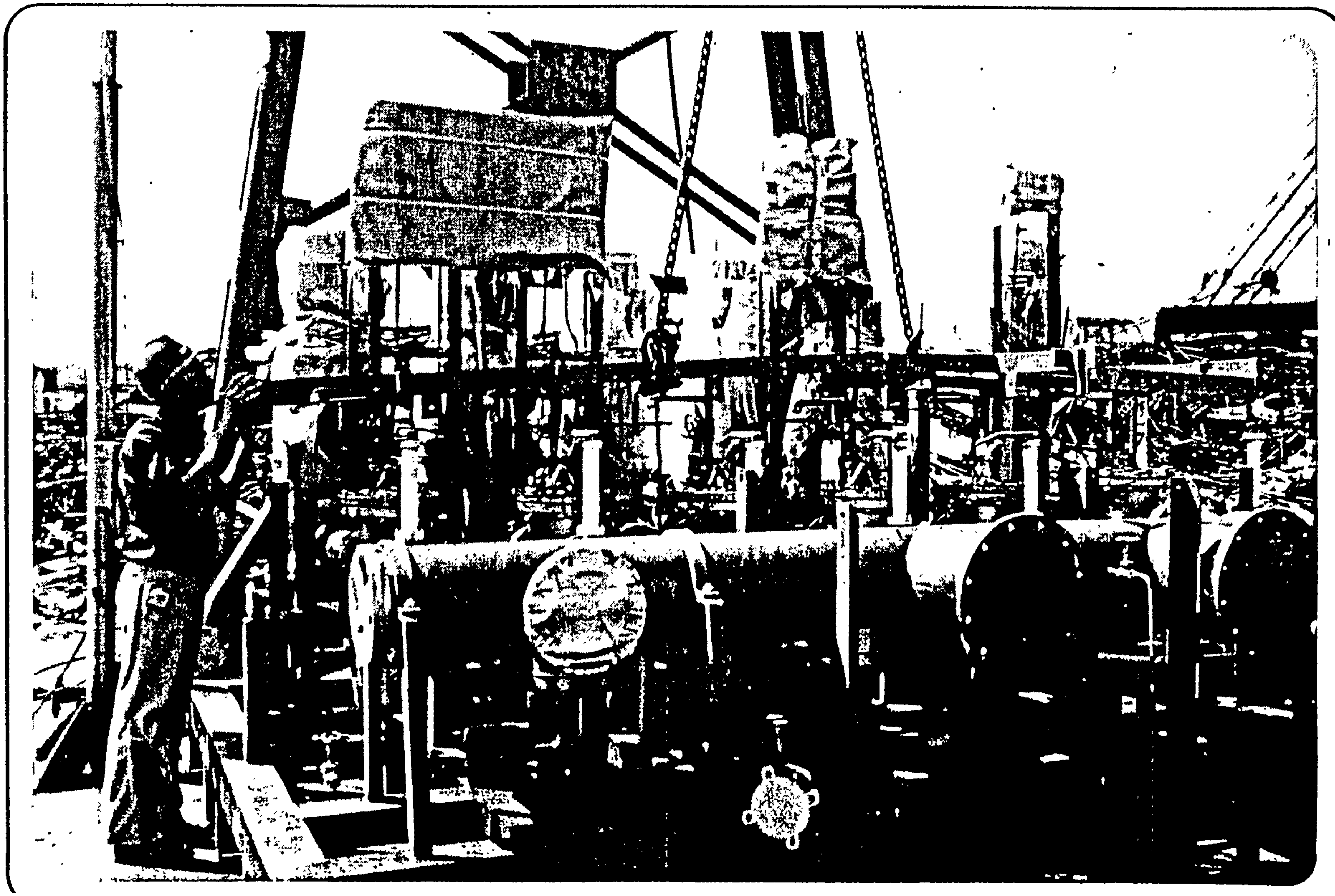
14-ZO MATERIAL AND REQUIRED DATE RELATIO

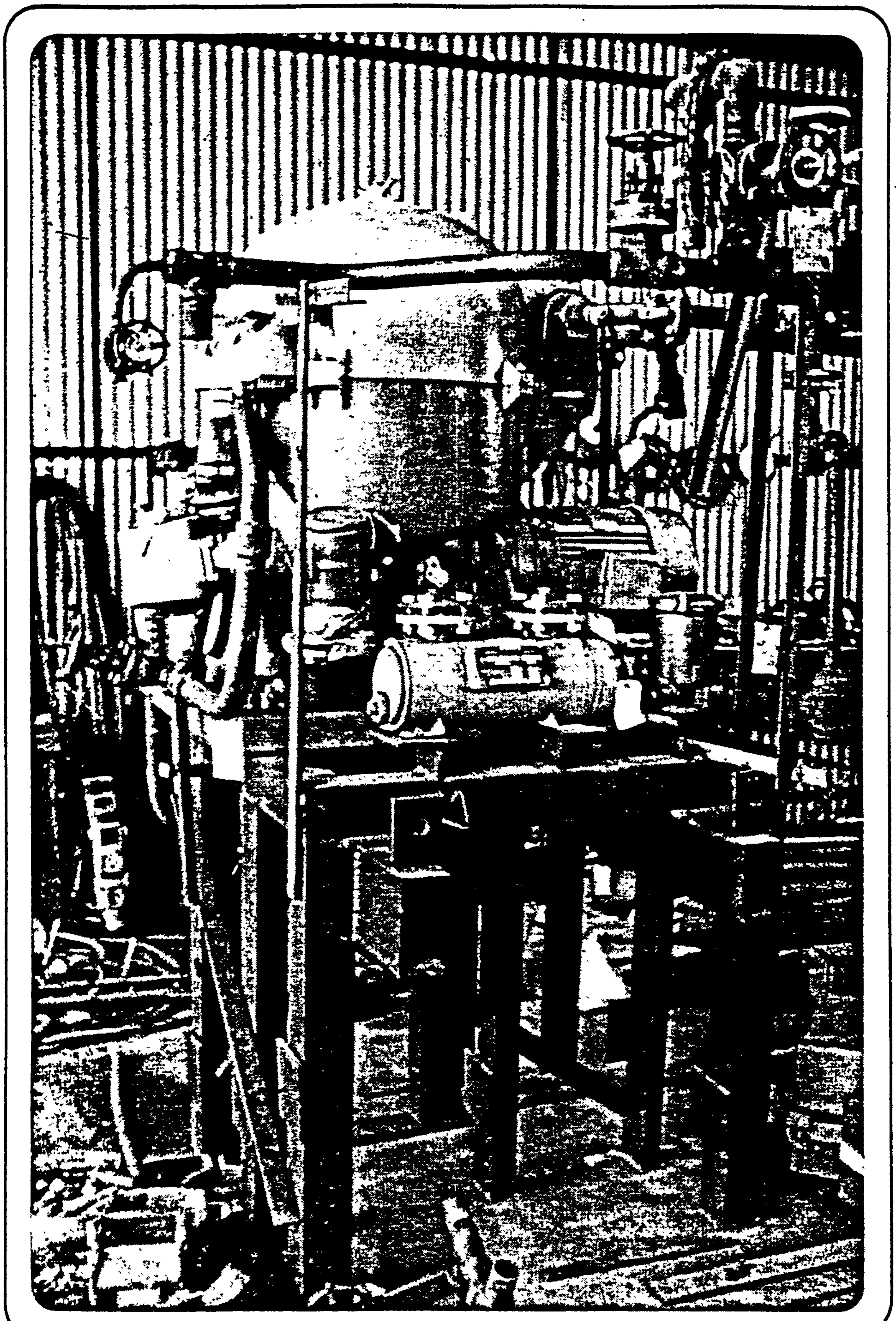

STANDARD SCHEDULE OF MATERIAL PROCUREMENT
REGULATORY BODIES
ASI
OWNER
VENDOR
DWG APPROVAL
DWG APPROVAL
DWG APPROVAL
DWG APPROVAL
MATERIAL REQUEST RELEASE DATE
DATING
SCREENING
INQUIRY REVIEW SELECT
PURCHASE ORDER ISSUE DATE
DRAWING APPROVAL COMPLETION
MAT'L NEED DATE
MAT'L ISSUE DATE
PALLETIZING
VENDOR DRAWING PREPARATION
MANUFACTURING LEAD DAYS
MATERIAL REQUEST RELEASE DAYS



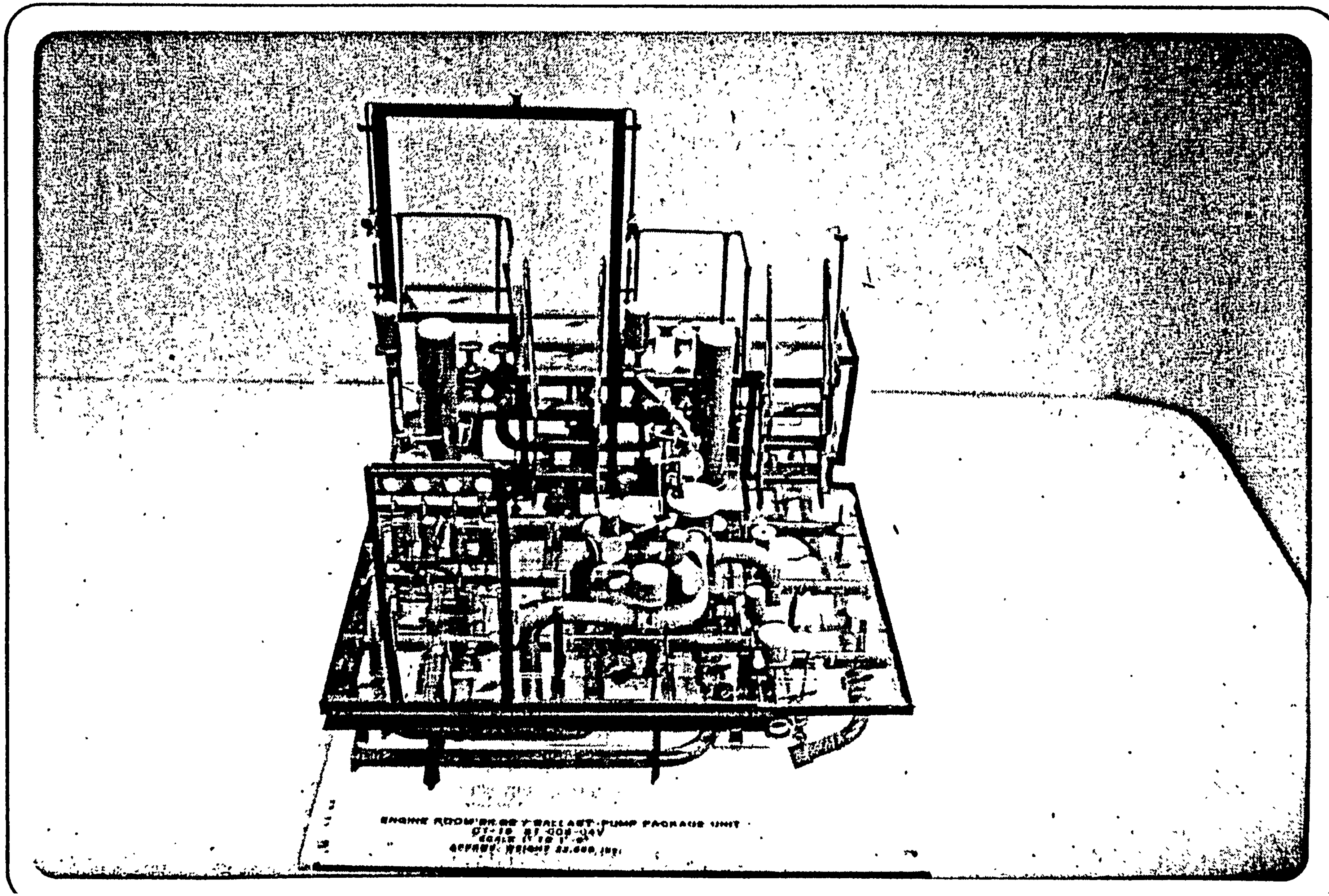
16-ZO BUILDING A PACKAGE UNIT

GRAPH 17.





18. 7C LUBE OIL PACKAGE UNIT


ENGINE ROOM BALLAST PUMP PACKAGE UNIT

ENGINEERING PROCEDURE AT ASI

CONTRACT SIGNING — GO MEETING

1 MONTH

PREPARATION STAGE

(B)
- FAIRED LINES (BY STATIONS) — FAIRED LINES (BY FRAMES)→
- LABOR AND MATERIAL ESTIMATE
- PURCHASE REQUEST FOR MAJOR ITEMS
- BUDGET
- ADJUSTMENT OF SPECIFICATION AND DRAWINGS
- BASIC UNIT ARRANGEMENT
- DRAWING ISSUE SCHEDULE
- SEA CHEST DESIGN (LOCATIONS AND NOZZEL LOCATIONS)
- OUTFIT PALLET LIST (PRELIMINARY)

3 MONTHS

- PROPELLER DESIGN
- FINALIZED APPLICATION OF PACKAGE UNITS, ON-UNIT AND ON-BOARD INSTALLATION OF MATERIAL
- OUTFIT MILESTONE SCHEDULE REVIEW
- TORSION ANALYSIS
- SHAFTING ARRANGEMENT

PALLET NUMBERS AND CODES

CONTRACT: C1-015

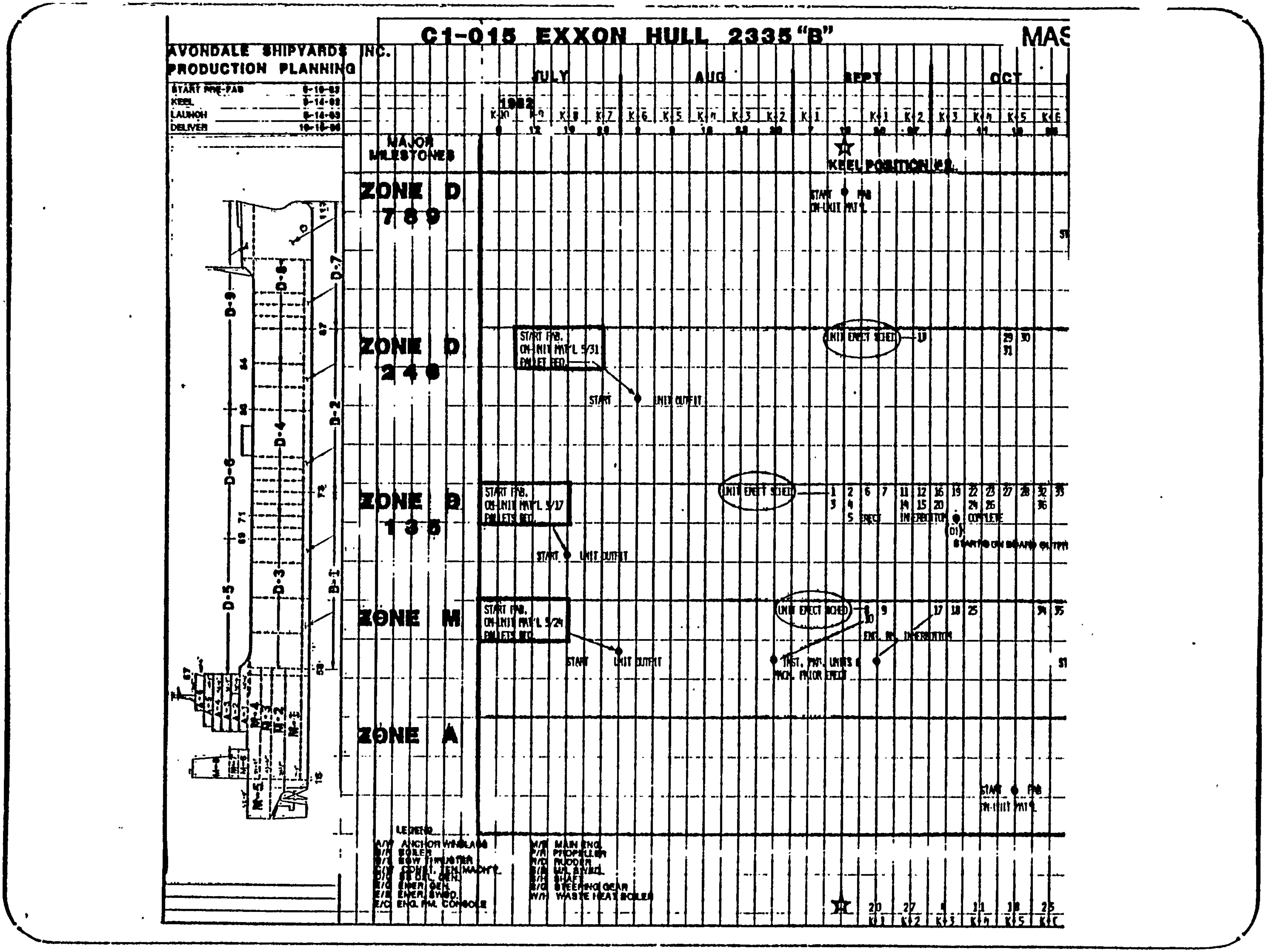
HULL: "B" 2335

PALLET CODES

S – During Sub Assy./On a Sub. Assy.
U – Before Turning – During Mn. Assy.
T – After Turning – Prior B & P
V – After B & P – Prior Erect

ON UNIT OUTFITTING

ZONE	UNIT	DESCRIP.	FRAME	LOC.	PALLET NUMBER STAGE	OUTFITTING DRAWING REQUIRED	START FAB OUTFIT MAT"L	PALLET REQUIRED
D1	2	IB	58-61	P	S, U, T, V	3/22	5/17	7/19
	3	IB	58-61	S	S, U, T, V			
	1	IB	61-65	CL	S, U, T, V	3/29	5/24	7/26
	4	IB	65-69	CL	S, U, T, V			
	5	IB	69-73	CL	S, U, T, V			
M1	8	IB	44-58	P	S, U, T, V			
	9	IB	28-49	CL	S, U, T, V			
	10	IB	44-58	S	S, U, T, V			
D3	16	BHD	64	CL	S, U, T, V			



22-ZO MILESTONE SCHEDULE

SPECIAL DESIGNATION CODES
A/W Anchor Windlass
B/R Boiler
B/T Bow Thruster Mach'y
C/W Const. Ten Winch
D/G SS Dsl. Gen.
E/G Emerg. Gen.
E/C Eng. Rm. Console
M/E Main Eng.
P/R Propeller
R/D Rudder
S/B Main Swbd.
S/H Shaft
S/G Steering Gear
W/H Waste Heat Boiler

PALLET NUMBERS/CODE

DRAWING REQ. SCHEDULE

CONTRACT C1-0015 "B"

HULL 2335 EXXON

INSTALLATION CODE
X = Prior Closing
Y = Easy Access/Prior Launch

ON BOARD OUTFITTING

ZONE SUB-ZONE	LOCATION	PALLET NO/CODE	OUTFIT DWG. REQ.	START FAB	START INSTALL
M-1	ENG. RM.LWR.LVL				
M-1	ENG. RM.LWR.LVL	20-M11-1X	6/28/82	8/23/83	10/25/82
M-1	ENG. RM.LWR.LVL	20-M12-1X			
M-1	ENG. RM.LWR.LVL	07-M11-1X			
M-1	ENG. RM.LWR.LVL	07-M12-1X			
M-1	ENG. RM.LWR.LVL	06-M11-1X			
M-1	ENG. RM.LWR.LVL	06-M12-1X			
M-1	ENG. RM.LWR.LVL	16-M11-1X			

JOB DESCRIPTION AT EACH STAGE
IN NEW HULL AND OUTFITTING
ENGINEERING PROCEDURE AT ASI

GO MEETING — 4 MONTHS — K MEE1TING

2 MONTHS	1 MONTH	1 MONTH
KEY PLAN CARGO BLOCK	AFT, PEAK AND E. R. SUPERSTRUCTURE	FORE BODY FWD. OF CARGO BLOCK

KEYPLAN STAGE

- FRAME BODY PLAN (BASED ON FAIRED LINES)
- SHELL EXPANSION
- FORE CONSTRUCTION
  - DECK, FLAT AND STRINGER
  - ELEVATION (LONGITUDINAL BULKHEAD AND GIRDER)
  - EVERY FRAME SECTION AND TRANSVERSE BULKHEAD
- HOLDPAR CONSTRUCTION
  - DECKANDFLAT
  - ELEVATION
  - EVERY FRAME SECTION AND TRANSVERSE BULKHEAD
- ENGINE ROOM AND AFT CONSTRUCTION
  - DECK AND FLAT
  - ELEVATION
  - EVERY FRAME SECTION AND TRANSVERSE BULKHEAD
- SUPERSTRUCTURE CONSTRUCTION
- SET-UP OF SPADE DATABASE
- APPROVAL OF REGULATORY BODY AND OWNER
- FINAL UNIT ARRANGEMENT AND LIST
- 70%-75%STEEL BILLED-BUYSTEEL ASNEEDED
  DETERMINE PLATES TOBE FURNACED BY ''K'' MEETING
- ISSUE FINAL OUTFIT MILESTONE SCHEDULE
- ISSUE FINAL PALLET LIST

STYLE OF DRAWING:

OVERVIEW OF STRUCTURE

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI

K MEETING

4 MONTHS

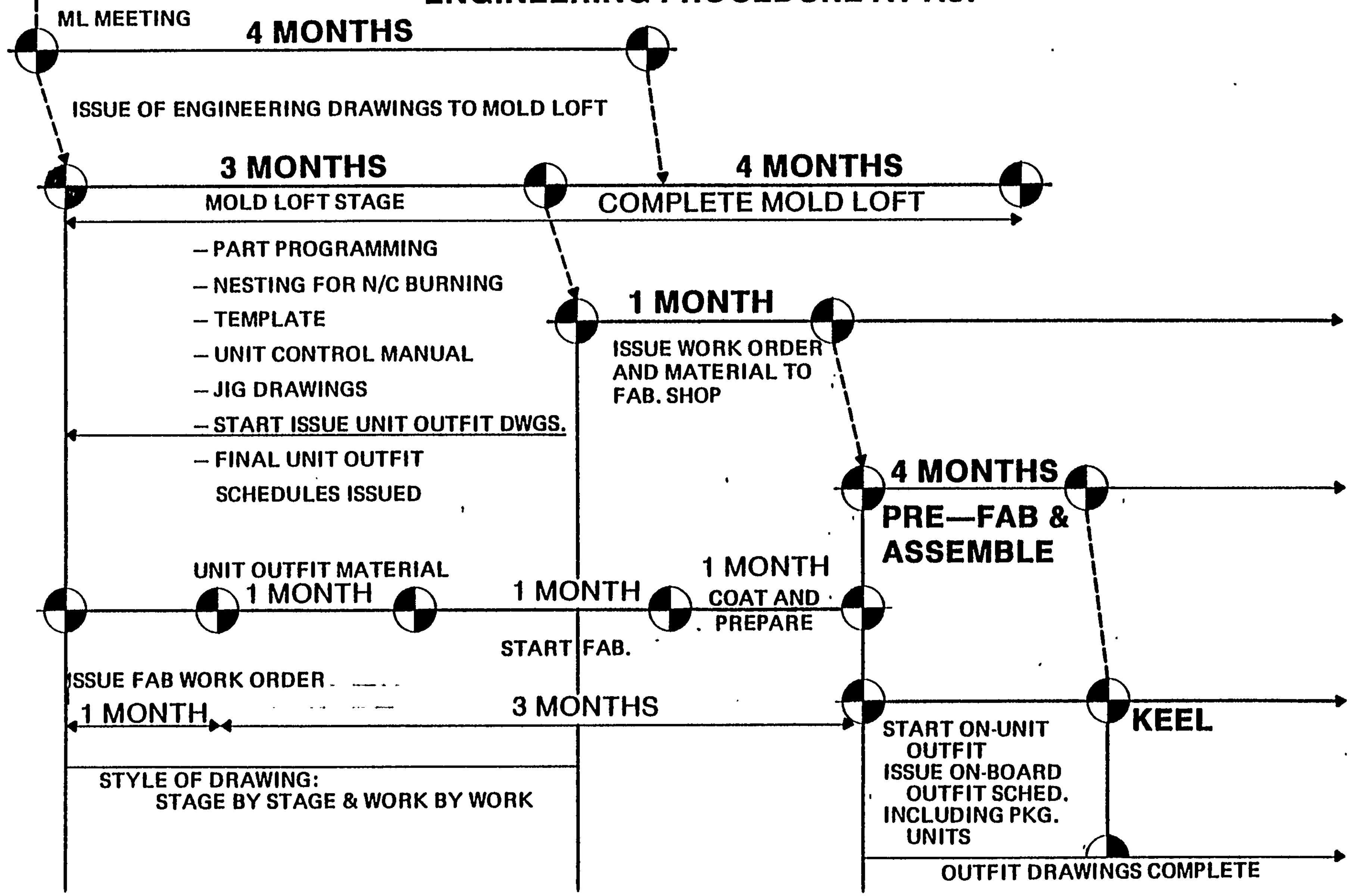
ML MEETING

ENGINEERING DRAWINGS STAGES

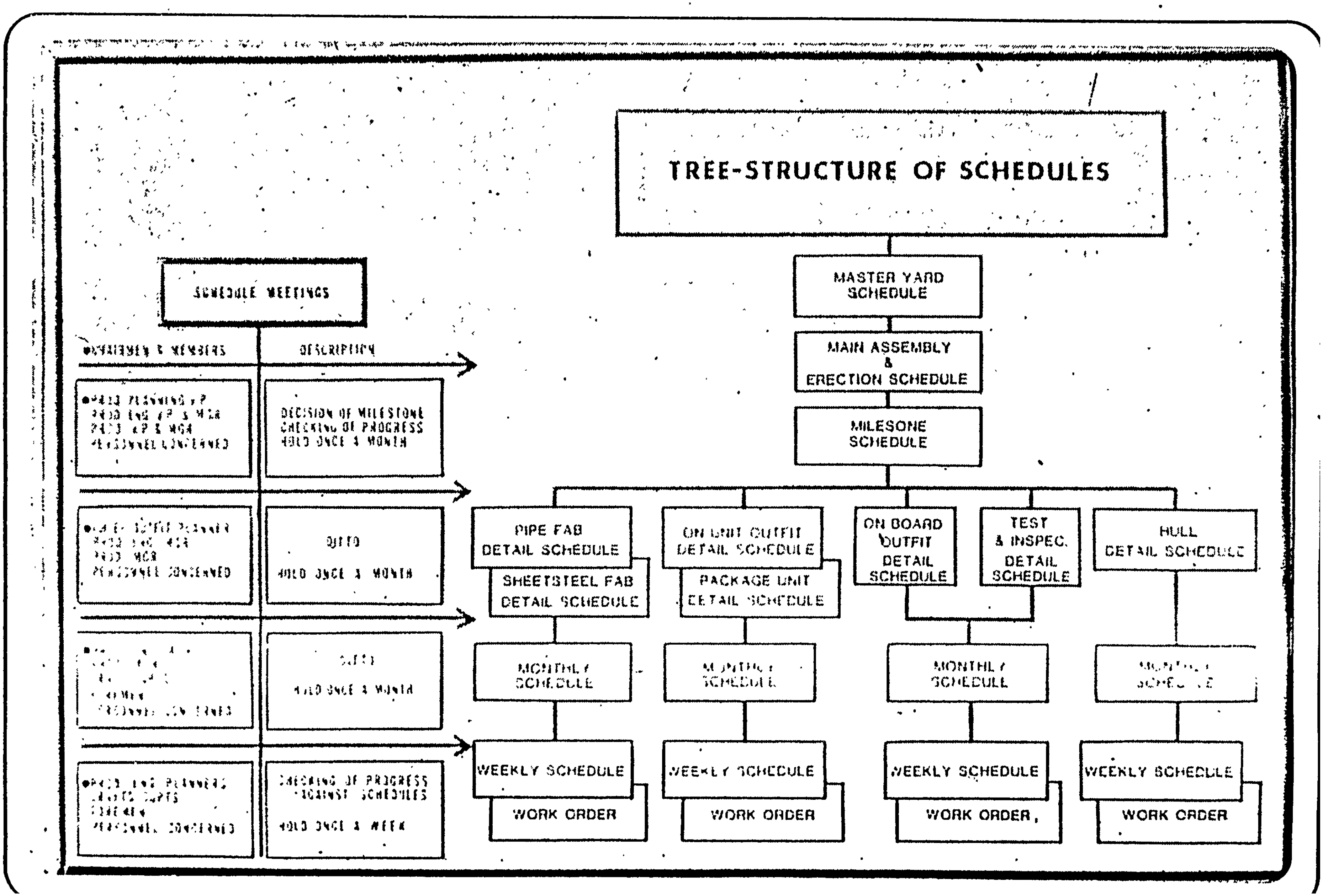
- STRUCTURE DETAILINGS
- PENETRATION CUT-OUT
- PIECE NAME
- STEEL PLATE TAKE-OFF
- UNIT PARTS LIST
- DEFINITION OF EDGE PREPARATION AND EXCESS
- SET UP OF PARTS DATA BASE
- SUB-UNIT BREAKDOWN
- HULL CASTING
- RUDDER SUPPORT SYSTEM AND RUDDER
- CLOSURES (DOOR AND WINDOW LIST)
- ANCHOR HANDLING SYSTEM
- MOORING ARRANGEMENT
- CARGO HANDLING SYSTEM
- SEA CHEST
- CARGO CONTAINMENT
- UNIT OUTFIT DRAWINGS DEVELOPMENT AND PALLET L/M
- START WEEKLY OUTFIT MEETINGS – ENGINEERING AND PRODUCTION

STYLE OF DRAWING:

JOB DESCRIPTION AT EACH STAGE IN NEW HULL AND OUTFITTING ENGINEERING PROCEDURE AT ASI



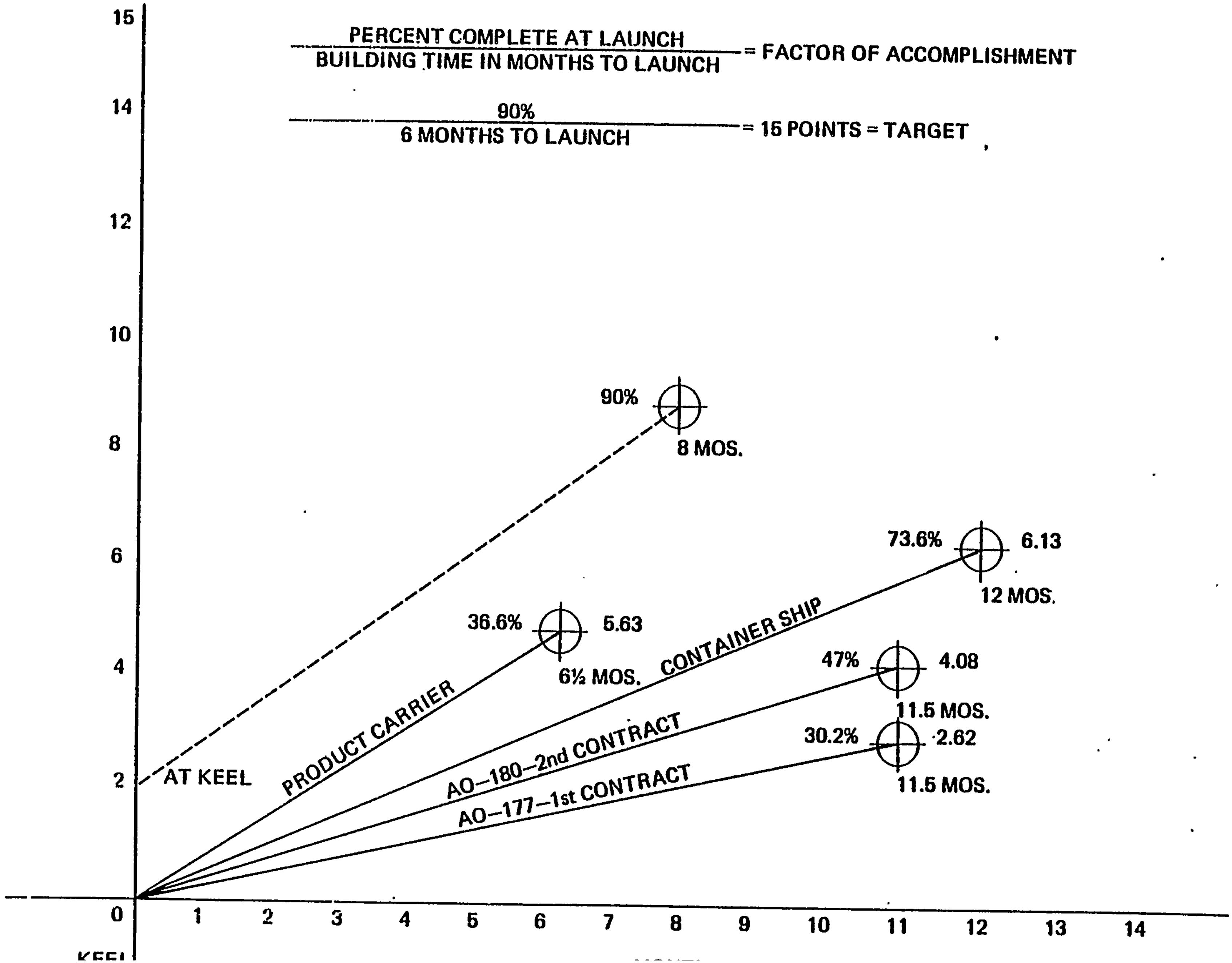
25K-ZO "ML" MEETING TO "KEEL" – SECTION



TREE-STRUCTURE OF SCHEDULES
MASTER YARD SCHEDULE
MAIN ASSEMBLY & ERECTION SCHEDULE
MILESONE SCHEDULE
PIPE FAB DETAIL SCHEDULE
SHEETSTEEL FAB DETAIL SCHEDULE
PACKAGE UNIT DETAIL SCHEDULE
ON BOARD OUTFIT DETAIL SCHEDULE
TEST & INSPEC. DETAIL SCHEDULE
HULL DETAIL SCHEDULE
WEEKLY SCHEDULE
WORK ORDER
SCHEDULE MEETINGS
DESCRIPTION
DECISION OF MILESTONE
CHECKING OF PROGRESS
HOLD ONCE A MONTH
HOLD ONCE A MONTH
CHECKING OF PROGRESS AGAINST SCHEDULES
HOLD ONCE A WEEK

MAJOR SCHEDULES ISSUED AT ASI

TYPE SCHEDULE	PURPOSE & USE	GENERATED BY	DISTRIBUTED TO	FREQUENCY OF
MASTER YARD SCHEDULE	TOTAL WORK LOAD INDICATOR PROJECT UP TO 3 YEARS	PRODUCTION PLANNING	TOP MANAGEMENT	MONTHLY
JOB STAGE DESCRIPTION FOR HULL & OUTFIT ENGINEERING	ESTABLISH NEED DATES FOR INFOR & DWGS. CONTRACT ORIENTED	ENGINEERING PRODUCTION PLANNING & ADVANCED PRGMS.	TOP MANAGEMENT	PRE-CONTRACT
HULL UNIT BREAKDOWN	IDENTIFY MODULAR SECTIONING OF SHIP	PRODUCTION PLANNING	TOP MANAGEMENT ENGINEERING PRODUCTION PURCHASING	PRE-CONTRACT
ADVANCED PURCHASING ZONES	PROJECT STANDARD ZONE DELIV. DATES	PRODUCTION PLANNING	DITTO	PRE-CONTRACT
MASTER MILE STONE	ESTABLISH ALL KEY EVENTS AND ALL MAJOR MILESTONES	PRODUCTION PLANNING	DITTO	AFTER CONTRACT AND MONTHLY UPDATE
PALLET SCHEDULE	ESTABLISH STAGE CODES AND DATES FOR MATERIAL PALLETS	PRODUCTION PLANNING	DITTO	AFTER CONTRACT
MAIN ASSEMBLY AND ERECTION	ESTABLISH ERECTION SEQUENCE AND UNIT IDENTIFICATION	PRODUCTION PLANNING	TOP MANAGEMENT ENGINEERING PRODUCTION	AFTER CONTRACT MONTHLY REVIEW
PRE-FAB & SUB ASSEMBLY	IDENTIFY LEAD TIME & STAGES OF FABRICATION	PRODUCTION PLANNING	DITTO	AFTER CONTRACT MONTHLY REVIEW
DRAWING SCHEDULE	IDENTIFY ALL DWGS AND ESTABLISH ALL NEED DATES	ENGINEERING	DITTO	AFTER CONTRACT
DRYDOCK & WHARF SCHEDULE	ESTABLISH DRYDOCK PERIODS AND WHARF TIME & LOCATION	PRODUCTION PLANNING	DITTO	MONTHLY
LONG TERM PROCESS LANES	LONG TERM PRODUCT WORK BREAKDOWN FOR HULL WORK	PRODUCTION PLANNING	DITTO	AFTER CONTRACT REVIEW MONTHLY
SHORT TERM PROCESS LANES	SHORT TERM PRODUCT WORK BREAKDOWN FOR HULL WORK	FABRICATION SHOP PLANNERS	DITTO	AFTER CONTRACT REVIEW WEEKLY
COMPARTMENT COMPLETION	ESTABLISH COORDIN-ATED COMPLETIONS OF COMPARTMENTS	PRODUCTION FIELD PRODUCTION PLANNING	DITTO	AFTER CONTRACT REVIEW WEEKLY
MECHANICAL TEST SCHEDULE	ESTABLISH COORDIN-ATED COMPLETIONS OF TEST PROCEDURES	PRODUCTION FIELD PRODUCTION PLANNING	DITTO	AFTER CONTRACT REVIEW WEEKLY


PERCENT COMPLETE AT LAUNCH / BUILDING TIME IN MONTHS TO LAUNCH = FACTOR OF ACCOMPLISHMENT
90% / 6 MONTHS TO LAUNCH = 15 POINTS = TARGET
90%
8 MOS.
73.6%
6.13
12 MOS.
36.6%
5.63
6½ MOS.
CONTAINER SHIP
47%
4.08
11.5 MOS.
30.2%
2.62
11.5 MOS.
PRODUCT CARRIER
AT KEEL
AO–180–2nd CONTRACT
AO–177–1st CONTRACT
15
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

PARAMETERS FOR PROGRESS

STEEL- FNDS ETC.	-	TONS
PIPE & P.D's	-	TONS
MACHINERY	-	TONS
STEETMETAL	-	TONS
ELECTRICAL	-	TONS/LINEAL FOOTAGE
INSULATION	-	TONS/SQ FOOTAGE
PAINTING	-	SQ FOOTAGE
OUTFITTING	-	TONS

RECOMMENDED AREAS OF CHANGE

BY IHI

1. RE-ORGANIZE ENGINEERING FUNCTIONS

2. RE-ORGANIZE PRODUCTION PLANNING & PRODUCTION ENGINEERING

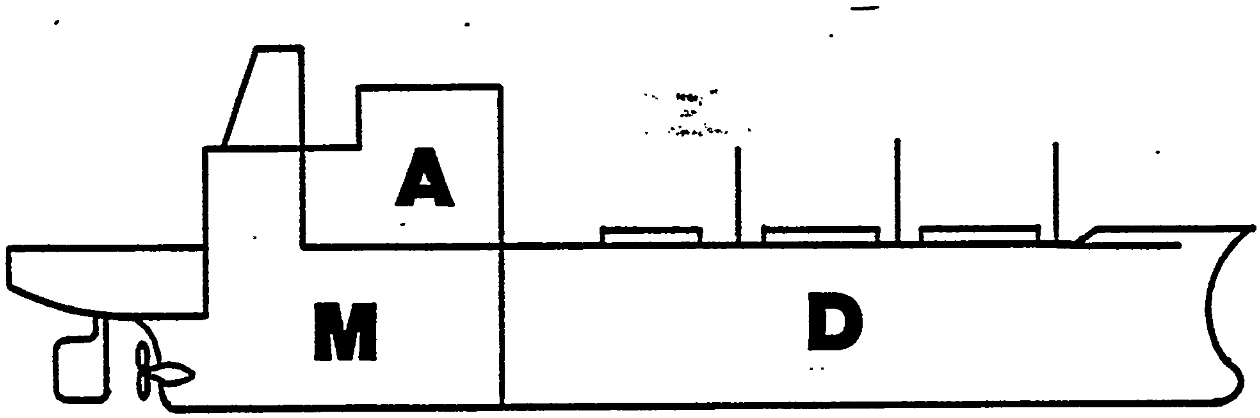
3. RE-ORGANIZE PRODUCTION WORK GROUPS

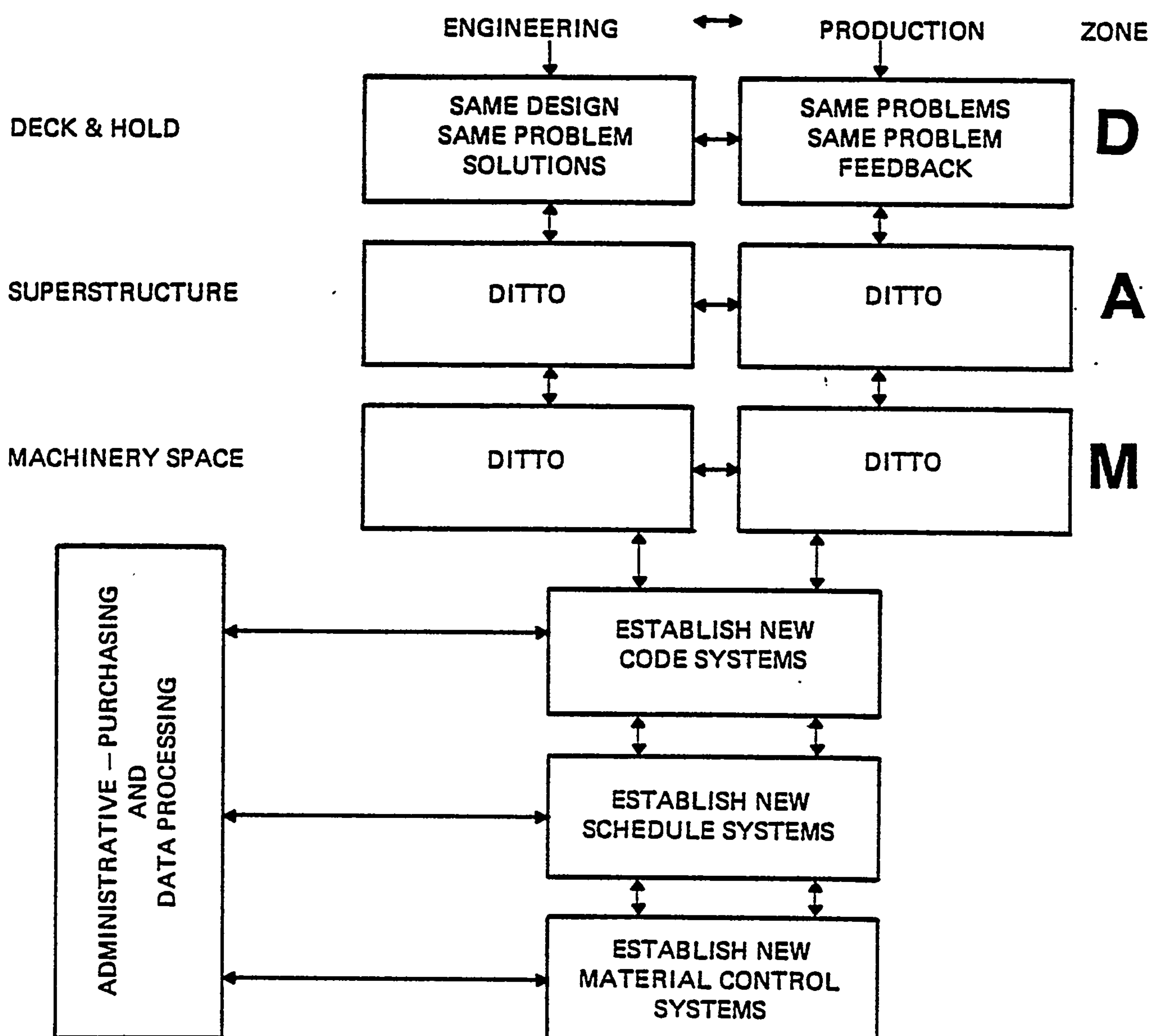
4. CHANGE THE CODE SYSTEM

5. CHANGE THE SCHEDULING SYSTEM

6. CHANGE THE MATERIAL CONTROL SYSTEM

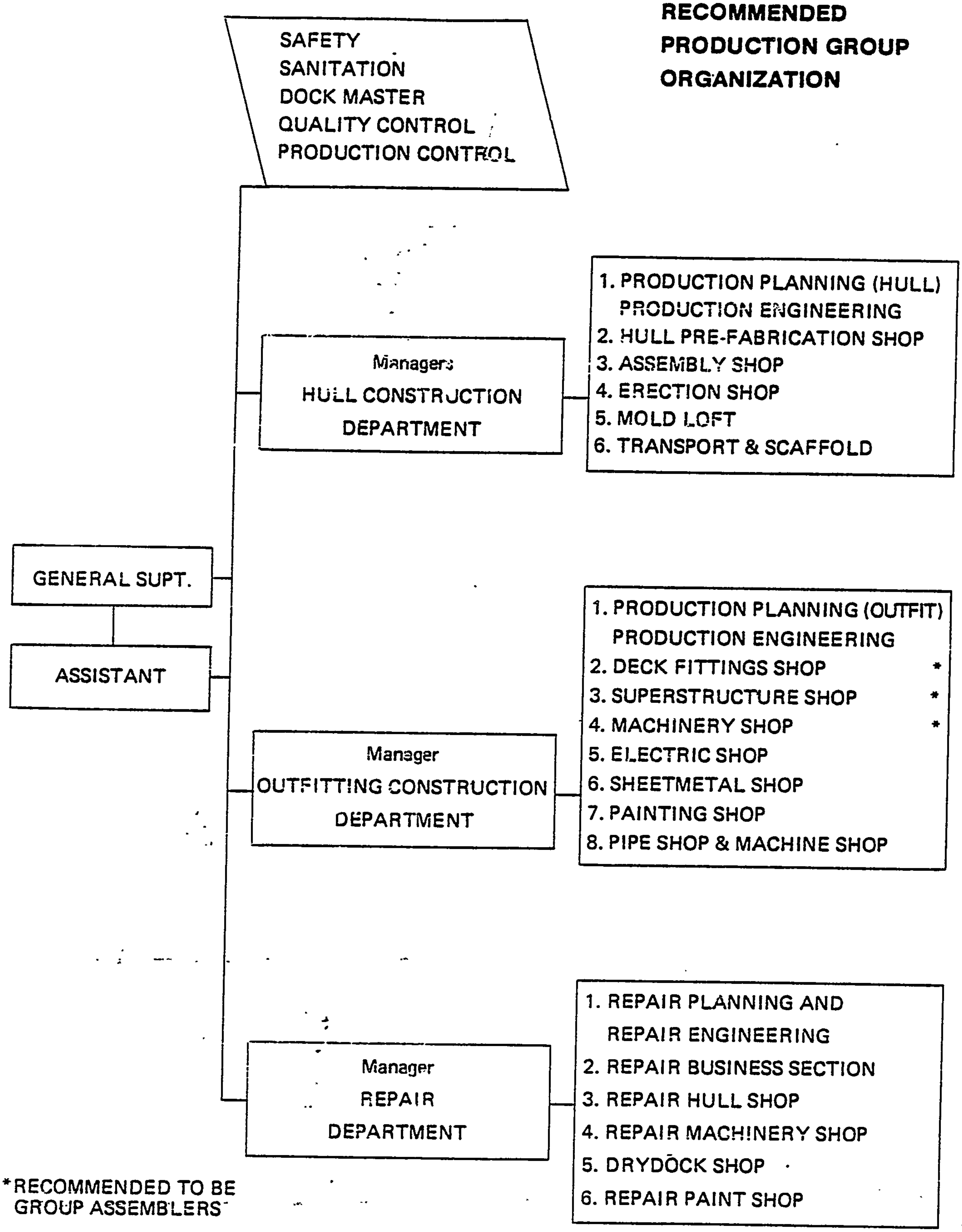
7. CHANGE IN COMPUTER AND DATA PROCESSIN(





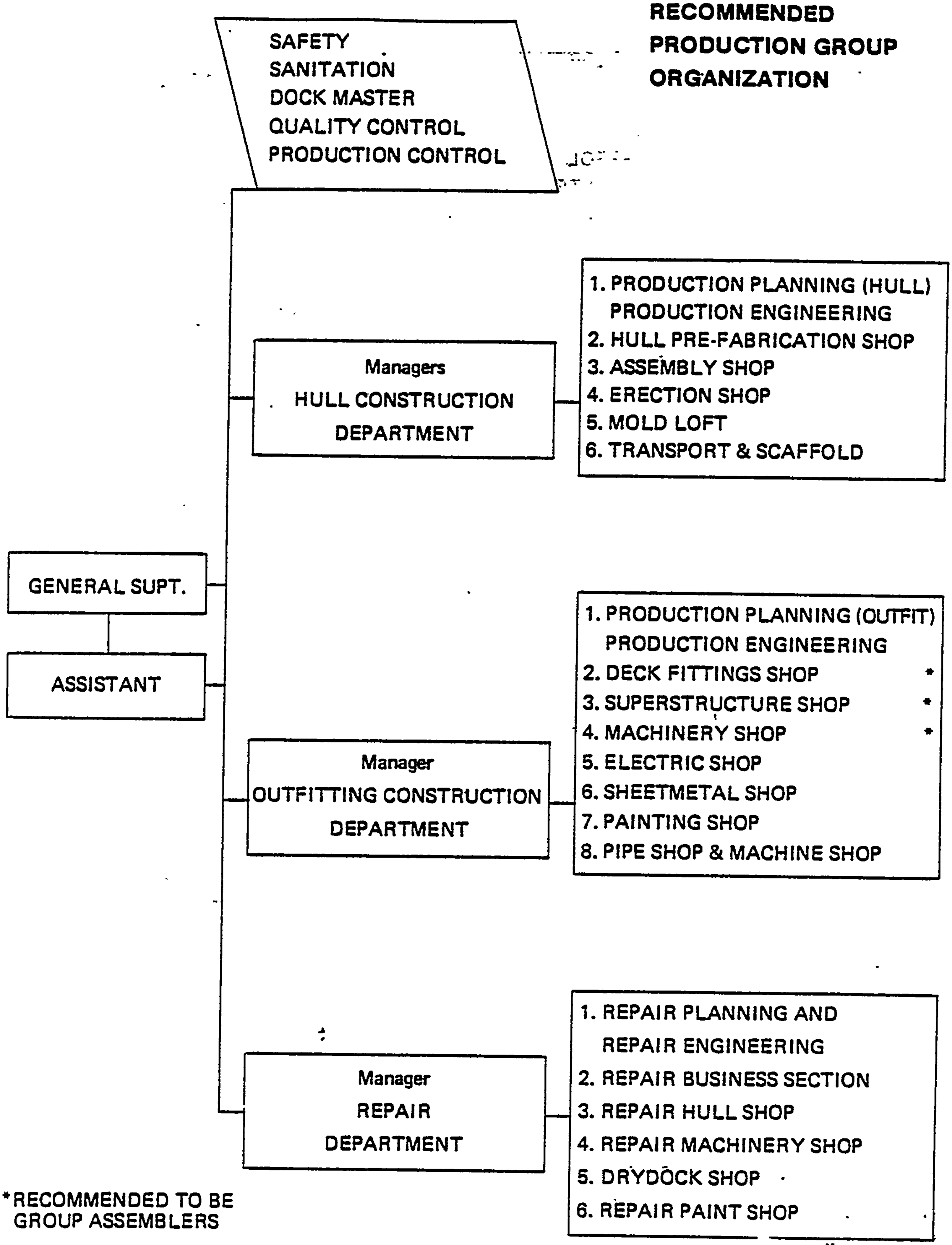
GRAPH of RELATED RECOMMENDED CHANGES

RECOMMENDED PRODUCTION GROUP ORGANIZATION



*RECOMMENDED TO BE GROUP ASSEMBLERS

RECOMMENDED PRODUCTION GROUP ORGANIZATION



*RECOMMENDED TO BE GROUP ASSEMBLERS

33-ZO EXISTING PRODUCTION ORGANIZATION

2 CODE CHANGES MADE TO ACCOMMODATE IHI RECOMMENDATIONS

DRAWINGS

PREVIOUS CODE EXAMPLE

48 - 01 - 11 BILGE & BALLAST SYSTEM

- 48 — PIPING SYSTEM CODE NAVY "S" SYSTEM & MARAD
- 01 — SUB SYSTEM BILGE & BALLAST
- 11 — SERIAL NO. OF DWG.

NEW UNIT COD

06 - 036 - 01 SI U

- 06 — COST CODE PIPING
- 036 — UNIT NO.
- 01 — DRAWING SERIAL NO.

06 - 000 - 01 M T SI U

- 06 — COST CODE PIPING
- 000 — MUTIPLE UNIT DESIGNATION
- 01 — SERIAL NO. OF DRAWING

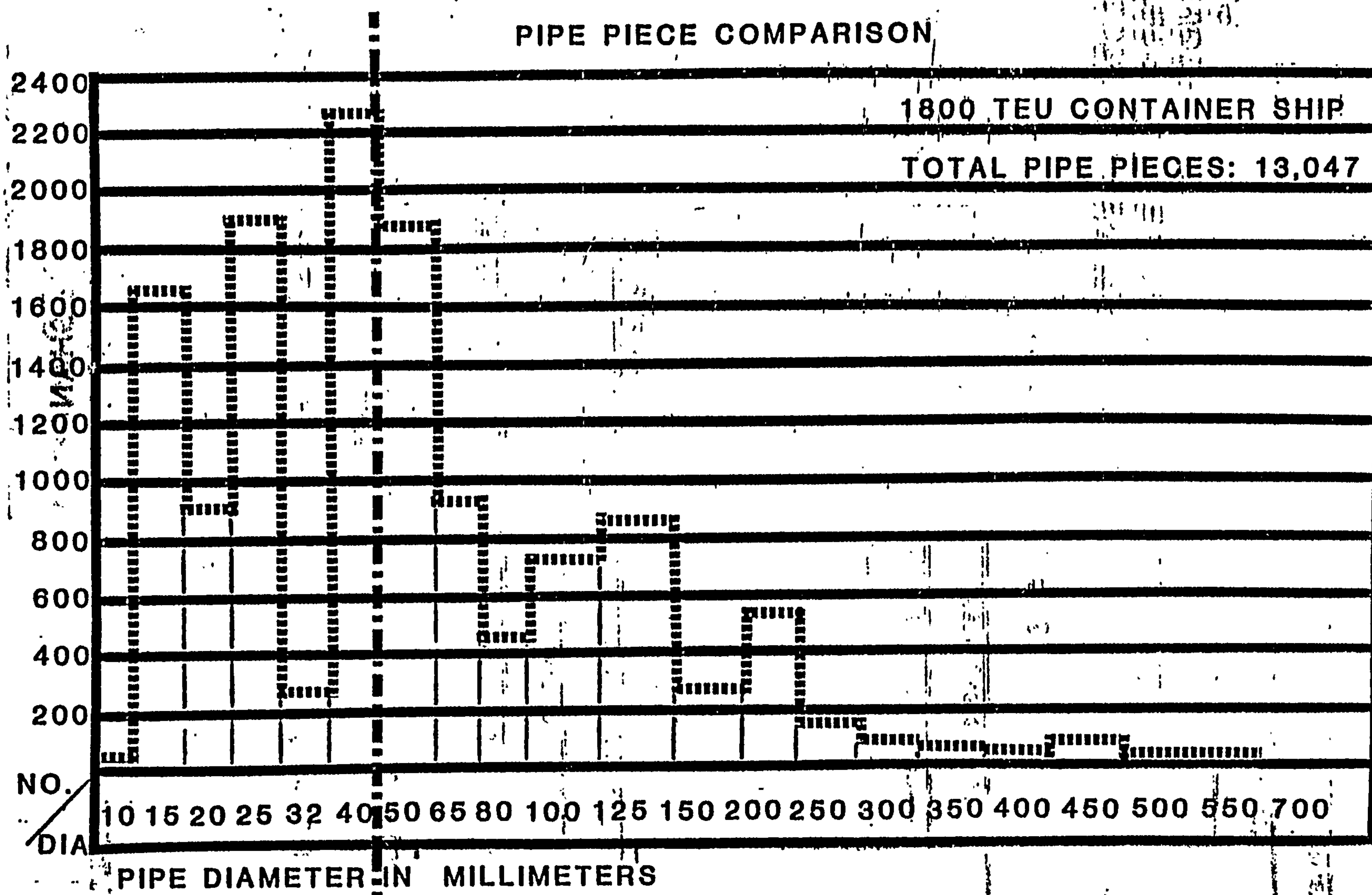
MATERIAL PALLETS

NO CODE — ALL SYSTEM MATERIAL WAS SENT TO THE JOB SITE OR SHOP.

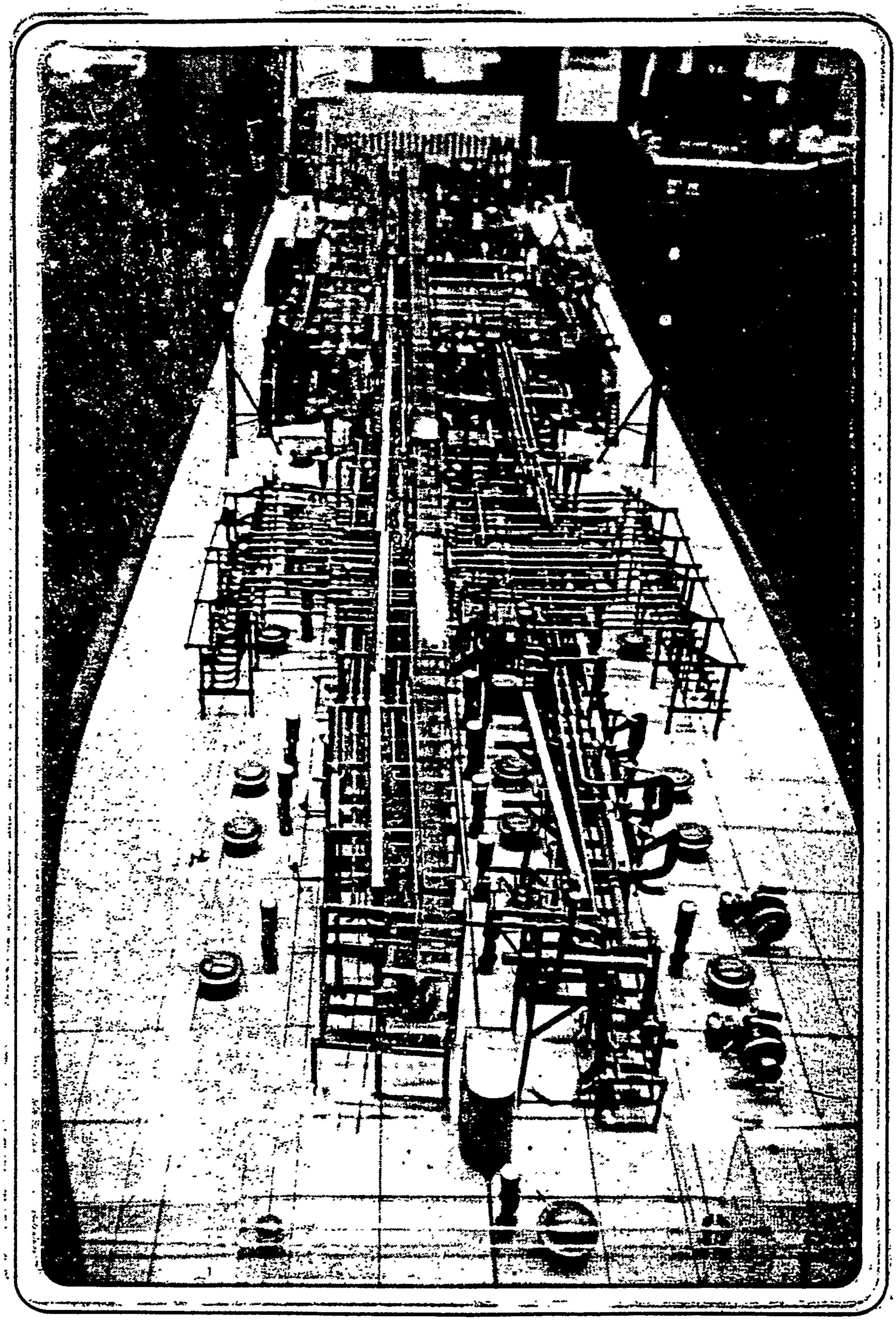
06 - 036 - 01-U

- 06 — COST CODE
- 036 — UNIT NUMBER
- 01 — SERIAL NO. OF PALLET
- U — STAGE – U = BEFORE TURNOVER

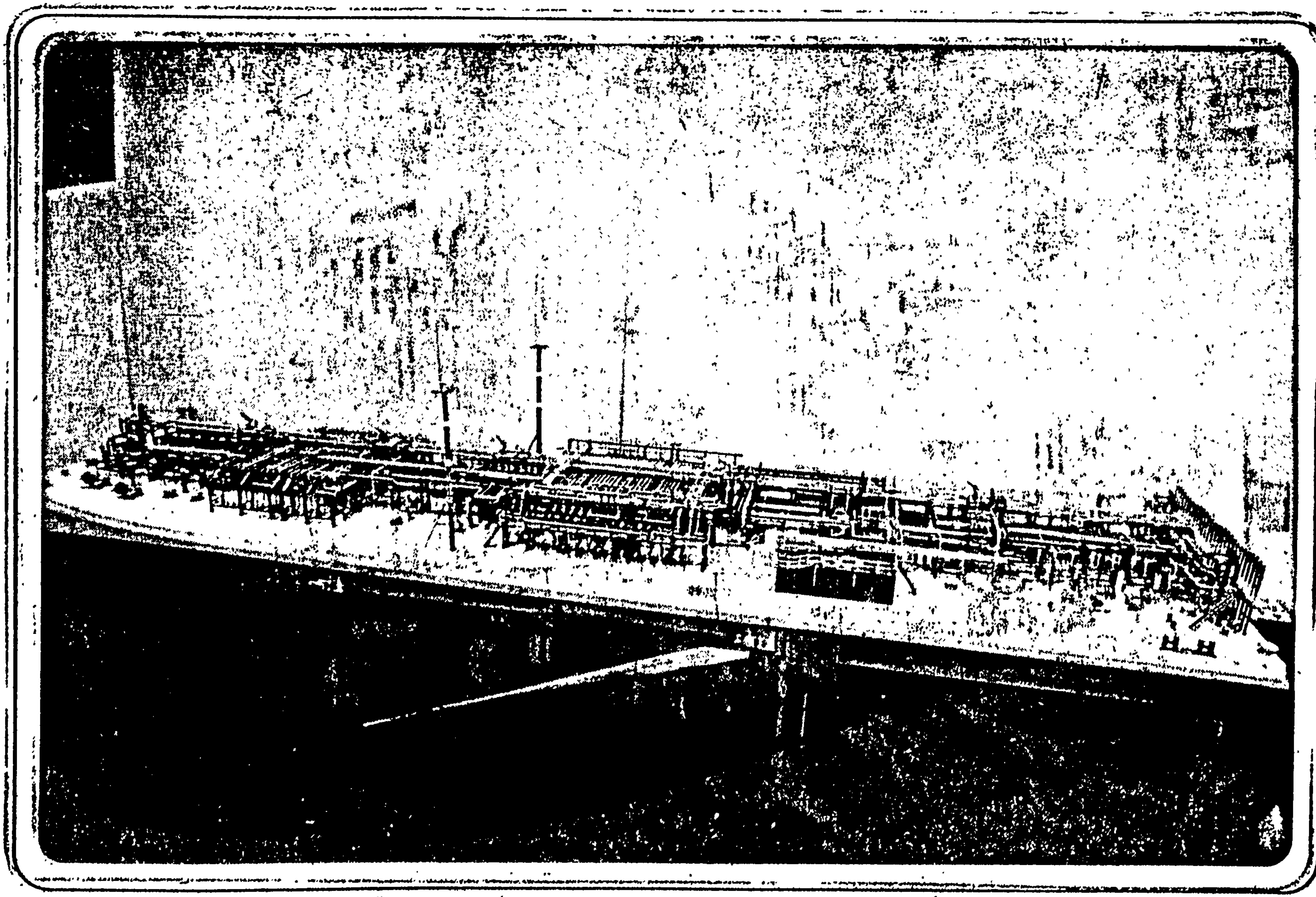
34-70 CHANGES TO DRAWING AND PALLET



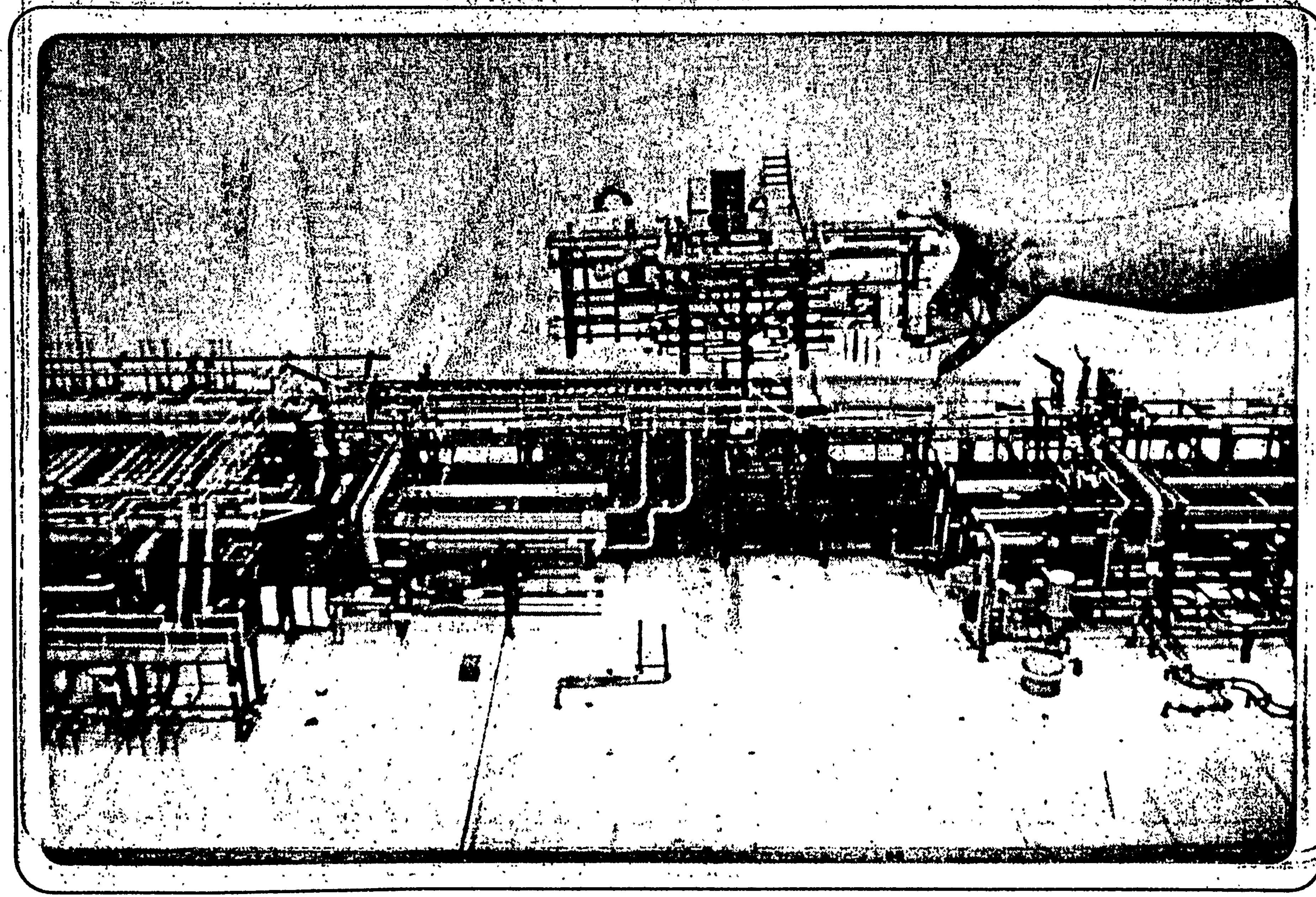
35-ZO PIPE PIECE COI ARISON

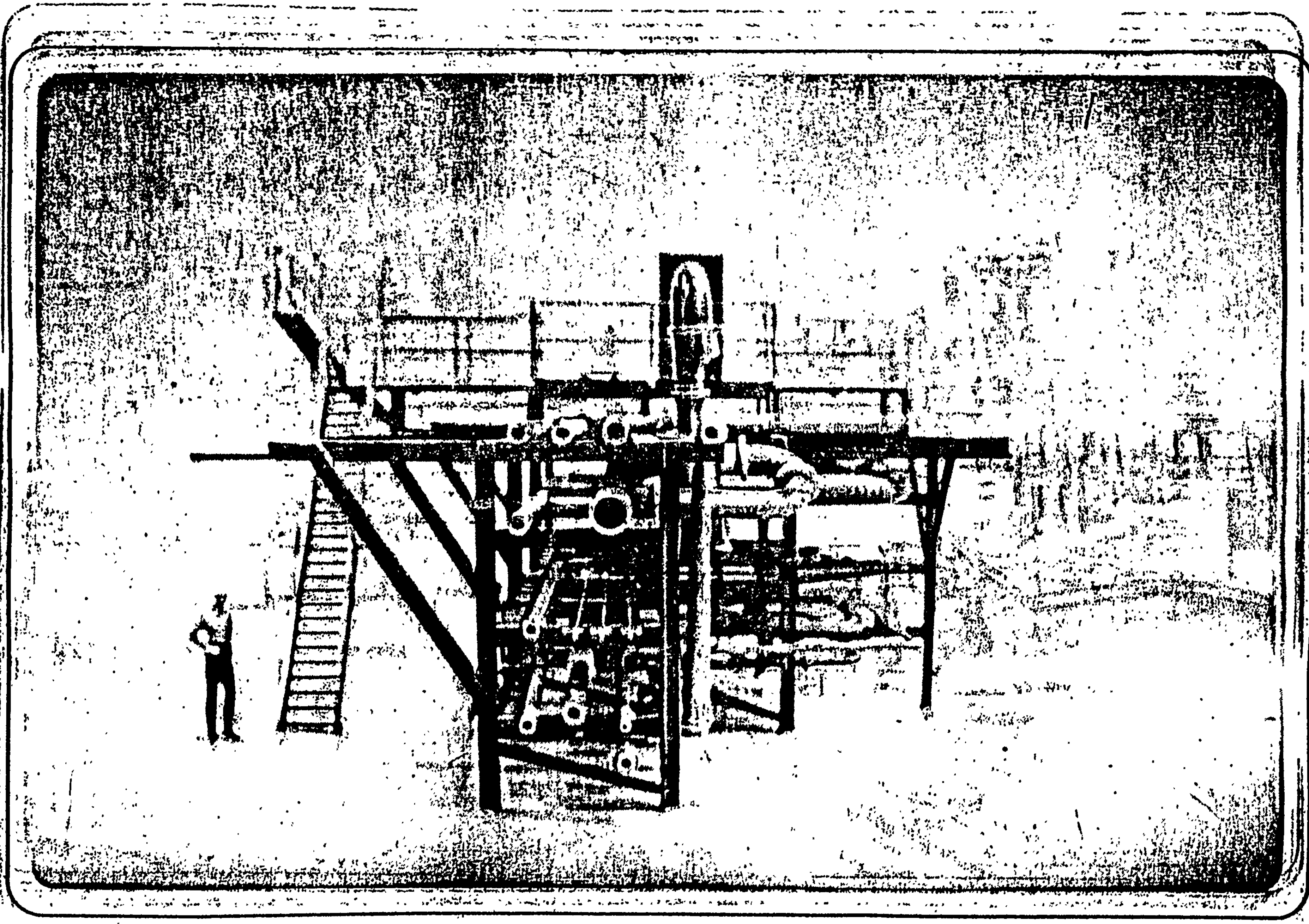


[illegible] OVERVIEW OF PIPE RACK MODEL (E



37-ZO OVERVIEW OF PIPE RACK MODEL (EXXON)





39-ZO 33.5 TON PIPE RACK UNIT

SEMINAR ON ZONE OUTFITTING PRODUCTION PLANNING AND SCHEDULING AVONDALE SHIPYARDS, INC.

Prepared By: C. J. STARKENBURG